TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LTD.

2X660 MW ENNORE Supercritical Thermal Power Project

VOLUME – II – B

TECHNICAL SPECIFICATION FOR

VENTILATION SYSTEM

SPECIFICATION NO.: PE-TS-412-554-A001 Rev 0

BHARAT HEAVY ELECTRICALS LIMITED

POWER SECTOR

PROJECT ENGINEERING MANAGEMENT

NOIDA, INDIA

Anshul S A Khan Praveen Kishore

VOLUME – IIB

SECTIONS	TITLE			Page No
SECTION-A	INTENT OF SPECIFICATION			2-4
SECTION-B	PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA			5-17
SECTION-C	TECHNICAL SPECIFICATIONS			18
	SECTION-C1	SPECIFIC TECHNICAL REQUIREMENT		19-38
	SECTION-C2	CUSTOMER SPECIFICATION		39
		C2 - A	TECHNICAL REQUIREMENT	40-70
		C2 - B	PROJECT SPECIFIC GENERAL REQUIREMENTS INCLUDING:	71-277
			GENERAL TECHNICAL REQUIREMENT	
			PERFROMANCE GUARANTEE TESTS	
			QUALITY ASSURANCE	
			DRAWINGS / DOCUMENTS SUBMISSION PROCEDURE	
			PACKING PROCEDURE	
			PROJECT MANAGEMENT AND SITE SERVICES	
		C2 - C	PAINTING SPECIFICATIONS	278-293
	SECTION-C3	TECHNICAL SPECIFICATION (ELECTRICAL PORTION)		294-360
	SECTION-C4	TECHNICAL SPECIFICATION (C&I PORTION)		361-511
SECTION-D	STANDARD TECHNICAL SPECIFICATIONS			512-553

SECTION-E	ANNEXURE-I	LIST OF MAKES OF SUB-VENDOR ITEMS	554-556
	ANNEXURE-II	MANDATORY SPARE LIST	557-562
	ANNEXURE-III	PAINTING & COLOUR SCHEME	563
	ANNEXURE-IV	LIST OF TOOLS & TACKLES	564-565
	ANNEXURE-V	CLARIFIED WATER ANALYSIS	566-567
	ANNEXURE-VI	DRAWINGS / DOCUMENTS SUBMISSION PROCEDURE	568
	ANNEXURE-VII	INSPECTION AND TESTING	569-572
	ANNEXURE-VIII	MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION	573-576
	ANNEXURE-IX	FORMAT FOR OPERATION AND MAINTENANCE MANUAL	577-580
	ANNEXURE-X	SITE STORAGE AND PRESERVATION	581-596
	ANNEXURE-XI	PACKING PROCEDURE	597

Anshul S A Khan Praveen Kishore

VOLUME-III

SECTIONS	TITLE			Page No
1	LIST OF DOCUMENTS TO BE SUBMITTED WITH BID			599
2	COMPLIANCE CUM CONFIRMATION CERTIFICATE			600-601
3	PRE BID CLARIFICATION SCHEDULE			602
4	NO DEVIATION CERTIFICATE			603-604
5	GUARANTEED POWER CONSUMPTION			605
6	SUGGESTIVE PRICE FORMAT INCLUDING MANDATORY SPARES ALONGWITH PERCENTAGE BREAKUP			606-613
8	**DRAWINGS**			
		DRG TITLE	**DRG NO**	
	a	PID (FLOW DIAGRAM)AIR WASHER & UAF		614-615
	b	TERMINAL DETAIL AND MAKE UP WATER / STEAM SCHEME	PE-DG-412-553-A055	616
	c	PLOT PLAN	PE-DG-412-100-M001	617
	d	MECHANICAL LAYOUT DRAWINGS SHOWING LOCATION OF EQUIPMENT	PE-DG-412-100-M001-M007	618-622
	e	ESP BUILDING	PE-DG-412-100-E008	623
	f	TYPICAL EQUIPMENT ARRANGEMENT DRAWING	PE-DG-412-553-A003	624

VOLUME II B

SECTION-A

INTENT OF SPECIFICATION

1.0 INTENT OF SPECIFICATION

1.1 The specification covers design, engineering, manufacture, supply / procurement, inspection and testing at vendor's / sub vendor's / manufacturer's works, painting, forwarding, proper packing and shipment and delivery at site, unloading, handling & transportation, storage, preservation , security / safety at site , Erection & Commissioning, minor civil & structural (as applicable) works as required on FOR site basis, Performance and guarantee testing / demonstration testing and handing over to BHEL's customer of **VENTILATION SYSTEM** as per details in different sections / volumes of this specification and various pre award agreements for **2X660 MW ENNORE STPP at Kattupalli, Chennai, Tamil Nadu**.

1.2 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve the contractor of the responsibility of providing such facilities to complete the supply, erection and commissioning, performance and guarantee/demonstration testing of **VENTILATION SYSTEM.**

1.3 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to highest standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgement is not in full accordance herewith.

1.4 The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing. Similarly, the extent of supply also includes all Items required for completion of the system and not withstanding that they may have been omitted in drawings / specifications or schedules.

1.5 The general term and conditions, instructions to tenderers and other attachment referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification is subject to compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.

1.6 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under Vol-III of the specification **within 10 days of receipt of tender documents.** In absence of

any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of Purchaser / Customer shall prevail and shall be complied by the bidder without any commercial implication on account of the same. Further in case of any missing information in the specification not brought out by the prospective bidders as part of pre-bid clarification, the same shall be furnished by Purchaser/ Customer as and when brought to their notice either by the bidder or by purchaser/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.

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

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

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

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

1.11 For definition of word like Contractor, bidder, supplier, vendor, Customer/ Purchaser Employer, consultant, please referred relevant clause

SECTION: B

PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA

CHAPTER 1

PROJECT SYNOPSIS

1.0 GENERAL BACKGROUND AND SALIENT FEATURES

1.1 Introduction

Tamilnadu Generation and Distribution Corporation owns the proposed green-field 1320 MW (2 units of 660 MW each) Coal Based Thermal Power Station at Katupalli. This is an expansion of North Chennai Thermal Power Station (NCTPS) and located on some portion of the ashdyke of NCTPS.

1.2 Location

The proposed site for main power plant is located near Ennore port (approx 5 kms).

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

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

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

1.3 Type of Plant

The proposed 2x660 MW Super-Critical Power Project consists of coal fired steam generator connected to a reheat type steam turbine generator along with all the required auxiliaries. Circulating cooling water system is envisaged for condenser cooling.

The description and salient technical data of the Steam Generator, Steam Turbine Generator, Auxiliary systems, Electrical, Control & Instrumentation, Civil etc. are explained elsewhere in the specification:

1.4 PROJECT INFORMATION

Project Title : **2 x 660 MW Ennore SEZ Coal Based Supercritical Thermal Power Project at Ash Dyke of NCTPS**

Owner : **TAMIL N ADU GENERATION AND DI STRIBUTION CORPORATION (TANGEDCO)**

LOCATION

The site is located near Vayalur Village, Ennore

Latitude	:	$13^0$17' N to $13^0$18' N
Longitude	:	$80^0$18' E to $80^0$19' E
Distance from Chennai City	:	35 km
Nearest Airport is at Chennai at a Distance of	:	60 km
Nearest Seaport is	:	Ennore
Nearest Railway Station is	:	Athipattu Pudunagar (approx 5 kms)

Meteorological Condition

Climate : Tropical ,very dry and hot summer, dry and cold winter and good rain-fall in monsoon accompanied with strong wind.

Climatological data :

Ambient temp. (^{0}C)

Annual Maximum Mean Temp	41.5(^{0}C)
Annual Minimum Mean Temp	24(^{0}C)
Design Ambient temperature	35(^{0}C)

Relative Humidity

Maximum	100%
Minimum	36%
Design	75%

Annual Rainfall

Maximum	2540 mm
Average	1600 mm
Minimum	1175 mm

Prevailing Wind Direction

Nov to Jan – From NW & NE

Feb to Mar – From East & SE

Apr to May – From South & SE

June – From SW

July to Aug – From NW

Sept to Oct – From SE & SW

Wind Speed 11.8 kmph (avg)

50 kmph (max)

Seismic Zone III as per IS:1893-2002

1.5 Access to Site

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

1.6 Plant Rating, Capacity, Availability, PLF

Each of the two units shall have a Turbine maximum continuous rating (TMCR) of 660 MW at generator terminals based on the following site conditions.

- Ambient air temperature
- Condenser cooling water inlet temperature of 33°C and 9°C temperature rise across the condenser.
- Generator power factor of 0.85.
- Fuel specification as given elsewhere.
- Design temperature for electrical equipment is 50°C.

The VWO capacity of the steam turbine shall not be less than 105% of TMCR flow at rated parameters. Boiler maximum Continuous Rating (BMCR) will be established to match the steam flow at VWO conditions, but BMCR flow shall not less than 108% of TMCR flow.

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%.

1.7 Power Evacuation

Power will be evacuated from the proposed thermal power station at 400 KV voltage level through 400 KV transmission lines . The power evacuation lines would be double circuit 400 KV lines which will act as Line in & Line out circuit.

1.8 Site Selection

The following factors which influence the project site selection have been found very favourable to establish and operate the project.

a. Availability of fuel.
b. Existing power plant
c. Availability of adequate cooling water.
d. Availability of adequate land for locating the power plant with approach roads.
e. Suitability of land from topographical and geological aspects
f. Proximity of National Highways, Ports & Transport of fuel & heavy equipment.
g. Facility for interconnection with transmission and distribution system for evacuation of power.
h. Environmental aspects.

Total land required for the project is 500 acres which is under the possession of TANGEDCO.

1.9 Fuel

1.9.1 Source of Fuel

Domestic coal requirement for the power plant will be sourced from Kalinga block of Talcher coal fields, Mahanadi and IB valley coal fields in the state of Orissa. Coal will be transported by sea. The port of dispatch and port of receipt for domestic coal would be Paradip port and Ennore port respectively. Imported coal shall be sourced from foreign countries through sea to Ennore port.

Coal can be transported from coal mines to Ennore port by sea and unloaded at proposed coal berth-III. Further the coal can be transported to the proposed power plant through pipe conveyor which shall have a system capacity of 2 x 2000TPH.

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

The analysis of fuel is given below :

1.9.2 Coal Analysis:

Coal Quality Parameters

SL.NO	DESCRIPTION	DOMESTIC COAL	IMPORTED COAL
1.	HIGHER HEATING	2800 (GCV as	6250 (GCV Air

	VALUE -As Fired basis given Kcal/kg	received basis)	dried basis) 5642 (as received basis)
2.	TOTAL MOISTURE %	During rainy season 20% (inherent + surface)	16.5%
3.	HGI Abrasiveness expected YGP Shale and sand stone content Feed coal size	45 to 55 Average 52 50 to 70 mg/kg 20% max. upto 50 mm.	51

DOMESTIC COAL

Sr. No.	Particulars	Units	Parameters
A.	**Proximate Analysis**		
1.	Moisture	%	16.00
2.	Volatile Matter	%	19.00
3.	Ash	%	45.00
4.	Fixed carbon	%	20.00
	Total	%	100
B.	**ULTIMATE ANALYSIS, % (As received)**		
1.	Carbon	%	27.70
2.	Hydrogen	%	2.60
3.	Nitrogen	%	0.52
4.	Oxygen	%	7.26
5.	Sulphur	%	0.50
6.	Ash	%	45.00
7.	Moisture	%	16.00
8.	Carbonates	%	0.38
9.	Phosphorous	%	0.04
10.	Others	%	-
	Total	%	100.00
C.	**Ash f usion temperature**	deg C	
1.	Initial deformation, IT	deg C	1100
2.	Spherical, ST	deg C	1200
3.	Hemispherical, HT	deg C	1300
4.	Fluid, FT	deg C	-
D.	**Ash Analysis, %**		
1.	Sio2	**%**	59.54
2.	Al 2 O3	**%**	29.00
3.	Fe2O3	**%**	6.42
4.	CaO	**%**	1.50
5.	Na2O	**%**	0.08

Sr. No.	Particulars	Units	Parameters
6.	K2O	%	-
7.	TiO2	%	1.60
8.	SO3	%	0.25
9.	P2O5	%	0.51
10.	MgO	%	0.50
11.	Others	%	0.60
12.	Total		100.00
E	**Resistivity of fly ash**	Ohm - cm	1.73x 10^12

IMPORTED COAL

Sr. No.	Particulars	Units	Parameters
A.	**Proximate Analysis (As received)**		
1.	Moisture	%	16.50
2.	Volatile Matter	%	36.45
3.	Ash	%	6.62
4.	Fixed carbon	%	40.43
5	Total	%	100.00
B.	**ULTIMATE ANALYSIS, % (As received)**		
1.	Carbon	%	60.12
2.	Hydrogen	%	4.38
3.	Nitrogen	%	1.48
4.	Oxygen	%	10.37
5.	Sulphur	%	0.53
6.	Ash	%	6.62
7.	Moisture	%	16.5
8.	Carbonates	%	-
9.	Phosphorous	%	-
10.	Others	%	-
	Total	%	100.00
C.	**Ash f usion temperature**	deg C	
1.	Initial deformation, IT	deg C	1230
2.	Spherical, ST	deg C	1270
3.	Hemispherical, HT	deg C	1320
4.	Fluid, FT	deg C	-
D.	**Ash Analysis, %**		
1.	Sio2	%	36.00
2.	Al 2 O3	%	13.90
3.	Fe2O3	%	14.80
4.	CaO	%	12.70
5.	Na2O	%	0.70
6.	K2O	%	1.70
7.	TiO2	%	0.80

Sr. No.	Particulars	Units	Parameters
8.	SO3	%	10.60
9.	P2O5	%	0.20
10.	MgO	%	8.60
11.	Others	%	-
12.	Total	%	100.00

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

S. No.	Particulars	Unit	Parameter
1	Total Moisture (ARB)	%	Up to 23 (Max)
2	Ash (ADB)	%	Up to 20 (Max)
3	Gross Calorific Value (ADB)	Kcal / Kg	5800 - 6500
4	Sulphur (ADB)	%	Up to 1 (Max)
5	Fixed Carbon (ADB)	%	30-50
6	Volatile Matter (ADB)	%	25-45
7	HGI		45-60
8	IDT (Under Reducing Atmosphere)	Deg C	1100-1250
9	Size	mm	< 50

Note: ADB stands for “As dried Basis” and ARB for “As Received Basis”

1.9.3 Specification of LDO

Specific gravity @ 15° C	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 Vol. Max. %	0.25

1.9.4 Specification of HFO

Flash point “°C” min.	66
K. Viscosity in Centistokes @ 50° C max.	370

Ash by wt. %	0.1
Water content by volume % max	1
Sediment by weight % max	0.25
Total Sulphur by weight % max	4.5
Gross calorific value, Kcal/kg	10800

1.9.5 Fuel Linkage

TANGEDCO has approached Ministry of Coal through Ministry of Power for the long term linkage of Coal from the coal sources of Talcher or Mahanadi in Orissa.

The coal requirement has been worked as under:-

Coal required at MCR per hr. (Blended) 872 tonnes

Per day	20928 tonnes.
Annual	6.5 MTPA for 85% PLF

1.9.6 Fuel Transportation

The coal shall be received at Ennore port. The coal will be transported by pipe conveyor from coal berth 3 in Ennore Port and then through 2 x 2000 TPH pipe conveyor to the bunker directly or to stockyard.

1.10 Source Of Water

1.10.1 Source

The raw water intake shall be from the existing cooling water forebay of NCTPS PHASE-II.

1.10.2 Chemical analysis of Sea Water:

As given in Annexure-1, Volume III, Chapter- 3.

1.10.3 Requirement

The requirement of water for the plant will be for meeting the requirement of make up for the re-circulating cooling water system, dust suppression system in coal handling plants, ash disposal system and the RO/ D.M. water plant which will be supplying the power cycle make up requirements, etc. In addition the water requirements will be for drinking and service purposes. Water requirement is estimated as approx. 15523 m^3/hr.

1.11 Source of Equipment

The proposed plant will be supplied, erected and commissioned on Single EPC basis.

1.12 Power Evacuation Plan

Power will be evacuated from the proposed thermal power station at 400 KV voltage level through 400 KV transmission lines . The power evacuation lines would be double circuit 400 KV lines.

1.13 400 KV GIS Switchyard

The 400 KV Switchyard is proposed to have one and a half bus arrangement and will comprise following bays/circuits :

- 2 – Generator transformer bays
- 1– Start up transformer bay
- 4 – Line Bays
- 2 – Bus VT's
- 2 – Bus Reactor Bays
- 2 – Spare bay (Equipped)
- 1 – Equipped bay for future GT
- 2 – Equipped bays for future lines

The switchyard will be complete with galvanized steel structures, lightning surge arrestors, OPGW Equipment, CTs, PTs of suitable VA burden and accuracy class as required for measurement protection and communication, insulators, bus-bars clamps & hard wares etc. The switchyard will be controlled by computerized control and data acquisition (SCADA) system.

1.14 Average Yearly Generation

The average yearly generation is calculated considering the following.

- The expected plant load factor is 85 %. With this PLF the average yearly generation will be around 11914 Million units.

1.15 INFORMATION FOR ENVIRONMENTAL APPRAISAL

1.0 GENERAL IN FORMATION ABOUT THE PROJECT

1.1	Name / Title of the Project	:	2 x 660 MW Ennore SEZ Coal Based Supercritical Thermal Power Project at Ash Dyke of NCTPS
1.2	Name of Owner	:	Tamilnadu Generation and Distribution Corporation (TANGEDCO)

1.3	Location of the Project	:	Near Vayalur Village, Ennore, Tamil Nadu
1.4	Site where proposed plant is to be located	:	Ash dyke of NCTPS
1.5	Capacity of the project under consideration	:	2x 660MW
1.5.1	Govt. land / Private land / others	:	TANGEDCO land
1.5.2	Topographical feature, demographic profile & physiography	:	Site has differential levels and require filling to maintain the desried grade level of +10.00 meter above MSL
1.5.3	Nature of soil	:	Clayey soil
1.5.4	Distance from the nearest town / city / major human settlements	:	Chennai -35 km
1.5.5	Population to be displaced	:	Nil
1.5.6	Distance from water source	:	Approx. 5 km (from Cooling Water Forebay of NCTPS Stage II)
1.5.7	Area of forest land, if involved	:	Nil
1.5.8	Distance of forest from the site	:	N.A
1.6	Is this an extension? If so indicate capacity of existing plant	:	No
1.7	What is the ultimate capacity envisaged	:	2x660 MW
2.0	**GENERAL ENVIRONMENTAL INFORMATION**		
2.1	Area of the land proposed to be acquired	:	Refer Plot Plan Land already acquired
	i. Area required for plant	:	500 Acres
	ii. Ash disposal	:	100 % dry fly ash disposal and

			100% wet bottom ash disposal is envisaged to existing ash pond.
	iii. Plant facilities	:	The area is adequate for locating all the required systems for 2x660 MW.
2.2	Area proposed to be built-up or developed	:	Power station will be built-up in the proposed site as indicated in the plot plan.
2.3	Specify site characteristics River basin/ estuarine / coastal / others	:	Site is close to Buckingham Canal
2.4	Is the site situated in the forest area? Give following details	:	No
2.4.1	Area	:	N.A
2.4.2	Type of forests	:	N.A
2.5	Is site situated near to the forests? Give the distance from the site.	:	N.A.
2.6	Give a description of the flora within 25 km of your plant site under the following heads	:	
	a. Crops	:	Refer details in the specification elsewhere.
	b. Forest	:	
	c. Grass land	:	
	d. Endangered species	:	
	e. Others (Specify)	:	
2.6.2	Give details of the following features, if they exist, within a radius of 25 km of the proposed site?	:	
	i. Fisheries	:	
	ii. Sanctuary / natural park biosphere reserve	:	
	iii. Lakes / ponds / reservoir	:	
	iv. Stream / river	:	Buckingham canal is close to the site
	v. Estuary / sea	:	Bay of Bengal is 5 km from site

	vi.	Hills / mountains	:
	vii.	Historic / cultural / tourist / archaeological scenic sites / defence installations	:
2.7		Human settlement	:
2.7.1		Total number of persons proposed to be employed	:
	i.	During construction	: 2500 450(0.75person/MW) TANGEDCO
	ii.	During operation	: direct employees

SECTION: C

TECHNICAL SPECIFICATIONS

SECTION: C1

SPECIFIC TECHNICAL REQUIREMENT

1. FUNCTION

1.1. The purpose of the system is to provide Ventilation System for different areas of **2 x 660 MW**, ENNORE STPP under the scope of BHEL.

2. SYSTEM DESCRIPTION

2.1. The Ventilation System is provided in the following locations within the Power House by Air washers. Coursing of air in desired direction / areas shall be made by using roof extractors and wall mounted exhaust fans.

2.2. Please refer to clause 19.5.2 & 19.7 and other relevant clauses of customer technical specifications **section C-2A** for other detail of system description.

2.3. Bunker bay tripper Floor, Coal Terminal Floor and Mill bay will be ventilated by exhausting air with the help of Roof Extractor Fans.

2.4. SWAS room (wet panel area)

2.5. Battery and Battery charger room (220V DC)

2.6. Hot air from electrical rooms will be exhausted outside through back draft dampers. Such hot air will not return to TG Hall.

3. DESIGN CRITERIA

3.1. System Design Criteria

3.1.1. The outside design conditions considered are as follows:

	Summer	Monsoon	Winter
DBT (°C)	47	28.3	18.3
WBT (°C)	27.7	26.7	13.8

3.1.2. The inside design conditions:-

3.1.3. In the areas ventilated by evaporative cooling units, the inside dry bulb temperature shall be restricted to 5°C less than the summer ambient temperature (DB).

3.1.4. In dry type forced (mechanical) ventilation system, the inside temperature shall be restricted about 3°C higher than the summer ambient (outside) temperature (DB).

3.1.5. The ventilation philosophy in various areas shall be as under:

S No.	Area	Air Changes
i.	For all evaporative type ventilation system	8
ii.	General areas	15
iii.	Various pump houses	20
iv.	Switch gear / MCC rooms.	25
v.	Battery rooms & other areas where gaseous fumes are generated	30
vi.	Chlorination plant building	30
vii.	D G set room	45

*In addition to above mechanical ventilation for other auxiliary buildings under BHEL scope shall also be provided.

3.1.6. All equipment shall be designed for continuous duty.

3.1.7. The ducting shall be sized to have constant friction drop along its length with air velocity in the ducts normally not exceeding 12 m/sec for ventilation system. However the air velocity shall be increased more than 12 m/sec., in case of neck formation / transmission piece not exceeding one meter of length.

3.1.8. Motorized type electrically operated fire dampers of 2 hours fire rating shall be provided in the ventilation supply air ducting leading to electrical rooms like switchgear rooms, cable spreader rooms etc. These dampers shall be operated with the help of signal from smoke detectors/ thermal sensors.

3.1.9. The air washer shall be designed for 90% saturation efficiency.

3.1.10. Efficiency of UAF shall be 60%.

3.1.11. For hazardous areas, fans with anti-spark characteristics shall be provided.

3.1.12. The fan capacities shall be decided on the basis of actual heat load or specified minimum air change rate, whichever is higher.

3.1.13. Please also refer to clause no. 19.4 and other relevant clauses of Customer technical specification section C-2A for design criteria.

4. LAYOUT CONSIDERATIONS

4.1.1. A total of 8 Nos. Air washers each of 250000 CMH capacity shall be provided for both the units 1 & 2. Each air washer with 2x50% duty Centrifugal Fans each of 125000 CMH. The tentative location of these air washers shall be as under.

4.1.2. 4 Nos. Air Washers shall be located outside the TG Hall A- row. 4 No Air Washer shall be located in BC Bay at 24.0 M between column No. 2-5 for Unit#1 and in CD bay at 33.0 M between Column No. 13-16 for unit#2.

4.1.3. Please refer to clause no. 19.8.9, and other relevant clauses of Customer technical specification section C-2AA for details of construction layout for Air washer.

4.1.4. 1 No UAF (1 x 100%) of capacity 100000 CMH shall be provided for each ESP Building of Unit-1 & 2. These UAF shall be placed in open at Roof level.

4.1.5. Total 28 nos. Roof Extractor units of each capacity 50000 CMH for TG hall shall be provided on the TG Hall roof.

4.1.6. For oil room ventilation please refer to clause no. 1.10.00 of Customer technical specification section C-2A.

4.1.7. For other areas fans shall be provided as elaborated in point No 3.1.5 above

5. EQUIPMENT AND SERVICES TO BE PROVIDED FOR VENTILATION SYSTEM

5.1. Air washer

5.1.1. Each air washer unit shall comprises of:

5.1.2. Please refer to clauses no 19.8.9 with other relevant clauses of Customer technical specification section C-2A for Air washer construction.

5.1.3. Individual air tight inspection door with ladder and cat walk is to be provided for different section of the air washer unit, marine light (2 Nos.) in each section.

5.1.4. Low Level switch for Air washer sump.

5.1.5. Inter connecting GI piping between centrifugal pump sets (both HSC and Monoblock) and air washer unit spray headers/ sump, with necessary supports and supporting structure.

5.1.6. Efficiency of centrifugal fan and pump shall not be less than 70%.

5.1.7. Electrical feeder suitable for following motor rating shall be provided for Air washer equipment. Vendor to ensure that motor rating is not more than the rating mentioned below.

Sr. no.	Items	Motor rating (Kw)
1.	Centrifugal fan (85,000 CMH / 75 mmWC SP)	30
2.	Centrifugal pump (275 CMH / 30 m head) (min.)	33

5.2. UAF

5.2.1. Each UAF shall comprise of:

5.2.2. Please refer to clause no 19.8.10 with other relevant clauses of Customer technical specification section C-2A for UAF construction.

5.2.3. Marine light (2 Nos.) in each section.

5.2.4. Efficiency of centrifugal fan and pump shall not be less than 70%.

5.2.5. Electrical feeder suitable for following motor rating shall be provided for UAF equipment. Vendor to ensure that motor rating is not more than the rating mentioned below.

Sr. no.	**Items**	**Motor rating (Kw)**
1.	Centrifugal fan (1,00,000 CMH / 75 mmWC SP)	37
2.	Centrifugal mono block pump (110 CMH / 30 m head) (min.)	13.2

5.3. Wall mounted axial flow fan

5.3.1. Each wall mounted axial flow fan shall be complete with

5.3.2. Please refer to clause no 19.8.14 with other relevant clauses of Customer technical specification section C-2A for detail construction of axial flow fan.

5.3.3. The speed of fans shall not exceed 960 rpm for fan with impeller diameter above 450 mm and 1400 rpm for fan with impeller diameter 450 mm or less. However for fans having static pressure of 30 mm WC or above the speed of the fan shall not exceed 1440 rpm for fan with impeller diameter of above 450mm and 2800 rpm for with impeller diameter of 450 mm or

less. The first critical speed of rotating assembly shall be at least 25% above the operating speed.

5.3.4. Adjustable damper, vibration isolators, nuts and bolts, back draft dampers etc. Shall be provided.

5.3.5. These fans shall cater to the areas as indicated in the fan schedule of ventilation system.

5.4. Centrifugal flow fan units

5.4.1. Each centrifugal fan shall be complete with:

5.4.2. Please refer to clause no 19.8.12 with other relevant clauses of Customer technical specification section C-2A for detail construction of centrifugal fan.

5.4.3. Centrifugal fans shall be provided with Variable frequency drive (VFD) and velocity sensor/static pressure sensor in supply air path to adjust air flow automatically. The minimum efficiency of VFD at full load shall not be less than 96%.

5.4.4. Removable drain plug with fan casing.

5.4.5. These fans shall cater to the areas as indicated in the fan schedule of ventilation system.

5.5. ROOF EXTRACTOR UNIT:

5.5.1. Each roof extractor unit shall be complete with:

5.5.2. Please refer to clause no 19.8.13 with other relevant clauses of Customer technical specification section C-2A for detail construction of RE Unit.

5.5.3. Foundation bolts including screen at bottom.

5.5.4. RE / wall mounted fans shall be selected so as to have motor rating as under:

5.6. All supply / Exhaust Air ducting

5.6.1. Air distribution from Air Washers and UAF would be done through ducting system, grilles and diffusers. Ducts shall be made of GI sheets of class 275 as per IS: 277 (i.e., having Zinc coating 275 gm/ m2). All ducting shall be designed on equal friction method and fabricated as per IS: 655.

5.6.2. Please also refer to clause no. 19.8.7 with other relevant clauses of Customer technical specification section C-2A for detail construction of ducting.

5.7. Insulation

5.7.1. Thermal insulation shall be provided for the duct exposed to sun / rain only.

5.7.2. 50 mm thick fibre glass rigid board (density 48 kg/cum and TF quality) finished with 26 swg aluminium cladding shall be provided on all ducting exposed to atmosphere

5.7.3. Please also refer to other relevant clauses of Customer technical specification section C-2A for detail construction of Insulation.

5.8. WATER PUMP SETS

5.8.1. Each circulating water pump set for air washer and UAF shall comprise of the following

5.8.2. Back pull out / Horizontal Split Casing centrifugal pump of adequate capacity to match the system requirement for air washer spraying arrangement and mono-block type pump sets for circulation of water through fill deck arrangement & Back pull out / Split Casing Centrifugal Pump of adequate capacity to match the system requirement for UAF.

5.8.3. One no. adequately sized TEFC sq. cage induction motor suitable for 415V, 3 phase, 50 Hz AC supply.

5.8.4. One no. Pot type strainer at inlet complete with screen, drain arrangement etc.

5.8.5. 150 mm dia. Dial Type pressure gauges one each at suction & discharge side of the pump set.

5.8.6. Gate valve, one each at suction and Globe valve, one each at discharge side of the pump set.

5.8.7. One no. non-return (check) valve at discharge side of pump set.

5.8.8. One set of base plate, coupling, coupling guard, anti-vibration mountings, foundation bolts etc.

5.8.9. Rain protection canopy for the pumps and motors, if located at outdoor shall be provided.

5.8.10. Please also refer to clause no 19.8.4 with other relevant clauses of Customer technical specification section C-2A for detail construction of water pump.

5.9. CONTROL PHILOSOPHY

5.9.1. Ventilation system control shall be done with common PLC located at 0 m in AC plant room 1.

5.9.2. Air washer units shall be start/stopped by initiation from the local panel and the starting/stopping of fans and pumps shall be automatic upon such initiation.

5.9.3. The fans (both supply and exhaust fans) associated with mechanical ventilation system shall be operated locally.

5.9.4. Auto / Manual selector switches and working / standby selector switches for the pump shall be provided in the panel.

5.9.5. A selection switch enabling the running of AWU fan or pump alone shall be provided.

5.9.6. The fire damper shall close the air flow inside the duct on receiving fire alarm signal from FPS. Also respective fan shall trip once the fire damper is closed

5.9.7. Supply air fans, exhaust air fans / roof extractor units of each area shall be provided with their local starter panel.

5.9.8. Please also refer to clause no 19.8.18 with other relevant clauses of Customer technical specification section C-2A for detail construction of water pump.

5.10. INDICATIONS PROVIDED FOR AIR WASHERS / UAF IN LOCAL CONTROL PANEL

5.10.1. FAN RUNNING

5.10.2. FAN STOP

5.10.3. PUMP - 1 RUNNING

5.10.4. PUMP - 1 STOP

5.10.5. PUMP - 2 RUNNING

5.10.6. PUMP - 2 STOP

5.10.7. FAN MOTOR OVERLOAD.

5.10.8. PUMP - 1 MOTOR OVERLOAD.

5.10.9. PUMP - 2 MOTOR OVERLOADS.

5.10.10. 'RH' HIGH.

5.10.11. 'RH' LOW.

5.10.12. The water sump of each Air Washer / Unitary Air Filtration Units shall be provided with a low level switch which will initiate an alarm and will trip the pump sets, in case the water level falls below the predetermined level.

5.10.13. At the delivery pipe of each pump, a pressure switch will be provided along with the pressure indicator.

5.10.14. Relative Humidity inside the ventilated areas shall be displayed digitally on the local control panel

5.10.15. Individual Fan Running / stop Indications should be provided

5.10.16. Individual Pump Running /Stop indications for both spray pumps and cell deck pumps should be provided

5.11. HUMIDITY CONTROL

5.11.1. FOR AIR WASHER

To protect the equipment located in the ventilated space from effects of high humidity, control device using Humidistat interlocked with the Pump Motor of the Fill Section shall be used in the electrical areas. Humidity beyond 60% RH in these ventilated space shall automatically trip the respective AWU pump for fill section only. The pump may be restarted automatically at about 50% RH. Selection and starting of stand-by pump shall be manual.

At least two (2) nos. Humidistat (RH High and Low) shall be provided for each Air Washer Unit. However, manual over riding facility shall be provided for humidistat controlled Pump sets of the Air Washer Unit.

5.11.2. UAF

To protect the equipment located in the ventilated space from effects of high humidity, control device using Humidistat interlocked with the Pump Motor of shall be used in the electrical areas. Humidity beyond 60% RH in these ventilated space shall automatically trip the respective UAF pump. The pump may be restarted automatically at about 50% RH. Selection and starting of stand-by pump shall be manual.

At least two (2) nos. Humidistat (RH High and Low) shall be provided for each UAF Unit. However, manual over riding facility shall be provided for humidistat controlled Pump sets of the UAF Unit.

5.12. Fire damper

Motorized type electrically operated fire dampers shall be provided in the ventilation supply air ducting/ fans leading to electrical rooms like various MCC rooms, switchgear rooms, cable spreader rooms and in the exhaust path of oil room and oil tank area. These dampers shall be operated with the help of signal from smoke detectors/ thermal sensors (These automatic dampers shall be interlocked suitably with fire alarm system and shall also possible from control panel room remote location). Motors shall remain energized in the normal condition to effect opening of dampers. In the event of fire, the motors shall be de-energized and the damper shall close due to spring action.

6. SPECIFIC REQUIREMENTS:-

6.1.1. The system shall be design to maintain specified inside design conditions during peak summer under design outdoor condition.

6.1.2. All ventilation system shall operate on 100% fresh air.

6.1.3. The air washer shall have minimum 90% saturation efficiency and UAF shall have 60% saturation efficiency.

6.1.4. Ventilation ducts shall be provided with motorized type fire dampers at the supply duct in electrical area like MCC / Switch gear room/ cable spreader room in power house building, as well as Electrical areas of ESP/VFD Building which will close in case of fire. Fire Damper shall have fire rating minimum 120 minutes.

6.1.5. The fire damper shall close the air flow inside the duct on receiving fire alarm signal from FPS. Also respective fan shall trip once the fire damper is closed.

6.1.6. Velocity of air in duct shall not normally exceed 12 m/sec for main duct, 9.0 m/sec for branch duct. However higher velocity of air shall be selected in case of layout constraint to run the ducting.

6.1.7. Air Velocity through different system equipment should be maintained as follows:

- AWU/UAF Units shall be designed for a max face velocity: 2.0m/s
- Exhaust Louver: 2m/s through face area (Max.)
- Volume Control dampers: 10m/s through face area (Max.)
- Back Draft dampers: 6m/s across damper (Max.)
- Fill deck Section: 2.25m/s through face area (Max.)
- Moisture eliminators: 2.5m/s through face area (Max.)
- Supply Air Grills/Diffusers: 3.75 m/s through face area (Max.)

6.1.8. For pumps, fans and blowers, continuous motor rating (at 50 C ambient) shall be at fifteen percent (15%) above the demand of the equipment at duty point or ten percent (10%) above maximum load demand of the equipment whichever is higher.

6.1.9. All the pumps shall have 10% margin on capacity and head over the actual requirement.

6.1.10. All fans shall be selected with non-overloading characteristics as far as practicable and the respective drive motor shall have a rating more than the limit load of the fan or at least 20% higher than the brake horse power, which is higher.

6.2 RE / wall mounted fans shall be selected so as to have motor rating and wall / slab opening as under. Feeder suitable for following ratings only shall be provided by BHEL.

1.	Roof extractor units with 15 mmwc static pressure.		
	Capacity	Motor rating	Roof / Slab opening
a.	50,000 CMH	5.5 KW	1320mm
b.	40,000 CMH	5.5 KW	1320mm
c.	20,000 CMH	2.2 KW	1140mm
2	Axial flow supply fans with 30 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	10,000 CMH	2.2 KW	800mmx800mm
b.	7,500 CMH	1.5 KW	700mmx700mm
c.	6,000 CMH	1.1 KW	600mmx600mm
d.	4,000 CMH	0.75 KW	500mmx500mm
3	Axial flow supply fans with 20 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	10,000 CMH	1.5 KW	800mmx800mm
b.	7,500 CMH	1.1 KW	700mmx700mm
c.	6,000 CMH	1.1 KW	600mmx600mm
d.	4,000 CMH	0.75 KW	600mmx600mm
4	Axial flow exhaust fans (Bifurcated type) with 15 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	15,000 CMH	2.2 KW	900mmx900mm
b.	10,000 CMH	1.5 KW	800mmx800mm
c.	7,500 CMH	1.1 KW	700mmx700mm
d.	2,000 CMH	0.55 KW	500mmx500mm
5	Axial flow exhaust fans with 10 mmwc static pressure.		

	Capacity	Motor rating	Wall opening
a.	15,000 CMH	1.1 KW	900mmx900mm
b.	10,000 CMH	0.75 KW	800mmx800mm
c.	7,500 CMH	0.55 KW	700mmx700mm
d.	6,000 CMH	0.55 KW	600mmx600mm
e.	2,000 CMH	0.37 KW	500mmx500mm
6	Exhaust fan (propeller type) with 5 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	1200 CMH	100 W	300 mm circular

7. MATERIALS OF CONSTRUCTION

7.1. CENTRIFUGAL FAN

7.1.1. Please refer to clauses no 19.8.12 with other relevant clauses of Customer technical specification section C-2A for MOC of centrifugal fan.

7.1.2. Fan Casing (side plates & stiffeners): Mild Steel Sheets/plate to IS: 2062 Gr.B / IS: 1079 /Eq. or heavy gauge galvanised sheet steel. The minimum thickness of casing shall be 3 mm.

7.1.3. Shaft: EN - 8 or eqv.

7.1.4. Shaft sleeve: EN - 8 or eqv.

7.1.5. Flexible connection at outlet/inlet: Fire resistant type plastic impregnated canvas with M.S. flange and cleats (3 mm thick).

7.1.6. V Belt (matched sets): ISI marked (Reinforced rubber section to (IS: 4776)

7.1.7. Bolts & nuts: Galvanized / MS (Epoxy painted).

7.1.8. Vibration isolating cushy foot mountings, foundation bolts and nuts etc.

7.2. AXIAL FAN

7.2.1. Please refer to clauses no 19.8.14 with other relevant clauses of Customer technical specification section C-2A for MOC of axial flow fan.

7.2.2. Casing : heavy gauge sheet steel – 3 mm thk for fan dia upto 750 mm 5mm thick for fan dia of 750 mm and above as per IS:1079 / IS:2062 Gr.B

7.2.3. Hub: As per manufacturer std. (AL- LM6)

7.2.4. Neoprene rubber pads: As required.

7.2.5. Supporting frame for mounting: Required.

7.2.6. Protective screen at inlet: Yes (Min 14 SWG Galvanized wire knitted in 1" square mesh).

7.2.7. Mounting flange on casing: At inlet and outlet.

7.2.8. Painting / protecting coating – All the MS parts shall be spray galvanised or hot dip galvanised.

7.3. ROOF EXTRACTOR UNIT

7.3.1. Please refer to clauses no 19.8.13 with other relevant clauses of Customer technical specification section C-2A for MOC of RE Unit.

7.3.2. Casing : Mild steel – 3 mm thk for fan dia upto 750 mm, 5mm thick for fan dia of 750 mm and above as per IS:1079 / IS:2062 Gr.B

7.3.3. Impeller : Cast aluminium.

7.3.4. Casing/cowl/hood: (Spray / hot dip galvanised M.S. Sheet to IS: 2062 Gr.B (Short duct casing).

7.4. AIR WASHER

7.4.1. Please refer to clauses no 19.8.9, c with other relevant clauses of Customer technical specification section C-2A for MOC of Air washer.

7.4.2. Moisture Eliminators plates: 24G thick GS sheets class 350 or from 100% virgin PVC of minimum finished thickness of 3 mm.

7.4.3. The PVC eliminators shall be UV stabilised using Titanium di-oxide and shall withstand the weathering test as per IS: 4892 for 500 hrs.

7.4.4. The distribution plate shall be fabricated out of 16G galvanized steel sheet & galvanized steel angle supports with minimum 50% free area.

7.4.5. The spray nozzles shall be of brass or bronze with chrome plating.

7.4.6. Tank: MS plate of minimum 6 mm thick and inside and outside surface of the casing and tank shall be spray galvanized. Min depth -600mm.

7.4.7. Suitable number of brass screen shall be provided in the air washer tank to arrest the dirt entering the circulating water pump suction.

7.5. Unitary Air Filtration

7.5.1. Please refer to clauses no 19.8.10, 19.8.10with other relevant clauses of Customer technical specification section C-2A for MOC of UAF.

7.5.2. Moisture Eliminators plates: 24G thick GS sheets class 350 or from 100% virgin PVC of minimum finished thickness of 3 mm.

7.5.3. Suction Screen Water: Brass.

7.6. Air Filters

7.6.1. PRE FILTER

7.6.2. Please refer to clauses no 19.8.5with other relevant clauses of Customer technical specification section C-2A for MOC of Filter.

7.6.3. Filter Media: Fibrous material (extruded polyethylene) or felt filter: Dry types with element of 5 ply construction for fabric type.

7.6.4. Efficiency: Average arrestance of 65-80% when tested in accordance with BS: 6540 / ASHRAE – 52-76.

7.6.5. Allowable pressure drop : Initial pressure drop – Not to exceed 5.0 mm WC at rated flow. Final pressure drops- Up to 7.5 mm WC.

7.6.6. Frame Work 18 G GI Sheet or 16 G aluminium alloy supported by galvanised steel wire mesh of 10 mm Square.

7.6.7. Size – 610 x 610 mm (Approx.)

7.6.8. Washable SS FILTER (for Air washer / UAF units)

7.6.9. The filter mat shall be weaved with SS wire of 0.16mm diameter providing an aperture of max 0.025mm

7.7. FINE FILTER

7.7.1. Please refer to clauses no 19.8.5 with other relevant clauses of Customer technical specification section C-2A for MOC of Filter.

7.7.2. Efficiency : Average arrestance of 80-90% when tested in accordance with BS: 6540 / ASHRAE – 52-76

7.7.3. Frame Work: 16 G Aluminium alloy conforming to IS: 737).

7.8. ABSOLUTE/HEPA FILTER

7.8.1. Please refer to clauses no 19.8.5 with other relevant clauses of Customer technical specification section C-2A for MOC of Filter.

7.8.2. Media : 100% sub-microscopic glass fibres

7.8.3. Efficiency : 99.97 % down to 0.3 micron when tested in accordance with BS: 3928 (Sodium flame test)/FED–209B.

7.9. PIPE WORK AND VALVES:

7.9.1. Please refer to clauses no 19.8.8 with other relevant clauses of Customer technical specification section C-2A for pipes and valves.

7.9.2. Valves shall have full sizes port and suitable for horizontal and as well as vertical installation.

7.9.3. Valves for regulating duty shall be of globe type suitable for controlling throughout its lift.

7.9.4. Gate, Globe and stop check valves shall have bonnet back seat to facilitate easy replacement of packing with the valves in service.

7.9.5. All safety / relief valves shall be so constructed that the failure of any part does not obstruct the free discharge.

7.9.6. Manual gear operators be provided for valves of size 250 NB and above.

7.9.7. All valves with rising stem shall have position indicators.

7.9.8. All valves shall be provided with locking arrangement.

7.10. CENTRIFUGAL PUMP

7.10.1. Please refer to clauses no 19.8.4 with other relevant clauses of Customer technical specification section C-2A for pipes and valves

7.10.2. Impeller: Bronze as per Grade IS: 318 Grade 2

7.10.3. Pump shaft: SS 410.

7.10.4. Casing: 2% Ni Cast iron to IS: 210 GR. FG-260.

7.10.5. Wearing ring: Bronze Grade IS: 318 GR-2.

7.10.6. Shaft Sleeve: SS 316.

7.10.7. Base plate: Carbon steel as per the IS-2062 Gr.B.

7.10.8. Bolt and nuts: M.S. (Epoxy painted / Galvanised).

7.10.9. Type of seal: Mechanical

7.10.10. Pump motor coupling: Pin & bush type.

8. GENERAL

1) Basis of design, all calculations including heat load calculations for summer seasons, equipment selection criterion, layout drawings/ schemes/G.A. dwg and documents like data sheet/ technical particulars etc. Are subject to Customer approval during detail engineering stage.

2) Vendor to furnish characteristic curves for all major equipment offered indicating duty point during detailed engineering.

3) Vendor to include the Back wash arrangement of pot strainer with gate valve, piping etc for the Air Washer.

4) Vendor to include level gauge & level switch for each Air-washer tank for alarm & trip of the pumps. Also include one no. Pressure switch for each air washer pump

5) All drawings and documents shall be computer based.

6) All commissioning spares & consumables for trouble free operation shall be provided.

7) Quality Requirements in the Technical Specification are indicating minimum requirements for inspection and testing. Vendor shall note that quality plan is subject to Customer & BHEL-approval during detail engineering stage. Standard QP format is enclosed in the technical specification.

8) Indicative list of makes is enclosed as per Annexure-I however these equipment's / items shall be subject to Customer & BHEL approval during detail engineering Stage.

9) Inserts or any support arrangement for fixing ducting, fans, piping etc. shall not be provided by BHEL. Necessary supports may be taken from nearest structure / walls / roofs / floors etc. by Vendor.

10) Fixing frame works for diffusers and grilles in the scope of Vendor.

11) Anchor fastener shall be used by vendor for fixing duct pipes etc. wherever applicable.

12) Necessary supports and structures / frames etc. as required for supporting the duct / piping / equipments etc. as lump-sum basis is in the scope of Vendor and no unit rates shall be applicable for these items.

13) Drain piping within room up to the drain point to be provided by the Vendor.

14) Vendor to furnish schedule of power and control cables. Vendor to furnish cable termination details interconnection drawings etc. during detail engineering stage.

15) The tools and machine required for erection of equipment shall be arranged by Vendor.

16) Tools & tackles as required for regular maintenance shall be supplied by Vendor.

17) Instruments required for performance testing of various equipment / system of the package shall be arranged by Vendor at site.

18) Instrument for testing shall be calibrated by Ventilation plant supplier before taking up testing.

19) Temperature gauges shall be provided with thermo wells and fixing arrangement.

20) Pressure gauges shall have provision for air venting. Three way valves shall be used which shall have air venting provision.

21) Matching sockets / stubs (weld type) for flow switches and other instruments shall be supplied.

22) Bidders shall guarantee to maintain specified inside design conditions during summer, monsoon and winter and also even if the internal equipment load varies from 100% to 25%.

23) Besides the system performance as above, bidder shall guarantee major technical parameters of various equipments as per design basis / details furnished.

24) The guarantee tests shall cover but not limited to the following rated parameters for smooth operation of ventilation system.

- Design dry bulb temperature and relative humidity of conditioned air, Auxiliary power consumption, Vibration and noise level etc.

- Performance test of the Ventilation system shall be carried out at site after proper installation. The site test shall include performance testing of equipment for 72 continuous hours in summer or monsoon and 24 continuous hours in winter. Bidder, as may be required to carry out site tests shall arrange all instruments, tools etc.

- All calibrated instruments to be used for the tests at manufacturer's works/site shall be arranged by the bidder. Any Electrical/C&I items and accessories like junction box, glands etc. shall be included by vendor in his scope. Only those items

shall be provide free of cost which are categorically listed in the Electrical scope sheet of technical specification.

25) Motorized fire damper will be installed at supply air duct in electrical areas like MCC / Switchgear room / cable spreader room etc. in power house building and ESP building. Fire damper will close on receiving fire signal from fire protection system and shall also be possible manually from remote control panel. Also respective Air washers / UAFs shall trip on receiving fire signal from fire protection system.

26) Vendor to furnish drawings / documents as per the drgs. /documents submission schedule given in the contract.

27) Each motor terminal box shall be provided with cable gland and lugs for the size and type of power and control cable of respective motor.

28) All electrical equipment shall be suitable for the power supply fault levels and other climatic conditions indicated in project information / synopsis enclosed.

29) The bidder's proposal shall be for equipment in accordance with the Tech. Specification.

30) Tender drawings enclosed form the part of specification and the bidder shall check the space requirements.

31) Bidder should suitably group the signals coming from various instrument etc. and the same shall terminate in local JB, from Local JB common cable to PLC / panel / MCC shall be selected. Any Electrical / C&I items and accessories like junction box, glands etc. shall be included by vendor in his scope. Only those items shall be provided free of cost which are categorically listed in the Electrical scope sheet of technical specification.

32) Feeder for a combination of fire dampers / valves etc. shall be derived from respective control panel by bidder. Distribution through junction box / distribution board shall be in bidders' scope and shall have provision for isolation of individual fire damper / valves. Suitable transformer shall be provided by bidder (if required) to derive the power input.

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

34) Bidder to note that BHEL reserve the right for drg/doc submission through web based Document Management System. Bidder would be provided access to the DMS for drg/doc approval and adequate training for the same. Bidder to ensure proper net connectivity at their end.

35) Quality requirements in the Technical specification are minimum requirements for inspection and testing. Vendor to note that quality plans are subject to Customer

approval during detail engineering stage. Standard QP format is enclosed in the technical specification.

36) The drawings/ documents submitted by vendor shall be complete in all respects with revised drawing submitted incorporating all comments. Any incomplete drawing submitted shall be treated as non- submission with delays attributable to vendor's account. For any clarification/discussion required to complete the drawings, the bidder shall himself depute his personal to BHEL / Customer's place any number of time as per the requirement for across the table discussions/ finalizations/ submissions of drawings.

37) All openings required in brick wall for installing the axial supply and exhaust fans, propeller fans, duct opening, louvers and damper openings etc shall be done by vendor. Grouting of fans along with anchor fasteners shall also be done by vendor. The openings shall be finished properly. In case openings are done once the wall have been painted, repainting, to match with the existing wall paint shall also be done by the vendor. Sealing of duct opening, grouting of foundation / foundation bolts etc. including special type of grouting like GPX2 etc. are in the scope of Ventilation system vendor.

38) Flat, platform type RCC / PCC foundation shall be provided for installing Air washer / UAF and UAF fan / pumps etc. Vendor shall fix the equipment using proper anchor fasteners to secure the equipment and obtain parameter related to vibration and noise.

39) Bidder to note that the P&ID shows only the bare minimum requirement of valves and instruments. Any instrumentation & valves as required for the completion of the system in line with technical specification shall be provided by bidder during detailed engineering without any commercial implication.

40) All codes and standards shall be as per contract specifications.

9.0 EXCLUSIONS

Items of works listed below are excluded from scope of the Ventilation plant supplier.

1. Construction of Air washer plant room, foundations for Ventilation equipment's (air washer, centrifugal fan, RE Unit only).
2. Slab cut out for running ducts, pipes, cables, grilles/dampers. Underground masonry trenches and masonry risers.
3. Provision of drain traps / points,
4. For Electrical scope, refer Electrical scope matrix sheet.
5. Lighting of Air washer plant rooms /areas
6. Lifting & handling arrangement in Air washer plant for maintenance purpose.
7. Structure for running the ventilation ducting header outside 'A'- Row, however required inputs shall be provided by the vendor.

Anshul S A Khan Praveen Kishore

SECTION: C 2

CUSTOMER SPECIFICATIONS

SECTION: C 2A

CUSTOMER SPECIFICATIONS
TECHNICAL REQUIREMENT

CHAPTER 19

19.0 AIR CONDITIONING AND VENTILATION SYSTEM

19.1 General

The air conditioning and ventilation system shall be provided so as to achieve inside design conditions for proper performance of equipment and personnel.

The extent of supply under this contract includes all items required to complete the intent of the contract not withstanding the fact that such items may have been omitted from the specification or drawings.

The air conditioning and ventilation system shall also meet the requirements specified elsewhere in the specification.

19.2 Codes and Standards

Relevant Indian/International standards, such as ASHRAE, ISHRAE, AMCA and IS etc. as applicable to AC & ventilation system and latest issues of these applicable codes and standards shall be adopted.

19.3 Design Criteria for Air conditioning system

19.3.1 Dry bulb temperature 47^{o} C.

For other details of ambient conditions, refer published documents for meteorological data for Plant site.

19.3.2 Inside design conditions to be maintained in all air-conditioned areas.

Dry bulb temperature : 22$\pm$ 1.0^{o}C

Relative humidity : 50$\pm$ 5%

19.3.3 A minimum design margin of 10 % shall be considered while sizing AC Plant and related equipment like chillers, chilled water pumps and AHUs for each area. Solar load, all internal loads due to equipment, lighting, fresh air, occupants etc shall be considered while calculating the heat load.

19.3.4 Margins for calculating heat load:

i. 12.5%, 10% & 10% margins on sensible heat, latent heat & overall heat respectively is to be considered while calculating heat load.

ii. For winter load calculations, 50% of the equipment load as available in the room is to be considered.

19.3.5 All windows in the air conditioned area shall be provided with light coloured venetian blinds.

19.3.6 Fresh air quantity of 1.5 air change/hour or 35m^{3}/hr per person or suitable to maintain over pressure of 2 MMWC whichever is higher shall be considered.

19.3.7 False-ceiling shall be provided in all air conditioning areas.

19.3.8 For chemical lab, the airconditioning system shall be designed for 100% outdoor air (the room air is exhausted and not recirculated through the A/C unit). 2 x 100 % Split units are acceptable for chemical lab.

19.3.9 To reduce the air-conditioning load the exposed roof slabs (Including beams and column etc.) of air-conditioning areas , air handling units room and Packaged Air conditioners (PAC) rooms shall be insulated with 50 mm thickness fibre glass insulation of density 48 kg/m^3 finished with 26 swg aluminum cladding.

19.3.10 AHU room's walls ,Packaged Air Conditioners room's walls and first 6 meters of supply air duct from AHU/PAC air outlet shall be acoustically insulated with 25 mm thick fiberglass crown 150 of density 48 kg/m^3 and shall be covered with 26G aluminum perforated sheet. Perforation area shall be 30% of free area.

19.3.11 Lighting load of 2 Watts per Ft^2 or actual which ever is higher shall be considered for heat load calculations.

19.3.12 The occupancy for general/ office area shall be minimum one person per 3 Sq.M and for conference room the same shall be one per 1.5 Sq.M. In the control rooms, control equipment rooms etc, the occupancy may be one person per 20 Sq.M (Minimum).

19.3.13 The Air-conditioning spaces shall be maintained at positive pressure of 2 mmwc to avoid any infiltration of dust.

19.3.14 Plant for all air-conditioned areas shall operate continuous (24 hours a day, 7 days a week except during loss of normal power failure).

19.3.15 Motor operated valves shall be provided as per system requirement for chilling machines, pumps, cooling towers in order to facilitate remote operation of entire air-conditioning plant and to select standby unit.

19.3.16 Noise Criteria – Design noise level shall be of NC 35-45 within Control room, Control equipment room, Instruments and Electronic room and offices.

19.3.17 Design Criteria for Air Inlet Louver – Face velocity of the louver shall be 2.5 m/s (max.).

19.3.18 Design Criteria for Volume Control Damper – Velocity across the Damper shall not exceed 10 m/s.

19.3.19 Duct Design Criteria – Velocity shall be 7.5 m/s.(max.) for main duct, 6.0 M/s. (max.) for branch duct and 2.0 m/s. for the diffusers/grills.

19.3.20 Coil face area of Air handling Units shall be designed considering a face velocity of not more than 2.5 M/ Sec.

19.3.21 Water piping shall be sized for a maximum velocity of 2.5m/sec. However gravity flow/pump suction line shall be sized for a maximum water velocity of 1.5 m/sec.

19.3.22 Refrigerant suction, discharge/hot gas lines & liquid lines shall be sized such that the total pressure drop is equivalent to not more than 1.1 deg C in saturation temperature of refrigerants. However, refrigerant velocity shall not be greater than 0.5 m/sec in liquid line.

19.3.23 All Carbon steel sheets under air conditioning system shall be hot dip galvanized or spray galvanized unless otherwise specified and minimum zinc deposition shall

conform to Class 275 of IS: 277.The air distribution system shall be sized to have a constant frictional drop.

19.3.24 For calculating friction loss in piping system: WILLIAM & HAZEN formula shall be used with C value as 100.

19.3.25 Thermal Insulation Design Criteria –

EQUIPMENT/MATERIAL	THERMAL INSULATION
Ducting	50 mm thick fibre glass of density 48 kg/cum and TF quality finished with 26 swg aluminium cladding. For Exposed ducting, 50 mm thick fibre glass rigid board (density 48 kg/cum and TF quality) finished with 26 swg aluminium cladding.
Refrigerant Piping for Split Air Conditioners and Packaged air conditioners	13 mm thick Nitrile foam.
Refrigerant Piping of Water Chilling Unit	75 mm thick expanded polystyrene (TF Quality) of density 32 kg/cum finished with chicken wire mesh, 12.5 mm thick sand cement plaster.
Chilled Water Piping and associated valves.	Chilled water piping shall be insulated with 50 mm thick (TF quality) expanded polystyrene of density 32 kg/cum covered with 12.5 mm thick Sand Cement Plaster. The portion of CHW pipe exposed to atmosphere shall be insulated with 50 mm thick (TF quality) expanded polystyrene of density 32 kg/cum and finished with 26 swg aluminium cladding.
Drain Piping from AHU and Chiller	Drain Piping shall be insulated with 25 mm thick EPS (TF quality) of density 16 kg/cum covered with 26 swg aluminium cladding.
Chiller	As per manufacturer standard.
Chilled Water Pump	50 mm thick thermal insulation of EPS (TF quality) of density 32 kg/cum covered with 26 swg aluminium cladding.
Expansion Tank	50mm thick thermal insulation of EPS (TF quality) of density 16 kg/cum covered with Sand Cement Plaster.
Air Handling Unit	Double skin type with PUF insulation
Indoor Unit of split AC	As per Manufacture's Standard
Package A.C	As per manufacturer's standard

19.3.26 Design Chilled water flow shall not be less than 0.7 Cu.M/hr per TR air-conditioning load and design Condenser cooling water flow shall not be less than 1.0 Cu.M/hr per TR air-conditioning load.

19.3.27 For maintenance of compressors/chilling units, pumps, AHUs (air handling units) etc. chain pulley block of suitable capacity and/or suitable structure shall be provided in the AC plant rooms and AHU rooms.

19.3.28 Redundancy of Equipments

The number of chilled water pumps, condenser water pumps and cooling towers shall be equal to the number of chilling units and condensing units.

- Chilling Units - 2 x 100%
- Condensing Unit - 2 x 100%
- Condenser water pumps - 2 x 100%
- Chilled water pumps - 2 x 100%
- Package air conditioners - 2 x 100%
- Window/Split air conditioners - 2 x 100%
- FRP cooling towers - 2 x 100%
- Air handling units (DX type) - 2 x 100% (Per AHU room)
- Air handling units water type) - Multiple AHUs of similar (Chilled capacities per AHU room
- Fresh air fan unit - 2 x 50% per AHU room

19.3.29 All the pumps shall have 10% margin on capacity and head over the actual requirement.

19.4 **Design Criteria for Ventilation system:**

19.4.1 The capacity of Air washers, Supply air fans, exhaust air fans/ roof extractors, ducting system shall be designed as per the Design criteria & Equipment specification elaborated below. Sizing calculations for all the equipments shall be submitted for approval of Owner. However the minimum quantity of the air washer units of Ventilation System for each unit shall not be less than 4 numbers (two numbers on A row and two on B row). A minimum 10% margin shall be considered while sizing the equipment/plant capacity.

19.4.2 The number of air changes per hour in evaporative/mechanically ventilated areas shall be as follows:

S No.	Area	Air Changes
i.	For all evaporative type ventilation system	8
ii.	General areas	15
iii.	Various pump houses	20
iv.	Switch gear / MCC rooms.	25
v.	Battery rooms & other areas where gaseous fumes are generated	30
vi.	Chlorination plant building	30
vii.	D G set room	45

19.4.3 However in areas producing lot of heat, the temperature limitation should be the criteria, which is as follows:

- Inside dry bulb temperature shall be minimum 5 deg.C below the design ambient dry Bulb temperature during summer for evaporative cooled areas.
- Inside dry bulb Temperature shall be maximum 3 deg.C above the design ambient dry Bulb temperature during summer for mechanically ventilated areas.
- The criterion which gives higher number of air changes/higher quantity of air in either of the conditions as mentioned above shall be the basis for selecting the required air flow for that area.
- Inside dry bulb temperature for battery room shall be maintained at 25^{o}C. The air flow rate for battery room shall be sized considering minimum 30 air changes per hour or hydrogen concentration of 2% or less of the room volume whichever gives higher air flow shall be considered.

19.4.4 All ventilation system shall operate on 100% fresh air.

19.4.5 All mechanically ventilated areas like MCC/Switchgear rooms shall be positively ventilated by means of supply air fans, generally in combination with exhaust fan/ roof extractors. Wherever exhaust fan/ roof extractors are not provided, the pressurised condition shall be maintained with gravity operated backdraft dampers. However, as exception, hazardous areas and fumes/odour generating areas such as toilets shall be negatively ventilated by means of exhaust air fans/ roof exhausters and inlet louvers.

19.4.6 Supply air fan catering for electrical switchgear/MCC rooms, Elevator machine rooms etc. shall be provided with pre filters and fine filters. Efficiency of Pre filter shall not be less than 90% down to 10 microns while for fine filter 99.5% down to 5 microns.

19.4.7 All the equipments of Ventilation system shall be designed for continuous duty for continuous operation of 24 hours a day.

19.4.8 The supply air ducts of evaporative/ UAF type ventilation system shall be provided with automatic (motor operated) fire dampers of fire rating 2 hours at the entry to each of the enclosed area like switchgear rooms, cable galleries etc. The operation of these automatic dampers shall be interlocked with the fire alarm system and the operation of these dampers shall also be possible from the control panel remote manually.

19.4.9 For maintenance of Air washer unit material handling equipment as per size & type defined in Chapter 17, Vol III of specification shall be provided in the Air Washer rooms of Evaporative Ventilation System.

19.4.10 Circulating water capacity for Air washer units shall be minimum 1 M^3/hr per 1000 M^3/hr of air flow while for Unitary Filtration Unit, it shall be minimum 0.6 M^3/hr per 1000 M^3 /hr of air flow.

19.4.11 Water piping shall be sized for a maximum velocity of 2.5 m/sec. However gravity flow/pump suction line shall be sized for a maximum water velocity of 1.5 m/sec.

19.4.12 The air distribution system shall be sized to have a constant frictional drop along its length.

19.4.13 The air washer unit and unitary air filtration unit shall be designed for a maximum face velocity of 2.0 m/sec.

19.4.14 The air washer unit shall be designed for at least 90% saturation efficiency while UAF for 60% saturation efficiency.

19.4.15 For pumps, fans and blowers, continuous motor rating (at 50^0 C ambient) shall be at fifteen percent (15%) above the demand of the equipment at duty point or ten percent (10%) above maximum load demand of the equipment whichever is higher.

19.4.16 For Belt drives, the belts shall be sized for 150% of the rated power and there shall be minimum of two belts per drive.

19.4.17 All Carbon steel sheets under evaporative ventilation system shall be hot dip galvanized or spray galvanized unless otherwise specified and minimum zinc deposition shall conform to Class 275 of IS: 277.

19.4.18 For calculating friction loss in piping system, WILLIAM & HAZEN formula shall be used with C - value as 100.

19.4.19 Supply air fans, exhaust air fans/ roof ventilators of each area shall be provided with their local starter panel.

19.4.20 Design Criteria for Back Draft Damper – Velocity across damper shall not exceed 6 m/s.

19.4.21 Duct Design Criteria – Velocity shall be 12 m/s.(max.) for main duct, 9.0 M/s. (max.) for branch duct and 3.75 m/s. for the grills.

19.4.22 REDUNDANCY OF EQUIPMENTS

- Pumps for each Air Washer Unit shall be 2 x 100% Capacity or 3 x50%. For UAF it shall be 1 x 100%.
- Fans for each air washer unit shall be 3x 33% capacity while for unitary air filteration unit shall be 1x100% capacity.
- Supply air fans/Exhaust air fans/roof exhausters shall be in multiplicity.

19.5 **Systems to be Furnished**

19.5.1 **Air Conditioning System**

a) A centralized water cooled chilled water system with screw chilling units shall be provided for the following areas:

Main control room areas comprising unit control room, electronic cubicle room, shift in-charge, engineers room, maintenance engineers room, printer room, UPS room, relay room, SWAS (Dry) panel room, conference room, office rooms, record room, analyzer room and static excitation room in TG building.

b) A separate water cooled direct expansion type air conditioning plant of 2x100% capacity shall be provided for ESP/VFD control room.

c) Water Cooled Precision Type Packaged air conditioners shall be provided for the following areas:

i) Switchyard control room

d) Water Cooled Package Type AC units shall be provided for the following areas

- Each floor of Administration building covering all areas
- Each floor of Service Building

e) Air Cooled Non Ductable Split/Window AC units shall be provided for the following areas

- Office and meeting room areas of workshop building
- Weigh bridge Control Room
- Elechtrochlorination plant control Room
- ETP Control Room
- CW Control room
- Fire Station building control room
- H2 Generation Control Room
- Technical library
- Space/ Room for storing C & I items in warehouse.
- Operator cabin of TG Hall EOT Crane
- Ash handling control rooms
- DM plant control room including labs & offices
- CHP Control Room
- ECHS Control Room in NCPTS Stage II
- Sea Water Intake Pumphouse Control Room at NCTPS
- Clarified Water Pumphouse Control Room
- Filtered Water Pumphouse Control room
- GIS Control Room
- Chemical laboratory
- RO Stage I Control room in including labs & offices
- RO Stage II Control Room
- C&I laboratory, training hall, MRT laboratory
- Fuel oil Control Room
- Any other Control Room

19.5.2 **Ventilation System**

a) TG Building

Evaporative type ventilation system shall be provided for TG building as specified below. Air washer units of double bank spray system shall be distributed along A-row and B-row of the building. Filtered and Cooled air from each air washer unit shall be distributed to various areas through supply air ducting and grills. The TG building shall be provided with adequate number of roof extractors.

b) ESP Control Room (Non air conditioned areas)

Unitary Air filtration units of single bank spray system using water repellant type nylon filters shall be provided for ESP building. Unitary air filtration units shall be located at roof top of ESP building.

c) Ambient air ventilation system for the other areas

i) Turbine hall- Roof exhausters
ii) CW pumphouse
iii) Filtered Sea Water Pumpshouse in NCTPS Stage II
iv) Filtered Water Pumphouse
v) Fire Water Pumphouse
vi) Ash Water Pumphouse
vii) Ash Recovery Pumphouse
viii) Ash Slurry pumphouse
ix) Workshop Building
x) Air compressor room
xi) Air Compressor Room in NCTPS Stage II
xii) AC plant rooms
xiii) DG set rooms
xiv) RO Plant I
xv) RO Plant Stage II
xvi) Sea Water Intake Pumphouse in NCTPS Stage II
xvii) RO Stage I Permeate Pumphouse in NCTPS Srage II
xviii) UF Permeate Pumphouse in NCTPS Stage II
xix) Chemical House in NCTPS Stage II
xx) DM Plant
xxi) CPU
xxii) Stores
xxiii) Gate Houses
xxiv) Switchyard control building (Non a/c areas)
xxv) Battery and battery charger rooms
xxvi) All MCC rooms & cable vaults
xxvii) Compressor/vacuum pumphouse (AHP)
xxviii) Coal handling switchyard gear room
xxix) Transfer tower/tunnel for CHP.
xxx) Elevator machine rooms
xxxi) All other areas not airconditioned.
xxxii) Workshop
xxxiii) Toilets
xxxiv) Stores
xxxv) H2 Generation Building

Any other area/building which has not been specifically included above, but required ventilation shall be provided with suitable ventilation system.

19.6 System description Air Conditioning System

19.6.1 Centralized Water Cooled Chilled Water System

(a) A centralized water cooled chilled water system with screw chilling units are envisaged for airconditioning the areas viz. main control room areas. The water cooled screw chilling units along with chilled water pumps, condenser cooling water pumps and cooling towers shall be provided. The number of chilled water pumps, condenser cooling water pumps, cooling towers shall be equal to the number of chilling units. The air conditioning system shall also include multiple air handling units, associated air distribution system, chilled water piping, condenser water piping, valves & fittings, insulation, strip heaters, humidifiers, expansion tank and all other associated accessories and controls. A central control panel within the air conditioning plant room is to be provided. Local control panel for individual AHU rooms and other areas to be provided. Makeup water for the condenser cooling

water system to be provided at the air conditioning cooling towers as per required pressure and flow. Fresh air system shall be provided in all the AHU rooms.

(b) The screw chillers shall operate to meet the overall building cooling load requirements through out the day. The chillers shall operate by a combination of chiller optimization and sequencing. The airconditioning controls shall be designed as to interface with the safety controls of each of the air conditioning equipment along with automatic operation. Selector switches and push buttons shall be provided for manual operation of all air conditioning equipment.

(c) Chilled water flow of 10 cum/hr shall be supplied to Sample Cooler in the Analyzer room from the main airconditioning chilled water system.

(d) The air handling units shall be draw through type and casing shall be of double skin construction. Fans shall be double inlet double width (DIDW) centrifugal type. Fans shall have forward or backward curved blades. The cooling coil face air velocity shall not exceed 2.5 m/sec.

(e) Strip heaters of suitable capacity with controls shall be provided in the supply air duct plenum.

(f) Humidification package with all necessary controls.

(g) Air distribution system including ducting, grilles, diffusers fresh air unit, fire dampers, volume control dampers, thermal and acoustic insulation for ducts and accessories.

(h) Monorail and hoist for handling the A/C units, pumps, etc.

(i) Required Pre filters, Fine filters and Absolute (Hepa) filters along with differential pressure gauge shall be provided for sensitive areas of main control room i.e unit control room, electronic cubicle room, printer room, UPS room, relay room, SWAS (Dry) panel room, & conference room. Other areas shall be provided with pre filters & fine filters. .

(j) The chilling plant and pumps shall be located in a separate room and the A/C plant room layout shall be made such that adequate space is provided for maintenance of chilling units, pumps etc.

(k) Online non- chemical type scale preventer shall be used to avoid formation of scale in the condenser water circuit.

19.6.2 **Water Cooled Direct Expansion System (DX System)**

Independent water cooled central air conditioning system of direct expansion (DX) type with reciprocating compressor is envisaged for ESP control room

i. The water cooled condensing unit along with Air handling units, condenser cooling water pumps and cooling towers shall be provided. The number of Air handling units, condenser cooling water pumps, cooling towers shall be equal to the number of condensing units. In addition, one common standby condensing unit and the associated equipment shall be provided. The air conditioning system shall also include associated air distribution system, condenser water piping, valves and fittings, insulation, strip heaters, humidifier, Differential pressure for filters and all other accessories and

controls. A central control panel within air conditioning plant room is to be provided. Local control panel for individual AHU rooms and other areas to be provided. Make up water for the condenser cooling water system to be provided at the air conditioning cooling towers as per required pressure and flow. Fresh air system shall be provided in all the AHU rooms.

ii. The air handling units shall be draw through type and casing shall be of double skin construction. Fans shall be double inlet double width (DIDW) centrifugal type. Fans shall have forward or backward curved blades. The cooling coil face air velocity shall not exceed 2.5 m/sec.

iii. Strip heaters of suitable capacity with controls shall be provided in the supply air duct plenum.

iv. Humidification package with all necessary controls.

v. Air distribution system including ducting, grillers, diffusers fresh air unit, fire dampers, volume control dampers, thermal and acoustic insulation for ducts and accessories.

vi. Monorail and hoist for handling the A/C units, pumps, etc.

vii. Required Pre filters, Fine filters and Absolute (Hepa) filters along with differential pressure gauge.

viii. The condensing plant and pumps shall be located in a separate room and the A/C plant room layout shall be made such that adequate space is provided for maintenance of condensing units, pumps etc.

ix. Online non- chemical type scale preventer shall be used to avoid formation of scale in the condenser water circuit.

19.7 System description Ventilation System

19.7.1 Evaporative Cooling System for Turbine Building

i. Four (4) nos. air washers of adequate capacity shall be provided for evaporative cooling of various floors of turbine building including maintenance bay and electrical bay. Each air washer system shall consists of two (2) nos. centrifugal fans (both working), two (2) nos. centrifugal circulating water pumps (1 working + 1 standby), Send trap and air intake louvers, filters, air washer internal, ducts and other accessories. Besides, roof extractors shall be provided. With this system the dry bulb temperature (DBT) within the turbine building shall be maintained at a temperature not exceeding 5^{o}C less than ambient DBT at all times of the year. The air washer capacity is to be decided based on:

a) Total internal heat load within the turbine building, inclusive of electricity bay and maintenance bay and considering the heat dissipated by various electrical switchgear, motors, equipment hot surface, steam piping as well as the dissipated heat, solar transmission through the building walls and glass, and any other sources of heat.

b) Summer ambient conditions as furnished to be considered.

c) Efficiency of air washer shall be 90% with two banks opposed type spray system

ii. The number of roof extractors in the turbine building to be sized so as to exhaust about 70% of the total air supplied in order to reduce ingress of dust-laden air into the building.

iii. Air washer shall be double bank spray type mainly consists of an airtight chamber or casing containing air distribution louvers, spray nozzles, a tank for collecting spray water, eliminators with flooding nozzles, pre and fine filters and a pump with piping valves, strainers and specialities for re-circulating water. One (1) level switch in the air washer tank shall be provided to give an alarm in the air washer plant room.

iv. The supplied air will be exhausted through roof exhausters to maintain an overpressure of 1-2mm of water column to reduce dust ingress.

19.7.2 **Unitary Air filtration Unit for ESP Control Building**

For ventilation of this building (except the control room), ambient air will be drawn through unitary air filtration units of single bank type comprising fresh air intake louvers, automatically cleanable nylon filters (with water spray) and moisture eliminator and supplied to the space by means of centrifugal fans.

The supplied air will be exhausted through wall mounted gravity operated dampers to maintain an overpressure of 1-2mm of water column to reduce dust ingress.

19.7.3 **Ambient Ventilation System for other areas**

Ambient ventilation system shall comprise of supply air fan assemblies with Pre & Fine filters, Gravity louvers, exhaust air fans, roof extractors, gravity dampers or a suitable combination of these along with necessary filters, ducting, grilles etc.

Transfer towers/tunnels of Coal handling plant shall mainly consists Supply air fans of DIDW type with pre and fine filters, Supply air ducting and grills, Exhaust air ducting and grills and Exhaust air fans of SISW type.

The ventilation system for the various areas shall be designed duly considering the factors such as temperature, relative humidity and maximum allowable concentration of gases present in the rooms, corresponding to international guidelines.

19.7.4 **Specific Requirements**

All battery rooms to be painted with acid & fume resistant paint.

iv. In chlorination room, ducted exhausts shall be provided and exhaust air grilles will be located near the floor level. The fan, motors ducting and grilles shall be given acid and fume resistant paint.

v. For hazardous areas, fans with anti-spark characteristics to be provided.

vi. For elevator machine room, filtered air shall be supplied by supply air fan. Exhaust shall be through gravity dampers.

vii. Evaporative cooling ventilation fans shall be interlocked with fire protection system, to get the same tripped in the event of fire.

viii. Online non- chemical type scale preventer shall be used to avoid formation of scale in the Airwasher nozzles/ water circuit.

19.8 Equipment Description

19.8.1 Chilling Unit/Condensing Unit

Type		Water cooled type.
Vibration isolators	:	Steel spring/ Neoprene rubber cushy foot/ neoprene serrated rubber pad type with isolation efficiency not less than 85%.
Compressor Type	:	a) For the Chilling units of T G building control room areas, the compressor shall be Hermetically sealed Screw type operating on R134a/R407C refrigerant complete with accessories and automatic control facilities b) For condensing units of ESP/VFD control rooms shall be Hermetically sealed screw type operating on R134a/R407C refrigerant complete with accessories and automatic control facilities
Type of drive	:	Motor driven, through direct
Accessories	:	High / Low pressure cutouts, Oil pressure switches, relief valves, Pressure gauges at each stage, lube oil/Control oil pressure gauges, Suction and discharge stop valves, Muffler, Crank Case heaters, Oil filters, Magnetic oil Separators, Temperature indicators for Lube oil/ Heaters, Oil level indicators, Safety thermostat for crank case heater, Vibration Isolators etc.
Condenser		
Type	:	Water cooled, shell and tube type.
Fluid		
	:	Shell side – Refrigerant
	:	Tube side - Water
Capacity	:	To match with respective compressor and to provide atleast 2 deg.C sub-cooling. To store full charge of refrigerant.
Design fouling Factor	:	Not less than 0.0002 (in MKS units)
Shell material	:	Mild steel (IS:2062)
Tube material	:	Replaceable seamless copper (ASME B-111)
Fin material		Copper
Accessories	:	Purge and drain connections, relief valves, liquid line shut-off valves, refrigerant filling charging, flow switches, Isolating valves, Pressure & temperature indicators at inlet and outlet etc.
Refrigerant	:	For chilling Unit- R 134a For Condensing Unit - R-22
Steel structure	:	The complete condensing/ chilling unit shall be mounted on steel structure and shall be provided with necessary vibration isolators
Chiller		
Type	:	DX type and Shell and tube type
Superheating of	:	At least 2 deg.C
Design Fouling Factor	:	Minimum 0.0001 (MKS units)
Fluid	:	Shell side - Water
		Tube side - Refrigerant
Capacity	:	To match with respective plant capacity.

Shell material	:	Mild steel (IS : 2062)
Tube material		Replaceable seamless finned copper
Fin material	:	Aluminium
Accessories	:	Purge and drain connections, Isolating valves, flow switches, Pressure & temperature indicators at inlet and outlet, Anti-freeze thermostats, thermostatic expansion valve or float assembly as applicable, pilot solenoid valve, Relief valves, Operating thermostats for capacity control, supporting frame etc.
Steel Structure	:	The complete condensing/ chilling unit shall be mounted on steel structure and shall be provided with necessary vibration isolators.

19.8.2 **Air Handling Unit (AHU)**

a) Each AHU shall consist of Casing, Fan impeller section, Cooling coil section, damper section, Steel frame with vibration isolators (minimum efficiency of 85%) for the complete AHU, Isolation dampers at the Suction and discharge of each AHU, Pre-filter at the suction and Fine filters (micro-vee type) in the discharge of each individual AHU/common plenum, Absolute (HEPA type) filters in individual discharge of all AHU's/common plenum of Control room, control equipment room, computer, programmer rooms etc and Heater section in the common discharge of AHUs.

b) The casing of AHUs shall be of double skin construction. Double skin sandwich panels (inside and outside) shall be fabricated using minimum 22 swg (0.8 mm) galvanized steel, with 25mm thick polyurethane (PUF) insulation of minimum 40Kg./ Cum density in between. 16 gauge galvanized steel hat-channel shall be used as reinforcing to give structural strength.

c) Face and bypass dampers (motor operated for DX type plant) of opposed blade type shall be provided. Dampers shall be made of 16 gauge G.S sheet metal (class 275 of IS: 277). The area of the bypass section shall be minimum 30% of the coil face area. Damper operating linkage and the operating motor shall be located outside the casing. Each AHU shall be provided with motorized volume control damper at air discharge.

d) Cooling coil shall be of seamless copper tubes with Aluminium fins and shall be provided with suitable drains and vents connections.

e) All filter plenum shall be provided with a walking platform inside the plenum chamber for filter cleaning purpose. Inspection door shall be provided at the plenum chamber and a removable type ladder shall be attached to plenum.

f) Air handling units/centrifugal fans shall be provided with Variable frequency drive (VFD) and velocity sensor/static pressure sensor in supply air path to adjust air flow automatically. The minimum efficiency of VFD at full load shall not be less than 96%.

g) Centrifugal Fan

a)	Fan impeller	:	Forward/ backward curved blade & centrifugal type.
b)	Impeller material	:	Mild steel spray galvanised with minimum zinc deposition conforming to Class 275 of IS:277.

c)	Fan bearings	:	Self aligning type, permanently lubricated, heavy duty with a design life of 10,000 operating hours.
d)	Critical speed	:	First critical speed of rotating assembly shall be at least 25% above the operating speed.
e)	Drive	:	Motor driven. With removable belt guard.
f)	Static pressure (minimum)	:	120 mm wc

19.8.3 **Precision Type Packaged Air Conditioners**

Packaged air conditioners shall be of precision control type complete with hermetic type Scroll compressor ,shell and tube type water cooled condenser, air handling fan, D-X cooling coil, Microvee filters,In-built dehumidification cycle thru solenoid valve for reading ADP, humidifier package with humidistat and other accessories and controls, electrical strip heaters with suitable thermostat, first charge of refrigerant and oil, controls and all necessary instruments and accessories, all housed in a cabinet made of heavy gauge sheet steel finished in epoxy paint of approved colour and suitable for floor mounting. Suitable drain connection shall be provided for removal of condensable collected inside a tray under cooling coil.

i. Compressor shall be hermetically sealed Scroll type with drive motor. It shall be suitable for R22/R407c refrigerant. The compressor shall be mounted on springs at the lower most section of packaged unit such that the same is easily accessible for servicing.

ii. The condenser shall be water cooled shell and tube type having replaceable seamless copper tubes with integral fins and removable head. The condenser shall be provided with fusible relief plug and all other accessories as required.

iii. The air handling fan shall be centrifugal type with forward curved blades and complete with belt drive and electric motor. Each PAC shall be provided with motorized volume control damper at air discharge.

iv. Cooling coils shall be of direct expansion type and made of heavy gauge copper with hydraulically bonded aluminium fins. Rows shall be staggered in the direction of air flow.

v. Filters shall be non-rusting corrugated metallic wire mesh cleanable type and of adequate area so that the air velocity across the filters shall not exceed 2.5 m/sec. Filter shall be in-built with unit heaving efficiency 95% down to 5 microns.

vi. Refrigerant piping shall be heavy gauge copper or IS:1239 heavy class seamless MS pipe complete with thermostatic expansion valve, liquid line shut-off valve, high and low pressure gauges.

vii. Cabinet Construction:

The frame & panel shall be constructed of Cold rolled cold annealed sheet steel duly powder coated and shall be assembled with pop rivets. The side panels of unit shall be double skinned for increase life span and reduction of noise & vibration. Front panel shall be removable hinge for easy service.

viii. De-Humidification

Specific de-humidification cycle (Split Liquid / Split Suction) shall operate by reducing the operating surface temperature in a section of one of the Refrigeration coil by means of a solenoid valve in the Liquid line / Suction line. Full air flow of the unit will be maintained at all times to ensure consistent air distribution to the conditioned space.

ix. All necessary operating and safety controls shall be provided including the following:

Controls:

The controls shall be of microprocessor based programmable PID (Proportional, integral and derivative control logic) controller. The controller shall have a LCD display screen, which shall be visible from the front of the unit without removing any covers/external panels. This LCD display screen should show the following information / data:

a) Modes of operation (cooling, heating, humidification, de-humidification).

b) Simultaneous displays of set temperature and actual temperature and set Relative Humidity and actual Relative Humidity.

c) Date, time and unit identification display.

d) System component Auto / Manual status display on the controller screen.

e) Backup battery charge status display on the controller screen.

f) Visual system alarm indication (along with mutable audio alarm as well).

g) Alarm display menu (incorporating various system alarms like temperature high / low, humidity high / low, Compressor HP/LP, Wet floor and loss of air flow conditions).

h) 24 Hours temperature and relative humidity graph display menu.

i) Programmable services interval indication display / alarm.

There should be a feature to enable operator to program the start-up and shut off of the system components (blower fan start / stop delay, first compressor start / stop delay, second compressor start / stop delay, etc.). Access to the controller settings shall be protected with passwords to prevent against unauthorized access.

Safety Protections:

The unit shall also incorporate the following protections:

a) High pressure trip- Manual reset for each compressor
b) Low pressure trip- Manual reset for each compressor.
c) Single phasing preventers.
d) Reverse phasing
e) Phase imbalancing
f) Phase failure

g) Overload tripping (MPCB) of all components

Safety Interlocks:

Operation of heaters & humidifiers shall be possible only when blower fan is in operation.

Fire detection signal from fire detector system shall be able to switch off the package unit operation in event of fire in conditioned space.

x. A suitable number of vibration isolation pads shall be provided for the packaged units.

19.8.4 **Centrifugal Pumps**

a)	Type	:	Horizontal Centrifugal, Axially split type casing pump
b)	Impeller	:	Closed type
c)	**Material of Construction**	:	
	i) Casing	:	2% Ni Cast Iron : IS:210 Gr. FG-260
	ii) Impeller	:	Bronze IS:318 Gr-2
	iii) Wearing rings	:	Bronze
	iv) Shaft	:	SS 410
	v) Shaft sleeve	:	SS 316
	vi) Lantern ring	:	Brass / Bronze
	vii) Packing	:	As per manufacturer's standard.
	viii) Base Plate	:	Carbon steel as per IS:2062
	ix) Speed	:	Maximum 1500 rpm

19.8.5 **Air Filters**

a) Pre Filter

1)	**Filter medium :**		
	i)	Fibrous material (extruded polyethylene) or felt filter fabric; Dry type with element of 5 ply construction for Fabric type.	
	ii)	V-fold galvanized wire mesh inter spaced with a flat layer of galvanized wire mesh for Metallic type pre-filters.	
2)	**Frame**		
		GI sheet (minimum 18 gauge thick) or Aluminium alloy of (minimum 16 gauge) supported by galvanised steel wire mesh of 10 mm Square with handles.	
3)	**Other requirements :**		
	a)	Suitable aluminium spacers be provided for uniform air flow;	
	b)	Casing shall be provided with neoprene sponge rubber sealing.	
	c)	Capable of being cleaned by water flushing.	
	d)	Density of filter medium shall increase in the direction of air flow in case of metallic filter.	
4)	**Efficiency :**		
		Average arrestance of 65 - 80 % when tested in accordance with BS:6540/ASHRAE – 52 - 76.	
5)	Minimum thickness	:	50 mm for Fabric type.
6)	Face Velocity	:	Not more than 2.5 m/sec.

7)	Pressure drop	:	Initial pressure drop - Not to exceed 5.0 mm WC at rated flow. Final pressure drop - Upto 7.5 mm WC.
8)	Location		
	a) Fabric type	:	1) At the suction of each AHUs (AC system)
		:	2) At the suction of each Fresh air fan (AC)
		:	3) At suction of each PAC unit

b) Fine Filters (Microvee type)

1)	Construction	:	By pleating a continuous sheet of filter medium into closely spaced plates separated by heavy corrugated aluminium spacers.
2)	Frame	:	Aluminium alloy of (minimum 16 gauge conforming to IS:737)
3)	Other requirements	:	A neoprene sponge rubber sealing shall be provided on either face of the filter frame. Capable of being cleaned by air or water flushing.
4)	Efficiency	:	Average arrestance of 80-90% when tested in accordance with BS:6540/ASHRAE–52-76.
5)	Minimum thickness	:	150 mm or 300 mm.
6)	Face Velocity	:	Not more than 1.2 m/sec for 150 mm and not more than 2.4 m/sec. for 300 mm.
7)	Pressure drop	:	Initial pressure drop - Not to exceed 10 mm WC at rated flow ; Final pressure drop-Up to 18 mm WC.
8)	Location	:	i) At the discharge of each individual AHU (AC system). ii) At the discharge of each Fresh air fan (AC system)

c) Absolute Filter / Hepa Filter

1)	Media	:	100% sub-microscopic glass fibres.
2)	Frame	:	Aluminium alloy of (minimum 16 gauge conforming to IS: 737) with handles.
3)	Other requirements	:	A neoprene sponge rubber sealing shall be provided on either face of the filter frame.
4)	Efficiency	:	99.97 % down to 0.3 micron when tested in accordance with BS: 3928 (Sodium flame test)/FED–209B.
5)	Minimum thickness	:	300 mm
6)	Face Velocity	:	Not more than 1.2 m/sec.
7)	Pressure drop	:	Initial pressure drop - Not to exceed 20 mm WC at rated flow; Final pressure drop - Up to 60 mm WC.
8)	Location	:	At the discharge of each individual AHU feeding to computer rooms, programmer rooms, control room and control equipment room in central control building.

19.8.6 Cooling Towers

Type		Induced draft, cross or counter flow.
Capacity		110% of rated capacity of each cooling water

		pump.
Material of construction of Casing & Sump tank		F.R.P
Fan		Cast Aluminium / FRP Propeller type and multi-blade aerofoil construction with adjustable pitch.
Fill		Non combustible PVC or Equivalent of light grey, cream or white colour.
Louvers		F.R.P / PVC / Aluminium.
Nozzles		Brass with chrome plating/Polypropylene.
Eliminators		In removable sections to reduce the drift loss to 0.2% of water flow.
Supporting structure		Mild steel with spray galvanisation or epoxy painting.
Strainer at water outlet		Plate strainer made of GI /SS wire mesh of 16 gauge.
Bird screen		25 mm square made of GI/SS wire mesh of 16 gauge.
Ladder		Hot dip galvanised steel ladder for each tower.
Distribution Pipe		Galvanised MS pipe.
Accessories		Drain connection with isolation valve Make up connection with ball - float valve, back up gate valve and a bypass with a gate valve for manual operation. Overflow connection Equalizing connection to connect sump of all the towers wherever applicable. Access door in louvers / fan deck.

Individual sets of cooling towers shall be provided for Central chilling plant in T G building areas, DX type air conditioning system for ESP/VFD control room and Packaged type air conditioning systems for Administrative building, Switchyard control room, AHP control room and other areas/control rooms.

Non- Chemical Type Scale Preventor

The unit should be a non-chemical on-line type scale preventor not requiring any chemicals. Non-chemical water treatment system should prevent the formation of hard scale in cooling circuits of air conditioning equipment.It should work with a combination of Adsorption, and Turbulence. The inner core should be able to convert the hardness salts into colloidal particles.The unit should not require any electricity or any other source of energy.The unit should not have any recurring, operating and maintenance cost.The size of the unit shall be determined based on the water quality and water flow rate.The unit shall be installed in the condenser water circuit.The outer casing should be of stainless steel.The method of checking the performance of system through computer simulation shall be provided

19.8.7 **Air Distribution System**

I) Galvanized sheet steel fabricated rectangular ducting shall be provided for the low pressure air distribution system. The thickness of sheets type of bracings and other fabrication details shall be as specified below: -

	Larger dimensions of Duct	Thickness of GS sheet (mm)	Type of Transverse Joint Connection	Bracing
a.	Upto 600	0.63 (24 g)	S-drive, 25 mm pocket or bar slips on 2.5 m centers	25 x 25 x3 angles 1.2 m from joint
b.	601 thru 750	0.63 (24 g)	S-drive, 25 mm pocket or 25 mm bar slips on 2.5 m centers	25 x 25 x 3 angles braced at 1.2 m from joints.
c.	751 thru 1000	0.80 (22 g)	S-drive, 25 mm pocket or 25 mm bar slips on 2.5 m centers	25 x 25 x3 angles braced at 1.2 m from joints.
d.	1001 thru 1500	0.80 (22 g)	40 x 40 angle connections or 40 mm pocket or 40 mm bar slips with 35 x 3 bar reinforcing on 2.5 m centers	40 x 40 x 4 angle braced at 1.2 m from joints.
e.	1501 thru 2250	1.00 (20 g)	40 x 40 angle connections or 40 mm pocket or 40 mm bar slips with 35 x 3 bar reinforcing on 2.5 m centers.	40 x 40x 4 angle braced at 600 mm from joints.
f.	2251 and larger	1.25 (18 g)	50 x 50 angle connections or 40 mm pocket or 40 mm bar slips 1 m centers with 35 x 3 bar reinforcing	50 x 50 x 5 angle braced at 600 mm from joints.

II) The longitudinal seams and transverse joints shall be flat and smooth inside the duct. All rectangular ducts shall be flat on face and pittsburgh on corner of duct. Duct pieces shall be joined together by 'S' and drive slip joints or by angle iron flanges. The size of connecting flanges shall be same as that of the bracing angle. The interconnecting flanges shall be connected with 10 mm galvanised bolts and nuts at about 125 mm centres. All flanges shall be connected to the ducts by rivets at about 125 mm centres. The ducts shall be tapped 6 mm across the flanges. All flanged joints shall have 6 mm thick felt packing stuck to the flanges with shellace varnish or approved equal adhesive. The holes in the felt packing shall be burnt through.

III) Ducts 2250 mm and larger require special field study for supporting. Unless otherwise specified, the ducts with larger side greater than 2250 mm shall be supported by 15mm MS rods and 65x65x5 mm MS angles while those below 2250 mm shall be supported by 10 mm MS rods and 50x50x4 mm MS angles. The MS rods and angles shall be given two coats of redoxide primer paint and final coat of silver colour. The duct support shall be at a distance of not more than 1800 mm. The MS rods shall be hung from the building steel with provision of necessary auxiliary steel members or approved means fixed to the ceiling slab. The auxiliary steel members, hooks, coach screws and all other supporting materials required shall be provided by the bidder. Wherever

in passage, if overhead vertical hanger supports are not possible for the duct length, then channel/beam shall be used, grouted in floor foundation is in the scope of bidders.

IV) Flexible joints shall be provided on the inlet and outlet of each fan and unit to which duct connections are made or where fan sections are isolated from other air handling sections. Connections shall be made from non-combustible heavy glass fabric 1.02 kg/M^2 (30 Oz per sq.yd) double coated with Du Pont's Neoprene (polychloroprene) or Hypalon. Fire standards shall comply with UL214 and NFPA Pamphlet 90A paragraph 2.1.2.3 outlining standards for vibration isolation connectors to duct systems. Minimum 25 mm stack shall be allowed in these connections to isolate transmission of vibration from fan or fan section. The fabric shall either be folded in with the metal or attached with metal collar frames at each end to prevent leakage. The width of the joints from metal edge to metal edge shall be not less than 80 mm and not more than 250 mm. The ends of the ducts or duct and fan connection shall be in line. Canvas or fiberglass shall not be accepted for flexible joints.

V) All curves, bends, offsets and other transformations shall be made for an easy and noiseless flow of air. The throat of every branch duct shall be sized to have the same resistance in the main duct to which the branch duct is connected. All elbows shall have the throat radius of at least seventy five (75) percent of the duct width. In case the throat radius is smaller, suitable single thickness vanes of approved details shall be provided.

VI) Wherever duct passes through wall, all the openings between masonary and duct work shall be neatly caulked or sealed to prevent movement of air from one space to the adjoining space. Where duct passes through the floor, at the lowest point in the elbow a drain trap of 100 mm width across the width of the duct and 50 mm deep shall be provided with suitable gauge valve.

VII) An adequately sized access doors lined with substantial felt edgings shall be provided in the duct work where required. The access doors shall be built up construction, structurally strong and each shall have two rust proof window sash locks of approved type. All doors shall be set out so as to flush with any insulation or plaster finish on the duct.

VIII) Splitters and dampers shall be placed at approved locations for proportional volume control of the system. Splitters and dampers shall be made in 18 gauge GSS of quadrant type with suitable locking device, mounted outside of duct in an accessible location. The metal shall be bent over at each side of the splitter to form a reinforced edge. Each splitter shall be securely attached with a locking device to rods which shall be installed through ducts. On one end of these rods, there shall be locking device with a mark to show the final adjusted position of the splitter

IX) All the plenum chambers or connections to fans, dampers etc, shall be constructed in 18 gauge GSS, supported on 40x40x6 mm MS angle frames. All vertical angles shall be rivetted at approximately 125 mm centres to the casing. 'Pecora' or equivalent caulking compound shall be inserted between the base of angle and all masonary construction to which angles are fastened.

X) Wherever pipe hangers or rods pass through the ducts, light and stream lined casement around the same shall be provided to maintain smooth flow of air.

XI) Supply air grilles shall be of mill finished extruded aluminium construction. Grilles shall be provided with volume control dampers of opposed blade type.

Supply air grilles shall be of double deflection type. All the required steel/wooden frame work for fixing grilles shall be furnished by the bidder.

XII) All air terminals shall be of mill finish extruded aluminium profile construction.

XIII) The proposed ducting scheme, duct sizes, location of supply air grilles etc shown on the enclosed drawings is tentative and subject to finalisation during detailed engineering by the contractor. The bidders shall furnish in their proposal quantities of ducting, duct insulation, supply air grilles. However, these quantities may increase or decrease depending upon the final layout.

XIV) Each branch line shall have dampers to isolate the branch for maintenance purpose.

19.8.8 **Pipe work Valves and Specialities**

i. Unless otherwise specified herein the specification. Piping for sizes smaller than 150 mm NB shall be continuous welded Galvanised steel pipes to IS: 1239 heavy class. Piping for sizes 150 mm and larger shall conform to IS:3589 with minimum 6.35 mm thickness.

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

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

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

v. All valves for sizes 65 mm and larger shall be 150 # ASA standard, double flanged, cast iron body to IS:210 Gr.260, stainless steel trim, bolted bonnet, bolted gland, rising stem outside scraw and yoke, back seated, ends flanged (PF) faced and drilled to ASA-B-16.5. All valves for sizes 50 mm and smaller shall be 800 class standard forged carbon steel body construction to ASTM A 105 stainless steel trim, union bonnets, rising stem inside screw, renewable seats ends female screwed to IS:554.

The butterfly valves shall be designed as per AWWA C 504 and designed to fit between flanges. The butterfly valves shall be provided with flow control lever, black nitrile rubber integrally moulded seating, disc of aluminium bronze to BS 1400 Gr. AB2/AB1, shafts of stainless steel AISI 410. The butterfly valve shall be rated for 16 bar; body/disc tested at 24 bar and seat at 14 bar.

vi. All the pipe supports, guides, anchors, turn buckles, rods, hangers with secondary structural steel framing shall be furnished and installed by the Seller. The Seller's support shall utilize the Purchaser's steel as far as practicable. Where additional secondary steel is required for the hangers, these shall be furnished. The secondary auxiliary steel required for the hangers and supports shall be welded to the Purchaser's steel structure as directed by the Engineer. Welding shall not be permitted across the bottom flange of main structural members.

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

viii. Bolted pipe clamps used for rod hangers shall be of minimum 6 mm thick. Hanger rods shall be 10 mm dia. All hanger components shall be given a shop prime coat of red lead paint.

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

x. All the drain piping between the drain connection of each equipment upto the Purchaser's common drain point in the equipment room shall be provided by the Contractor. Necessary seal loops as required shall be incorporated in the drain piping.

xi. The bidder shall submit the circulating water piping layout for Evaporative Cooling System. The quantities of piping, valves and instruments as required shall be included in the proposal. Requirement of pipe fittings, flanges, bolts and nuts, gaskets, couplings and associated accessories shall be estimated by the bidder and included in the scope of supply.

19.8.9 **Valves**

i. Valves shall have full size port and Suitable for horizontal and as well as vertical installation.

ii. Valves for regulating duty shall be of Globe type suitable for controlling through out its lift.

iii. Gate, Globe and stop Check valves shall have bonnet back seat to facilitate easy replacement of packing with the valves in service.

iv. All Safety / relief valves shall be so constructed that the failure of any part does not obstruct the free discharge.

v. Manual gear operator be provided for valves of size 250 NB and above.

vi. All valves with rising stem shall have position indicators.

vii. All valves shall be provided with locking arranement.

viii. All valves for sizes 65 mm and larger shall be 150 # ASA standard, double flanged, cast iron body to IS:210 Gr.260, stainless steel trim, bolted bonnet, bolted gland, rising stem outside scraw and yoke, back seated, ends flanged (PF) faced and drilled to ASA-B-16.5. All valves for sizes 50 mm and smaller shall be 800 class standard forged carbon steel body construction to ASTM A 105 stainless steel trim, union bonnets, rising stem inside screw, renewable seats ends female screwed to IS:554.

ix. The butterfly valves shall be designed as per AWWA C 504 and designed to fit between flanges. The butterfly valves shall be provided with flow control lever, black nitrile rubber integrally moulded seating, disc of aluminium bronze to BS 1400 Gr. AB2/AB1, shafts of stainless steel AISI 410. The butterfly valve shall be rated for 16 bar; body/disc tested at 24 bar and seat at 14 bar.

19.8.9 **Air Washer Unit**

i. Each Air Washer Units (Evaporative System) shall consist of the various Sections such as Air washer chamber / Casing, Tank, Distribution louvers, set of metallic/fabric filters, suction louvers, bird screens, water headers, Spray nozzle, piping, valves, etc, Drift eliminators, Pumps, Fans, Necessary controls & Instrumentation and all other required accessories.

ii. The air washer chamber casing shall be RCC or fabricated from MS sheet as the case may be. The sheet metal air washer chamber casing shall be fabricated from 3.15 mm black M.S. sheet with adequate stiffeners etc. and various sections shall be bolted through gaskets to avoid leakage of water. The inside of casing shall be protected by spray galvanization or by three coats of epoxy painting.

iii. The air washer tank shall be fabricated from MS plate of minimum 6 mm thick and inside and outside surface of the casing and tank shall be spray galvanized. Minimum depth of the tank shall be 600 mm. Tank construction shall be such that the suction screen can be replaced while the unit is operating. Tank shall be provided with overflow, drain with valve, float valve makeup connection with a gate valve backup, quick fill connection with globe valve etc. The overflow pipe shall be connected to drain pipe after isolating valve on drain pipe.

iv. The distribution plate shall be fabricated out of 16G galvanized steel sheet & galvanized steel angle supports with minimum 50% free area.

v. Air washer shall be two-bank construction (one uni-flow and the other cross flow). The water shall be sprayed at filter bank. All header and stand pipes shall be galvanized.

vi. The spray nozzles shall be of brass or bronze with chrome plating and shall be self cleaning type. The nozzle shall be designed to produce fine atomised spray and shall be properly spaced to give a uniform coverage of the air washer section. The pressure drop through the nozzle should be in the range of 1.4 to 2.4 Kg/cm^2(g).

vii. The eliminator plates shall be of 24G thick GS sheets class 350 or from 100% virgin PVC of minimum finished thickness of 3 mm. The eliminator section

made of GSS shall have minimum six bends. The PVC eliminators shall be UV stabilised using Titanium di-oxide and shall withstand the weathering test as per IS:4892 for 500 hrs. Type test report of the compound testing carried out in any reputed laboratory shall be submitted for approval. All supports, tie rods and space bar shall be of either galvanized steel or PVC construction and shall be complete with suitable drip tray and drain pipe.

viii. An airtight inspection door of 600mm X 700mm size and a water marine light be provided for each air washer unit.

ix. Suitable number of brass screen shall be provided in the air washer tank to arrest the dirt entering the circulating water pump suction. Suitable GI grid shall be used inside the screen for reinforcement

x. The specification for centrifugal fans shall generally be as indicated below. However, the fan shall be of DIDW type for TG building and SISW / DIDW for and ESP/VFD building.

xi. Both inside and outside of all the sections of the metal chamber unit shall be spray galvanized to prevent corrosion. The nuts and bolts used for joining the section shall be stainless steel. The connection pieces shall have at least two (2) coats of rust inhibiting paint.

19.8.10 **Unitary Air Filtration**

Each unitary air filtration shall be of single bank (cross flow) consist of Casing, Tanks, Fans, Distribution plates, Moisture eliminator and water repellant type nylon filter with frame and support, Header and standpipe with support, Spray and flooding type nozzle. Water shall be sprayed at filter bank .Screen type suction strainer, Pumps, Necessary controls & Instrumentation, and all other required accessories.

All equipments, components used in unitary air filtration system shall be in line with the specification requirements stipulated in air washer units above except the fans may be of SISW type.

19.8.11 **Instruments, Protective Devices and Interlock**

On-off thermostat with adjustable setting shall be provided with temperature control. Interlocks shall be provided such that compressor can start only after starting the air handling fan. Provision shall also be made to interlock the compressor with condenser water flow switch, chilled water flow switch / circulation pump. Safety devices such as high/low pressure cut out, hermetic motor winding thermostat etc. shall be provided. HP cutout shall be manual reset type while LP cutout shall be auto reset type. The control system shall be PLC based with redundant processor, power supply and communication modules, with CRT operator interface and peripherals serial link shall be provided for transfer of important signals to the DCS in the central control room.

Strip heaters shall be provided with an adjustable thermostat to control the temperature and a safety thermostat and safety interlock shall be incorporated to cut-off the electrical supply to the heater whenever there is failure of airflow.

Fire dampers (solenoid operated) shall be installed at places where supply air duct crosses fire barrier wall, floor slab, return air space (near the wall separating AHU rooms / PAC rooms and A/C area). The fire damper shall be of the same fire resistance as the structure but in no case less than 90 minutes and should be energized to close and the air conditioning equipment shall be tripped off in the event of fire.

19.8.12 **Centrifugal Fans for Evaporative cooling plants**

i. The casing shall be of welded construction fabricated with heavy gauge galvanised sheet steel or MS sheet with spray galvanisation. In case of spray galvaniation zinc deposition should conform to class 275 of IS:277. The minimum thickness of casing shall be 3 mm. It shall be rigidly reinforced and supported by structural angles. The seams shall be permanently sealed air-tight. Split casings shall be provided on larger sizes of fans. Casing drain with valves shall be provided wherever required. The fan shall be of class I construction and Fan velocity should not exceed 10 m/s.

ii. The impeller shall have die-formed backward-curved blades tie welded to the rim and back plate to have a non overloading characteristics of the fan. Rim shall be spun to have a smooth contour. If required intermediate stiffening rings shall be provided. Shaft sleeves shall be furnished wherever required. The impeller, pulley and shaft sleeves shall be secured to the shaft by key and/or nuts. The impeller along with driven pulley shall be dynamically balanced as per AMCA standard.

iii. The bearing shall be self aligning, heavy duly ball, roller or sleeve bearing. They shall be adequately supported. They shall be easily accessible and lubricated properly from outside.

iv. Inlet guard shall be spun to have a smooth contour. Inlet screen, if provided, shall be of galvanized wire mesh of 25 mm square.

v. Base plate with necessary number of spring type vibration isolators or ribbed neoprene rubber pad or cushy foot mounting shall be provided. The vibration isolators should have a minimum of 70% efficiency.

vi. The first critical speed of the rotating assembly shall be at least 25% above the operating speed.

vii. Centrifugal fans shall be provided with Variable frequency drive (VFD) and velocity sensor/static pressure sensor in supply air path to adjust air flow automatically. The minimum efficiency of VFD at full load shall not be less then 96%.

viii. The static pressure of fan shall not be less then 75 mmwc.

19.8.13 **Power Roof Extractors**

Power roof extractor's impeller shall be of axial type. Casing shall be made of MS minimum thickness of 3 mm up to a fan diameter of 750 mm, 5 mm for fans with impeller diameter of 750 mm and above and the same shall be spray or hot dip galvanized and impeller shall be made of cast aluminium impeller with blades of aerofoil design. The speed of the roof ventilators shall not exceed 960 rpm for impeller diameters larger than 450 mm and 1440 rpm for impeller diameters 450 mm and less. Hood of the roof ventilator shall be of hinged type providing easy access to motor and impeller. Mounting frame for mounting the roof ventilators shall be provided. Weatherproof lockable type disconnect switch shall be provided such that, the hood can be opened only when the disconnect switch is in "OFF" position.

The roof extractors shall shall be used for buildings of height 7 (seven) metres and above. The static pressure of power roof extractor shall not be less then 15 mmwc.

All accessories rain protection exhaust hood, transformation piece, vibration isolators, steel supports vibration isolators, bird screen, etc. as required shall be provided.

19.8.14 **Axial and Propeller Fans**

These fans shall have single piece cast aluminium impeller with blades of aerofoil design.

The fan casing shall be of heavy gauge sheet steel construction minimum thickness of 3 mm up to a fan diameter of 750 mm, 5 mm for fans with impeller diameter of 750 mm and above and the same shall be spray or hot dip galvanized.

Necessary rain protection cowl, inlet and outlet cones, bird protection screen, adjustable damper, vibration isolators, back draft dampers etc. shall be provided.

The speed of the fan shall not exceed 960 rpm for fan with impeller diameter above 450 mm and 1400 rpm for fan with impeller diameter 450 mm or less. However for fans having static pressure of 30 mm WC or above the speed of the fan shall not exceed 1440 rpm for fan with impeller diameter of above 450 mm and 2800 rpm for fan with impeller diameter of 450 mm or less. The first critical speed of rotating assembly shall be atleast 25% above the operating speed.

The static pressure of supply air fans with pre & fine filters shall not be less then 32 mmwc while for exhaust fans 10 mmwc. However the propeller fans for toilets and pantries shall be 5 mm wc.

All other accessories like supporting structure etc. as required shall be provided.

19.8.15 Gravity Damper

Gravity dampers (self acting dampers) are provided to ensure pressurization of electrical rooms, switch gears rooms, substations etc. Dampers shall be of gravity type designed such as not to allow infiltration of air from outside. The louvers of the dampers shall be freely mounted on Spindles to allow the damper to open freely with the pressure developed in the premises. The damper shall be provided with flange at the inlet, the pressure inside the premises shall be 1-2mm WC.

19.8.16 **Fresh Air Unit for Air Conditioning System**

The fresh air unit shall consist of:

- Wall cowl with bird screen, tube axial fan with motor.
- Pre-filter made up of HDPE and efficiency 90% down to 10 microns and maximum face velocity of 1.75 m/sec. The prefilter used for evaporative coolers and ventilation system shall be of same specification.
- Fine filter made up of HDPE and efficiency 99.5% down to 5 microns and maximum face velocity 1.25 m/sec.
- Volume control damper, ducting, fixing frame and necessary supports.
- Filter frame shall be of aluminium and shall be flanged.

19.8.17 **Plant Control for Air conditioning system**

a) **General**

Brief scheme of controlling the operation is described below. Detailed description of the control system for safe and efficient operation of the plant shall be elaborated, got approved from Bidder. The descriptions in the sub-sections of the Control & Instrument sections shall also be referred to.

b) **Control Scheme of Air Conditioning System**

i. The Air Conditioning System control system shall be PLC based. The PLC configuration and detailed specification of the same shall be as per Control & Instrumentation requirements specified elsewhere in the specification.

ii. Each system shall be provided with required I/O modules and two numbers of Operator Work (OWS) Stations. All the functional requirements specified below and general control logic specifed under this section shall be implemented in the respective PLCs.

iii. The basic function of the system shall be to closely control and monitor inside temperature and humidity conditions inside the air-conditioned spaces, to optimize/minimize energy consumption by automated operation, to provide remote centralized monitoring & control for various mechanical facilities including sequential start/stop of the whole HVAC System, automatically calculate record and cooling load for each hour/ day/season, to generate maintenance data & alarms, to maintain records of plant operation & energy consumption for varying loads, duty cycling to operate all the equipment including standby equipment for equal duration, automatic startup of standby equipment in case of failure of operating unit and displaying fault alarm status of the tripped unit, activating/ deactivating water valves to startup/stop water flow through chiller/condenser circuit. For sequential operation /duty cycling, Programmed startup/stop of individual AHU as per operating requirements and for maintaining the room temperature/ RH by controlling the 3 way mixing valves at chilled water line, humidified system and duct heater.

iv. PLC provided for the Control of AC system shall suitably interface with integral microprocessor based controls of Chiller units.

v. The PLC based control system of Air Conditioning system shall also interface with Wide Area Network of the Station to be supplied by the Bidder.

c) **Water Chilling Plant Control**

i. Microprocessor based controls shall be provided along with facilities to interface with central PLC and to meet the requirement of all system operations and controls.

ii. Water chilling unit control system shall be designed to have a constant chilled water outlet from evaporator at all load condition by means of controlling ON-OFF thermostat (one for each compressor). The closure of liquid line solenoid valve and tripping of compressor at lower water temperature and opening of solenoid valve and starting of compressor at high set point shall be automatic through the thermostat. Between the above set points the compressor capacity shall be controlled automatically.

iii. Water chilling unit shall be equipped with superheat control of water chilling unit through thermostatic expansion valve, which gets its impulse from temperature element connected with suction line after chiller outlet.

iv. High discharge pressure cut-out and oil pressure (OP) differential cut-out shall be of manual reset type and low pressure cut-out shall be automatic reset type. The OP cut-out shall trip the compressor in case of low oil pressure.

v.

vi. On-off toggle switch to close the liquid refrigerant line solenoid valve shall be provided to shut the compressor by the operation of the operation of low pressure cut-out (after the refrigerant has been pumped to the condenser).

vii. Switching of Crank case heaters shall be interlocked with starting and stopping/tripping of compressor motor. Further, the safety thermostat shall switch off the crank-case heater in the event temperature rises above safe limit.

viii. Provision shall also be made for the manual restarting of the compressor.

ix. On-off type anti-freeze thermostats, one for each chiller shall be provided in addition to the controlling on-off thermostat for safety purpose and shall act in the event of failure of on-off thermostat to close the liquid line solenoid valve and also to trip the compressor simultaneously.

x. Compressor starting/running shall be interlocked with the flow switches to be provided at the outlet of each chiller and each condenser and as well as with pressure in the inlet of the condensers. In addition closure or open status of various valves through limit switches shall be used for interlock, alarm and control of Air Conditioning System.

xi. The standby condenser water pumps, standby chilled water pumps, & standby AHU shall be started automatically when the working equipments are stopped/ tripped. Auto/Manual selector Switches and working/ Standby selector switches for the pumps/AHU/fresh air fan shall be provided in the panel.

xii. Closure of fire dampers shall raise an annunciation in the panel.

xiii. There shall be provision in control panel for temperature and flow readings in chilled water inlet and outlet line across AHUs to monitor the air conditioning load of each area.

xiv. Operation of Air conditioning system shall be interlocked with the required minimum pressure and temperature of cooling water at inlet to the condenser through pressure and temperature transmitters. Status indication of Station auxiliary Cooling water pumps & associated cooling towers shall be provided in the control panel of air conditioning plant.

d) **Air Handling Unit chilled water type**

i. Control of the inside room temperature and humidity shall be by controlling the chilled water flow by means of motor operated three way modulating valve and the modulating valve shall get its signal from the temperature sensor.

ii. Humidistat located in the return air duct shall actuate the pan humidifier to obtain the desired degree of humidification.

iii. Separate Humidistat and thermostats shall be provided and interlocked in steps with winter heater / re-heater / strip heaters for monsoon and winter re-heating or heating as the case may be.

iv. Heater banks shall be interlocked with the running of AHU, temperature of return air, humidity of return air and safety thermostat (Geyserstat located in front of the each heater in the supply air duct)

v. AHU shall be started either from its local panel or from the main control panel of AC system by means of Remote/Manual selector switches.

vi. The closure of fire dampers, automatic tripping of AHU fans and fresh air fans shall be interlocked with Bidder's fire Detection System.

vii. Each AHU shall be provided with temperature indictors and flow indicator in the chilled water piping inlet and outlet to monitor the air-conditioning load of each area.

viii. Miscellaneous control requirements

ix. Separate emergency local stop push button shall be provided for each pump, compressor, fans etc. of AC system.

x. Lamps shall be provided for indicating the status of each pump, compressor, fans etc. of AC system in the main and local panel.

xi. All the annunciation related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped / tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, compressor, AHU, PAC etc. in the respective panel.

xii. Fully wired, twenty percent (20%) spare annunciation windows shall be provided in all the panels.

19.8.18 **Plant control for Evaporative cooling and Ventilation system**

i. Brief scheme of controlling the operation is described below. Detailed description of the control system for safe and efficient operation of the plant shall be elaborated, got approved from Owner. The descriptions in the sub-sections of the Control & Instrument sections shall also be referred to.

ii. Air Washer Units (AWU) & Unitary Air Filteration Units (UAF)

iii. Air washer units shall be started/stopped by initiation from the local panel and the starting/stopping of fans and pumps shall be automatic upon such initiation.

iv. The operation of the pumps shall be interlocked with the low level of water in the sump. High level of the sump shall be annunciated. The standby pump shall be started automatically when the working pump is stopped/tripped.

v. Auto/Manual selector Switches and working/Standby selector switches for the pump shall be provided in the panel.

vi. A selection switch enabling the running of AWU fan or pump alone shall be provided.

vii. Miscellaneous control requirements

viii. Separate emergency local stop push button shall be provided for each pump, fans etc. of Ventilation system.

ix. Lamps shall be provided for indicating the status of each pump, fans etc. of Ventilation system in the main and local panel.

x. All the annunciations related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped / tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, AWU etc. in the respective panel.

xi. The fans (both supply and exhaust fans) associated with mechanical ventilation system shall be operated locally.

xii. Fully wired, twenty percent (20%) spare annunciation windows shall be provided in all the panels.

19.8.19 Bidders shall ensure that the guaranteed control room noise level is maintained and the units are designed for achieving the same. The vibration level of the units shall be within limits and vibration isolation shall be achieved by providing suitable spring type or pad type (or combination) vibration isolators for ventilation system equipment (centrifugal fans) and airconditioning system equipment (A/c units, AHUs, Cooling Towers, Pumps etc.)

SECTION: C 2B

CUSTOMER SPECIFICATIONS
PROJECT SPECIFIC GENERAL REQUIREMENTS

CHAPTER – 3

GENERAL TECHNICAL REQUIREMENTS

1.00.00 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.

2.00.00 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.

3.00.00 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.

4.00.00 COMPLETENESS OF FACILITIES

4.01.00 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.

4.02.00 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.

5.00.00 CODES & STANDARDS

5.01.00 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.

5.02.00 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)

5.03.00 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, alongwith 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 else where in the specification together with the complete word to word translation of the standard that is normally not published in English.

5.04.00 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.

5.05.00 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.

5.06.00 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.

5.07.00 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.

6.00.00 EQUIPMENT FUNCTIONAL GUARANTEE

6.01.00 The Equipment and Auxiliaries shall be capable of continuous operation in frequency range of 47.5 to 51.5 Hz.

6.02.00 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.

6.03.00 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.

7.00.00 DESIGN OF FACILITIES/ MAINTENANCE & AVAILABILITY CONSIDERATIONS

7.01.00 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.

7.02.00 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.

8.00.00 DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY BIDDER

8.01.00 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/drgs. in accordance with the schedule of information as specified in Technical Specification and data sheets.

8.02.00 The number of copies/prints/CD-ROMs/manuals to be furnished for various types of documents is given in Annexure-I attached with Chapter 3.

8.03.00 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:

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/ 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 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.

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

ii. Flow diagrams, Process & Instrumentation Diagrams alongwith 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 system wherever applicable & input and output data alongwith 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, 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, 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 alongwith the date vide which the submissions are made.

8.03.01 **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. 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.

Erection Manuals

The erection manuals shall be submitted atleast 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 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

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 maloperation 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.

8.03.02 **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

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.

8.03.03 **Project Completion Report**

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

8.03.04 **Drawings**

(a.) 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.

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

(c.) The completed plant documentation with equipment drawings, data sheets, P&ID, BOQ, schematics, logic diagrams, test reports and quality plan, etc. shall be furnished to Owner.

(d.) All documents/text information shall be in latest version of MS Office.

(e.) 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.

(f.) 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, notings, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

(g.) 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”.

(h.) Similarly, all the drawings/ documents submitted by the Bidder during detailed engineering stage shall be stamped “FOR APPROVAL” or “FOR INFORMATION” prior to submission.

(i.) 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.

(j.) 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.

(k.) 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.

(l.) Drawings shall include all installations and detailed piping layout drawings. Layout drawings for all piping of 65 mm and larger diameter shall be submitted for review/ approval of Owner prior to erection. Small diameter pipes shall however be routed as per site conditions in consultation with site authority/representative of Owner based on requirements of such piping indicated in approved / finalized Flow Scheme / Process & Instrumentation Diagrams and/or the requirements cropping up for draining & venting of larger diameter piping or otherwise after their erection as per actual physical condition for the entire scope of work of this package.

(m.) Assessing & anticipating the requirement and supply of all piping and equipment shall be done by the Bidder well in advance so as not to hinder the progress of piping & equipment erection, subsequent system charging and its effective draining & venting arrangement as per site suitability.

(n.) As Built Drawings

After final acceptance of individual equipment/system by the Owner, the Bidder will update all original drawings and documents for the equipment/ system to “as built” conditions.

(o.) Drawings must be checked by the Bidder in terms of its completeness, data adequacy and relevance with respect to Engineering schedule prior to submission to the Owner. In case drawings are found to be submitted without proper endorsement for checking by the Bidder, the same shall not be reviewed and returned to the Bidder for re-submission. The Bidder shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data/drawings at site which are needed as an input to the engineering. The Bidder shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Owner’s scope and submit all necessary drawings/ documents for the same.

(p.) The Bidder shall submit adequate prints of drawing/data/document for Owner’s review and approval. The Owner shall review the drawings and return one (1) copy to the Bidder authorizing either to proceed with manufacture or fabrication, or marked to show changes desired. When changes are required, drawings shall be re-submitted promptly, with revisions clearly marked, for final review. Any delays arising out of the failure of the Bidder to submit/rectify and resubmit in time shall not be accepted as a reason for delay in the contract schedule.

(q.) All engineering data submitted by the Bidder after final process including review and approval by the 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.

8.04.00 **Engineering Information Submission Schedule**

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

(a.) Information that shall be submitted for the approval of the Owner before proceeding further, and

(b.) Information that would be submitted for Owner's information only.

The Engineering Information Schedule shall be updated monthwise.

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.

8.05.00 **Engineering Progress and Exception Report**

8.05.01 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.

8.05.02 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.

8.06.00 **Co-Ordination Meetings**

8.06.01 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.

8.06.02 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.

8.06.03 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.

8.06.04 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.

8.06.05 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.

8.07.00 **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.

8.08.00 **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.

8.09.00 **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.

8.10.00 **Lubricants, Servo Fluids and Chemicals**

8.10.01 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.

8.10.02 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.

8.11.00 **Lubrication**

8.11.01 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.

8.12.00 **Material of Construction**

8.12.01 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.

8.13.00 **Rating Plates, Name Plates & Labels**

8.13.01 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.

8.13.02 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.

8.13.03 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.

8.13.04 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.

8.13.05 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.

8.13.06 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.

8.13.07 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.

8.13.08 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.

8.13.09 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

8.14.00 **Tools and Tackles**

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

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

8.15.00 **Welding**

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

8.16.00 **Colour Code for all Equipment/ Pipings/ Pipe Services**

8.16.01 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.

8.17.00 **Protection and Preservative Shop Coating**

8.17.01 **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 nonmetallic 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 overground environment as the case may be.

8.17.02 **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 atleast 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 colors shall be as per manufacturer's standards, to be selected and specified by the Owner at a later date.

8.17.03 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.

8.17.04 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.

8.17.05 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.

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

9.00.00 QUALITY ASSURANCE PROGRAMME

9.01.00 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.

9.02.00 **General Requirements - Quality Assurance**

9.02.01 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.

9.02.02 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.

9.02.03 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.

9.02.04 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.

9.02.05 No material shall be despatched from the manufacturer's works before the same is accepted, subsequent to predespatch final inspection including verification of records of all previous tests/inspections by Owner's Project Manager/Authorised representative and duly authorised for despatch by issuance of Material Despatch Clearance Certificate (MDCC).

9.02.06 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.

9.02.07 The Bidder shall submit to the Owner Field Welding Schedule for field welding activities in the enclosed format No.: QS-01-QAI-P-02/F3. 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.

9.02.08 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.

9.02.09 All brazers, welders and welding operators employed on any part of the contract either in Bidder's/sub-Bidder's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Owner.

9.02.10 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.

9.02.11 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.

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

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

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

9.02.15 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.

9.02.16 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.

9.02.17 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. With in 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.

9.02.18 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.

9.02.19 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.

9.02.20 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.

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

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

9.02.23 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.

9.03.00 **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.

9.03.01 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.

9.03.02 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

9.03.03 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.

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

(a.) If the result of the review carried out by the Inspector is satisfactory, the Inspector shall stamp the quality document (or applicable section) for release.

(b.) If the quality document is unsatisfactory, the Supplier shall endeavor to correct the incompleteness, thus allowing to finalize the quality document (or applicable section) by time compatible with the requirements as per contract documents. When it is done, the quality document (or applicable section) is stamped by the Inspector.

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

QA documentation package shall not be later than 3 weeks after the despatch of equipment.

9.03.05 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.

9.04.00 Project Manager's Supervision

9.04.01 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.

9.04.02 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.

9.05.00 Inspection, Testing And Inspection Certificates

9.05.01 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.

9.05.02 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.

9.05.03 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.

9.05.04 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.

9.05.05 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.

9.05.06 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.

9.05.07 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.

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

9.05.09 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.

9.06.00 **Associated document for quality assurance programme:**

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

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

9.06.03 Field Welding Schedule (Annexure-V).

9.06.04 Manufacturing Quality Plan (Annexure-VI).

9.06.05 Field Quality Plan (Annexure-VII).

10.00.00 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 of 1st unit. The chart should contain :

(1.) Biodata 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.

10.02.00 **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 performacne 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 with holding the aforesaid permission.

10.03.00 **Guarantee Tests**

a) The final test as to prove the Functional 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 and completed as per schedule indicated in Vol I GCC

b) These tests shall be binding on both the parties of the Contract to determine compliance of the equipment with the functional guarantee.

c) For performance/ demonstration tests instrumentations, of accuracy class, to the approval of the Owner shall be used. The numbers and location of the instruments shall be as per the specified test codes. In addition the values of parameters shall be logged from the information system provided under Owner's Distributed Digital Control Monitoring and Information system. Test will be conducted at specified load points.

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

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

11.00.00 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 with held 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.

12.00.00 TRAINING OF OWNER'S PERSONNEL

12.01.00 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.

12.02.00 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.

12.03.00 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 reappropriate the training period between O&M and engineering depending upon the details of training module proposed by the Bidder.

12.04.00 Clause 12.02.00 & 12.03.00 shall be applicable for domestic bidders. For foreign bidders refer Vol I GCC.

12.05.00 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.

12.06.00 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.

12.07.00 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.

13.00.00 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.

14.00.00 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 intermittantly operating control valves, the noise level shall be within the limit of 85 dBA.

15.00.00 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 labeled 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.

16.00.00 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.

17.00.00 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.

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

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

a)	Temperature	-	Degree centigrade (deg C)
b)	Pressure	-	Kilograms per square centimeter (Kg/cm^2). Pressure instrument shall have the unit suffixed with 'a' to indicate absolute pressure. If nothing is there, that will mean that the indicated pressure is gauge pressure.
c)	Draught	-	Millimeters of water column (mm wc).
d)	Vacuum	-	Millimeters of mercury column (mm Hg) or water column (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.

17.02.00 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.

17.03.00 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.

18.00.00 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.

19.00.00 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.

20.00.00 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

21.00.00 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.

22.00.00 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 developmental 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:

The environmental appraisal minutes are indicated below.

"Expert Appraisal Committee/MoEF has considered the project on 25th June 2012 and recommended issue of EC subject to TANGEDCO furnishing the cumulative impact on air, water and soil considering the Industries located 15km radius from the Ennore SEZ Project Site. The same is being furnished. Copy of Minutes of EAC is enclosed. Final Environmental Clearance yet to be received. 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/$Nm^{3.}$.
c) Bag filters have been proposed for the coal crushers to collect suspended particulate emission.
d) Dust suppression system has been proposed for the coal yard.
e) Equipment for continuous monitoring of Ambient Air Quality has been proposed.
f) On line / automatic continuous stack monitor has been proposed.
g) Port holes in the chimney and sampling facilities for the stack for the proposed Boiler, as per the Central Pollution Control Board guide lines.
h) 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 equipments / machines shall be erected over the Anti vibration foundations to reduce noise, vibration etc.,
i) The unit shall have separate energy meter for the operation of the Electro Static Precipitator, the Air pollution control equipment for the proposed Boiler.

j) Alternate power source will come into effect in case of power failure for the operation of Air Pollution Control measures

k) laboratory for analysis of gaseous / particulate emissions

l) 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.

m) 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.

n) Closed conveyors for coal transport and Bag filters in all the transfer points to control dust emission have been proposed

o) Dust suppression system / water sprinklers to keep the stock pile sufficiently wet all the time to avoid carryover of dust.

p) 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.

q) Burners have been designed for low NOx.

r) 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.

s) 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.

t) The unit shall have on line/automatic continuous stack monitors with computer recording arrangement for monitoring SPM, Sox and Nox in the boiler emission.

u) Sewage Treatment Plant & Effluent Treatment Plant has been proposed.

v) Natural draft cooling tower has been included in the specification.

w) 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.

x) 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	1	

S. NO.	DESCRIPTION OF MANUALS	NO OF PRINTS (sets)	NO. OF CD-ROMs (sets)
	Organization for implementation and QA system manual (with revision-servicing)		
16	Vendor details in respect of proposed vendors including Bidder's evaluation report.	1	
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	4	2 CD ROMS
19	Monthly Vendor Approval	2	1 CD ROM
	and QP approval status		
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	Familiarization with various system and equipment	Manufacturing processes of pressure parts, and equipment	Control philosphy operation, notices, logic & protection schemes, O&M manual familiarization O&M issues
	Combustion and Air & gas weight calculation	Performance data collect-ion analysis and review	Welding process	
	Pressure part calculation	O&M feed back	Testing facilities	Familiarization of special maintenance techniques.
	Pressure part and strength calculation	Operation history of various equipment and system	Product development in process	Special tool and tackles familiarization
	Tube metal temp. calculation and selection.	Failure analysis	Future plan for technology induction	
	Performance calculation		R&D work inprogress	
	Duct design.			
	Pressure part			

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PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design 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.	**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 Em- ployer's engineers with the help of trainer.			

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PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	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.			
	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**	**-**	**-**	**-**

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

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PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	Design principle for Up rating/down rating of existing design/ modules for the specific project.			
	Selection of nos., type and arrangement of bearings, load calculation on bearings, bearing oil flow calculation Selection, design and control principle for Turbine governing system 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	Familiarization of power plants of various makes of feed pumps Data collection of BFP	Manufacturing process of various components of BFP Assembly of BFP	

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	Feed Pump parameters	parameters and configur ation		
	Rotor design, strength calculation and rotor dynamic behavior studies wrt critical speed, vibration etc	Collection of data for analysis of availability of BFP	Testing, capabilities of BFP at works wrt performance, NPSH, thermal shock, dry run, visual cavitation, string test, axial thrust measurement	
	Impeller design and its hydraulic behavior	O&M history/problems related to BFP	Product development in process	
	Role of critical 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		R&D work in progress	
	Guiding factors for selection of BFP seals			
	Computation of axial thrust under various flows			
	Performance calculation			
	Transient analysis in pump			

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PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	suction piping wrt NPSH margin Latest technological trends in BFP design			
MANDAYS	**20**	**5**	**10**	
Condenser	Selection of condenser type and its optimization wrt temp rise across condenser, pressure drop in condenser, surface area etc.	Comparative studies of salient features	Manufacturing process of various components of condenser Assembly	
	Techno economic studies for Selection of condenser tube material and other parts depending on water quality Condenser support selection & design Sizing of condenser w.r.t. super critical units Latest technological trends in condenser arrangement and design Condenser vacuum system 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 Future plan for technology induction R&D work in progress	

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PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
MANDAYS	**10**	**5**	**5**	
Feed Regenerative Equipment's	Thermal and mechanical design calculation 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	Comparative studies of salient features Analysis of data O&M history/problems related to heaters	Manufacturing process of various components of heaters Assembly Testing capability at works Product development in process	
	Sizing criteria for De-aerator/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.			

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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	
Ash Handling System	Equipment Theory & Maintenance Practice			
MANDAYS	16	4	4	
Coal Handling System	Equipment Theory & Maintenance Practice			
MANDAYS	20	5	5	
H_2 Plant	Equipment Theory & Maintenance Practice			
MANDAYS	10	3	3	
Condensate Polishing Unit	Equipment Theory & Maintenance Practice			
MANDAYS	15	5	5	

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PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
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			
	Development of mimics			
	Other application like calculations, logs historical storage functionalities & use			
MANDAYS	**40**	**6**		8

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PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
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		
	Critical analysis of few control loops e.g., TSCS Stress Control boiler startup control etc.			

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
MANDAYS	**12**	**4**		
DDCMIS-Burner Management System	Hardware logic, NFPA/ VDE requirements other safety standard Flame scanner location	Operational feedback	Manufacturing procedure& precautions for handling the system 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 Details of software & methods of modification/ customisation	Operational feedback		
Misc. systems for SG/TG C&I				

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PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
MANDAYS	**6**	**3**		
BOP (DDCMIS)	Hardware organization		Manufacturing process of PLC hardware	
	Operating system features		Integration & testing facilities	
	Data base organization			
	Logic/loop algorithm Development of control logic & loop s/w & MMI application development			
MANDAYS	**24**	**-**	**6**	
BOP Controller System				
1) Hard Ware	**Equipment Theory & Maintenance Practice**			
MANDAYS	**30**	**10**	**10**	
2) Soft Ware	**Equipment Theory & Maintenance Practice**			
MANDAYS	**30**	**10**	**10**	
VMS				
1) Hardware	**Equipment Theory &**			

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PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
	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 &			

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PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	Maintenance Practice			
MANDAYS	**16**	**-**	**4**	
Networking / MIS	**Equipment Theory & Maintenance Practice**			
MANDAYS	**12**	**-**	**4**	
Electric Power Supply System	Theory & design features		Manufacturing/assembly process	
			Testing methodology	
MANDAYS	**5**	**2**		

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PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
(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		(b) Testing facilities	
MANDAYS	**30**	**15**	**15**	
Generator Excitation System including AVR.	Design features of various sub-systems	- Operational feed back	- Manufacturing process& testing facilities for various equipment of excitation system	
	Excitor	- Familiarisation with various equipment functioning at reference plants		
	PMG			
	Transformer			
	Controllers & different limiters etc.			
	PSS & associated system studies			
MANDAYS	**30**	**15**	**15**	

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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 Rotor core & wdg Insulation system Cooling arrangement	Operational feed back	Manufacturing process & test facilities	
MANDAYS	20		5	
POWER TRANSFORMER	**Equipment Theory & Maintenance Practice**			
MANDAYS	12	-	4	4
UPS/BATTERY CHARGER	**Equipment Theory & Maintenance Practice**			
MANDAYS	8	-	4	4
GIS	**Equipment Theory & Maintenance Practice**			
MANDAYS	24	4	12	24
SAS	**Equipment Theory & Maintenance Practice**			
MANDAYS	12	-	6	6

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PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
CRITICAL PIPING & POWER CYCLE PIPING	Design familiarization for critical piping of supercritical Plant	Familiarization with feed back (in super critical plant) on failure analysis and vibration analysis of piping.	Cold Setting of spring hanger	
	Optimization study for sizing including pressure drop calculation and selection of single or double lead together with Owner's engineers	Study of Feed back regarding hanger setting strategies and practice	Cyclic tests carried on spring hangers.	
	Design and stress analysis of lines with Expansion Joints together with Owner's engineers		Cyclic tests carried on expansion joints	
	Design and stress analysis of piping systems with two phase flow involving Owner's engineers		Manufacturing process of critical piping components and appreciation of their testing facilities at shop	
	Transient analysis and optimum sizing of feed suction piping together with Owner's engineers.			

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PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	Static and dynamic analysis of critical piping including siesmic and other occassional load analysis (safety valve blowing condition). A joint activity together with Owner's engineers. Study and collection of data pertaining to special welding requirements (pre and post weld heat treat ment and electrode selection criteria etc.) of materials used in high temp piping system. Study and collection of data on special requirements in case of welding dissimilar metals and electrode selection criteria			
MANDAYS	**45**	**10**	**10**	

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ANNEXURE-III

	Project : **Stage :** **Package :** **Supplier :** **Bidder No. :**	**LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL** **SUB-SYSTEM:**	**DOC. NO.:** **REV. NO.:** **DATE :** **PAGE : OF**

S. N.	Item	QP/ Insp. Cat.	QP No.	QP Sub. Schedule	QP approval schedule	Proposed sub-supplier	Place	Sub-suppliers approval status/ category	Sub-supplier Details submission schedule	Remarks

LEGENDS

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

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

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

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

2. **QP/INSPN CATEGORY**:

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

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

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

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

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ANNEXURE-IV

	Project : S Package : Bidder : Bidder No. :	STATUS OF ITEM REQUIRING QP& SUB-SUPPLIER APPROVAL	DOC. NO.: REV. NO.: DATE : PAGE : OF

S. N.	Item/ Service	QP/ Insp. Cat.	QP Sub. Schedule Approval schedule	Date of sub-mission	Date of commt Appl.	Status Code C/II/I	Proposed Sub-suppliers	Place of manufacturing works	Approval Status	Sub-supplier detail submission schedule	Remarks

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ANNEXURE-V

	Project : Stage : Bidder : Bidder No. : System :	**FIELD WELDING SCHEDULE** **(To be raised by the Bidder)** **Welding Code: ……**	**DOC. NO.:** **REV. NO.:** **DATE :** **PAGE : OF**

Sl. No.	DRG No. for Weld Location and Identification mark	Description of parts to welded	Matl. Spec.	Dimensions		Process of welding	Type of Weld	Electrode filler spec.	WPS. No.	Min. pre-heat	Heat treatment		NDT method/ Quantum	REF		Remarks
											Temp.	Holding time		Spec. No.	ACC Norm Ref.	

NOTES:

SIGNATURE

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ANNEXURE-VI

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

MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER	**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	FOR THE	DOC. NO.: REV…… CAT…..

SIGNATURE	**P:** PERFORM **W**: WITNESS AND **V:** VERIFICATION. AS APPROPRIATE, **CHP:** THE OWNER SHALL IDENTIFIED IN COLUM "N"	**OWNER USE**	**REVIEWED BY**	**APPROVED BY**	**APPROVAL SEAL**

ANNEXURE-VII

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

SL. NO	ACTIVITY AND OPERATION	CHARACTERISTICS / INSTRUMENTS	CLASS# OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	REMARKS
1.	2.	3.	4.	5.	6.	7.	8.	9.		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;**		DOC. NO.: REV……	
MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER		FOR THE		

SIGNATURE	**'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)	**OWNER USE**	**REVIEWED BY**	**APPROVED BY**	**APPROVAL SEAL**

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13.0 QUALITY PLAN FOR MANUFACTURE OF EQUIPMENT:

13.1 The Quality plan for manufacture is a document, which presents in a tabular form. The Quality Control checks to be exercised by the Contractor during the various stages of manufacture and despatch in order to meet the requirements of this Contract. This plan shall detail the components manufactured, characteristics being controlled and acceptance norms for this characteristic and the agency responsible for performance and witnessing the checks.

13.2 After issuance of Letter of Intent (LOI), the contractor shall submit to the Owner, the detailed quality plans to be followed during manufacture of all major equipments. These quality plans shall be discussed mutually and updated by the Contractor taking into consideration the requirement of the Owner. The quality plan when approved shall form a part of the contract. This document shall be followed for inspection of the concerned equipment.

13.3 The details of the quality assurance / quality checks envisaged by the Contractor during manufacturing of the equipment supplied by him or procured through his sub-vendors / sub-contractors shall be detailed out in the quality plans to be submitted by the Contractor. The contractor may also furnish any additional information regarding quality assurance / quality checks in the additional sheets, if required. Quality plans for major equipments manufactured by the Contractor or procured through his sub-vendors / sub-contractors shall be submitted during engineering. After approval of the Owner is accorded various quality plans shall be bound as a booklet and shall be submitted to the Owner as soon as possible. The contractor shall ensure that the approved quality plans are followed scrupulously by him and by his sub-vendors / sub-contractors and manufacturing of the items covered under the quality plans shall be taken up only after Owner has approved the quality plan.

14.0 OWNER'S REPRESENTATIVE AT SITE:

14.1 SE/ Projects, "2 x 660 MW Ennore SEZ Supercritical Thermal Power Project at Ash Dyke of NCTPS" shall be the Owner's representative at site and shall act as an In-charge for all the site works. The contractor's Resident Engineer shall report to him for all the day to day works.

15.0 CONSIGNEE:

All materials shall be consigned to:
SE/ Projects
Tamil Nadu Generation and Distribution Corporation
Ennore SEZ Supercritical TPP

16.0 PAINTS, CONSUMABLES:

16.1 Pursuant to the Clause No. 25.0 of Section 3, Volume I, it shall be the responsibility of the contractor to supply all the paints as required.

16.2 It shall be the responsibility of The Contractor to supply all consumables like, grease, lubricating oils, all chemicals, ink & graphs for recorders etc., up to satisfactory completion of trial operation and three months thereafter. The Contractor shall also arrange any additional quantities required specifically for the Performance Guarantee Test. Contractor shall furnish specifications of all such consumables to enable the Owner to purchase his future requirements well in advance.

17.0 THIRD PARTY INSPECTION:

a) Indigenous supplies: - The equipment to be supplied under this Contract shall be inspected during manufacturing as per the quality plan to be finalized. Material verification and stage inspection at all important stages as well as final testing and inspection fall within this scope. The inspection shall be carried out by a third party inspection agency to be appointed by the Owner for

indigenous supplies. The cost towards this inspection shall be borne by the Contractor.

b) In the case of imported supplies: - For imported materials or non- indigenous supplies, the inspection shall be carried out by a foreign agency of repute to be appointed by the contractor as approved by the Owner. The cost of such inspection shall be borne by the Contractor.

18.0 OPERATION AND MAINTENANCE MANUALS:

18.1 For all the equipments supplied by the Contractor, he shall submit to the Owner ten sets of the O&M manuals. The manual shall contain the operational features of the equipment, DOs & DON'Ts, trouble shooting, maintenance schedules for preventive maintenance, detail dimensional drawings, cross sectional drawings, method of assembly etc. to make the Owner's staff acquainted with the equipment as well as to enable them to operate and maintain the same in prescribed manner. Manuals shall contain all information for ordering of the spares, like part name, part no., Drawing/ material Specifications, address of the supplier with phone no. & fax no. etc. Contractor shall ensure that these O&M manuals are made available to the Owner well before starting of initial trials of equipment.

18.2 ERECTION MANUALS:

18.2.1 In order to enable the engineers of the Owner to supervise the works properly, Contractor shall furnish five copies of erection manuals depicting therein the erection procedure, special precautions to be taken, various clearance to be maintained, erection checks and tests to be carried out before the equipment is put to initial trials.

19.0 SUBMISSION AND APPROVAL OF DRAWINGS:

19.1 The contractor shall submit the drawings in sequential order to match with completion of milestone activity. The contractor shall submit all the G.A. drawings, mechanical, electrical and

civil drawings, data sheets etc. for approval of the Owner along with the design calculations and general write up wherever involved. The drawings for all the systems shall be properly coordinated. While scrutinizing the drawings, the Owner shall indicate the corrections to be made in these drawings and documents, which the contractor shall incorporate or justify its correctness. The Contractor then shall submit the revised drawings for approval of the Owner. On approval of the same, Contractor shall furnish six copies and soft copy on CD of these approved drawings to the Owner as per the distribution to be intimated. Any delay in approval of drawings by Owner, due to submission of incorrect data, non-submission of data, non-updating the drawings in line with the corrections indicated shall be to the Contractor's account. During the currency of the contract, if any approved drawings are required to be modified, such details of the modifications required to be carried out shall be separately maintained. On completion of all the works, the Contractor shall incorporate all the changes necessitated in the drawings and submit 6(six) sets of all the "As built" drawing for the records of the Owner. As the drawings shall be approved based on the basic information furnished by the Contractor, approval by the Owner shall not absolve the Contractor of his responsibilities towards correctness of design & performance of the equipment.

20.0 TEST REPORTS:

20.1 On completion of tests of equipment at manufacturer's works, the Contractor shall furnish 4 copies of test certificates to the Owner for approval and subsequent despatch clearance. The test report shall invariably indicate identification data, including model no., sl. no. etc. of the equipment, method of application and duration of test along with test results. Only on approval of these test results by the Owner or Owner's representative, dispatch clearance will be issued for dispatch of material to site.

21.0 FIELD QUALITY PLAN:

21.1 Erection shall be carried out as per ECC, manufacturer's manual, approved quality plan & best practices of the industry. After completing erection of individual equipment, the equipment shall be tested for starting up. The list of all the inspections, tests to be carried out before starting up of the equipment shall be mutually decided. Subsequent to these tests, the equipment shall be tried as a sub system and further as a system as a whole. All the inspections and tests to be carried during these stages shall be mutually decided and as per the best practices. This schedule of inspections and the tests shall be called as field quality plan and Contractor shall follow the same during various stages of erection, testing and operations.

22.0 COMMISSIONING AND HANDING OVER:

22.1 INITIAL TRIAL:

On completion of erection of equipment, each item of the equipment shall be thoroughly cleaned and inspected jointly by the Owner / Consultant and Contractor for correctness and completeness of installation and acceptability for initial trials of the equipment by the Contractor & Owner. During the above joint walk down, the list of equipment deficiency & defects shall be prepared and for such a punch list, action shall be initiated by the Contractor in agreed time frame. The list of tests to be performed prior to initial trials shall be mutually agreed and included in the Field Quality Plan by Contractor. The purpose of these trials is to ensure integrity of each individual equipment for its operation in the system for initial operation.

22.2 INITIAL OPERATION:

After successful initial trials of all the individual equipment, all equipments shall be operated together as a system. The purpose of this initial operation is to ensure integrity of all the

sub-systems which compose the total system. Based on the observations made during initial operation, necessary corrections shall be effected in the equipment / systems to ensure proper integrated operation of the system. After satisfactory completion of initial operation for each equipment & sub-system, the complete equipment shall be considered ready for trial operation. During initial operation, any adjustments/calibrations to the instruments fitted in the new system shall be done in the presence of testing staff of Owner so as to enable them to familiarize themselves with its adjustments and maintenance. The Contractor has also to ensure that he trains Owner's Engineers at site dealing with this system in proper way.

22.3 TRIAL OPERATION:

22.3.1 After satisfactory initial operation, the plant shall be put on trial operation. The period of trial operation shall be Thirty (30) days of which minimum continuous seventy two (72) hours shall be at full load. During the period of trial operation, all the necessary adjustments in the plant / equipments shall be made by the Contractor to establish that the complete system as a whole with all sub-systems and with all standby equipment is ready for continuous operation. During these trials, all the standby equipments also shall be run alternatively and continuously for 14 days to prove their performance. During this period, the Contractor shall demonstrate capabilities of his supplied equipment as indicated in the specification or in subsequent discussions. Duration of Breakdown due to grid disturbances will not be reckoned as interruption.

22.3.2 A trial operation report comprising of dates and duration of trial, observations and recordings of various parameters to be measured shall be prepared by the Contractor and signed jointly by the Owner and the Contractor. The report shall have sheets, recording all the details of interruptions occurred, adjustments made and any minor repairs done during the trial operation. If the trial operation is established

to be satisfactory, except for some minor adjustments, if any, the plant shall be taken over by the Owner for day to day operation and maintenance from the date of conclusion of trial operation. If the trial operation is not satisfactory, then based on the observations during trial operation, necessary modification / repairs to the plant / equipment shall be carried out by the Contractor and on completion of such works, the trial operation shall be repeated again on a date and for a period for 28 days as per clause no. 22.3.1 mentioned above.

22.4 After the trial operation is carried out successfully, to declare it as such, a joint protocol should be signed between TANGEDCO and the Contractor.

22.5 The goods supplied under the contract shall be fully insured up to 3 months from the date of taking over of the plant. However in case the trial operation is extended due to reasons attributable to the Owner, then the insurance policy shall be extended by the Contractor till successful completion of trial operation / taking over of the plant and the actual premium charges towards this extension of insurance policy shall be reimbursed by the Owner to the Contractor without any handling charges.

23.0 PERFORMANCE GUARANTEE TEST:

23.1 After satisfactory completion of the trial operation, the performance test shall be conducted at site by the Contractor. Any preparations required for this test shall be carried out by the Contractor for which Owner will provide required shutdown. The duration of the Performance Guarantee Test of the Plant at the rated capacity shall be mutually agreed. However, a stability period of 2 hours before commencement of test and 2 hours test period followed by another 2 hours stable period shall be maintained. The PG test procedure should be submitted to the owner well in advance and got approved before the commencement of PG test. Performance Guarantee Test shall be conducted within 30 days of intimation from the

Contractor about his readiness for conducting Performance Guarantee Test. These tests shall be binding on both the Owner and the Contractor to determine performance of the equipment/system with the performance guarantee data.

23.3 The tests shall be conducted at the specified load conditions or as near the specified conditions as practicable. The Owner/Contractor will apply agreed factors to compensate for deviation from the designed parameters. The suitable correction curves mutually agreed by the Owner and the Contractor shall be used.

23.4 All test instrumentation as required for the Performance Guarantee Test shall be arranged by the Contractor free of cost. Precision instruments required for Performance Guarantee Test shall, however, be arranged by the contractor. Calibration before and after test and installation of the test instrumentation for the test shall be the Contractor's responsibility. All test instrumentation shall be in accordance with the applicable code. All test instruments and calibration procedures shall be duly approved by the Owner. Batch calibration shall not be accepted. The test shall be commenced only after clearance of owner on the above vital issues.

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

23.6 The performance guarantee figures of the equipment shall be proved by the Contractor during the Performance Guarantee Test.

23.7 Should the results of these tests show any decrease from guaranteed values, the Contractor shall modify the equipment within 90 days from the date of intimation by the owner as required to bring it to meet the guarantees. In such cases, the performance tests shall be repeated within one month from the date on which the equipment is made ready again for tests subject to grid requirements at that time. All

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

23.8 The provisions outlined in the ASME performance test code or other International and Indian approved equivalents shall generally be used as a guide for all the above test procedures unless specified otherwise in the specification. The details of all measuring/recording meters, test instrumentation such as class of accuracy, make etc. shall be covered in the trial operation/ performance test reports. All the list of equipments, accuracy class and test certificates to be submitted and got approved by the owner before the commencement of trail operation.

PG test to be witnessed by the consultant and the owner.

23.9 The above shall be read in conjunction with Volume – I, Section 1, General Technical Specification on Performance Guarantee Test.

24.0 PERFORMANCE GUARANTEES, PENALTIES & CAPABILITY TESTS:

24.1 The Contractor shall meet the Performance Guarantees as have been indicated in the Specifications and Schedule thereof.

24.2 The penalty for not meeting the performance guarantees during the Performance Guarantee Test shall be assessed and recovered from the Contractor. Such penalty shall be levied without limitations, in accordance with stipulations made in Technical Specification and shall be without prejudice to all the other conditions of the contract.

24.3 If the guarantees specified are not achieved by the Contractor within 90 days of notification by the Owner, he may at his discretion reject the equipment or accept it after levying and recovering suitable penalties.

24.4 In case there is shortfall in capability of equipment while demonstrating capability tests, the Contractor shall forth-with rectify his equipment within 90 days and re-perform the capability tests to Owner's satisfaction.

24.4.1 Any recoveries by the Owner from the Contractor due to shortfall in guaranteed performance shall be independent of provisions of clause no. 6.0 "Liquidated damages of Special Conditions of the Contract. "

25.0 PENALTY FOR POOR PERFORMANCE:

25.1 The contractor shall furnish performance guarantee as have been specified in Guarantee Schedule under Technical Specification Vol-II. This guarantee shall be met by the Contractor.

25.2 The penalty for not meeting the performance guarantees during the Performance Guarantee Tests shall be assessed and recovered from the Contractor as under.

EVALUATION / LOADING CRITERIA & PENALTY TOWARDS SHORTFALL IN PERFORMANCE PARAMETERS:

S. No.	Variation Factor	Loading for evaluation of shortfall in performance	Penalty for shortfall in performance
1	2	3	4
1	HEAT RATE:- Increase in Station heat rate in kCal / kWh under rated steam conditions at 100% TMCR	Rs.428.41 lakhs per kCal / kWh increase in heat rate over lowest quoted Heat Rate as base.	Rs. 428.41 lakhs per kCal / kWh or part thereof increase in heat rate from guaranteed value

S. No.	Variation Factor	Loading for evaluation of shortfall in performance	Penalty for shortfall in performance
1	2	3	4
	after subtracting excitation power with following conditions: 1.Cycle make-up : 0% makeup 2.Cooling water inlet temperature of 33 deg.C 3.TDBFP's in operation 4. Generator power factor of 0.85 (Gross Turbine cycle heat rate at 100% TMCR condition is guaranteed after accounting for pressure drop in main steam piping, Reheater system and all extraction steam piping from steam turbine to feed water heaters & deaerator)		

S. No.	Variation Factor	Loading for evaluation of shortfall in performance	Penalty for shortfall in performance
1	2	3	4
2	Total auxiliary power consumption of all auxiliaries (*) at 660 MW at after subtracting excitation power with following conditions: 1. Cycle make-up : 0% makeup 2. Cooling water inlet temperature of 33 deg.C 3. TDBFP's in operation 4. Generator power factor of 0.85	Rs.4,70,72,094 for every 0.01 % increase (considering 5.5 % lowest quoted Auxiliary Power Consumption as base)	Rs.4,70,72,094 for every 0.01 % increase or part thereof from guaranteed value
3	Capitalization of losses of Transformers Iron losses Copper losses Cooler pump/fan losses (applicable for each transformer separately	Rs.3,49,880 /kW Rs.2,89,701 /kW Rs.2,79,904 / kW (considering lowest quoted values as base)	Rs.3,49,880 /kW Rs.2,89,701 /kW Rs.2,79,904 / kW Increase per kW or part thereof from guaranteed value

S. No.	Variation Factor	Loading for evaluation of shortfall in performance	Penalty for shortfall in performance
1	2	3	4
4	Deficiency in capacity of TG from 660 MW at Generator terminals with following conditions: 1. Cycle make-up : 0% makeup 2. Cooling water inlet temperature of 33 deg.C 3. TDBFP's in operation 4. Generator power factor of 0.85	--	Rs 10,55,668 for every kW or part thereof by which output determined by the tests fall short of guaranteed figure of 660 MW
5	Steam Generator Efficiency with following conditions: i) 100% TMCR ii) Firing design coal iii) On Gross Calorific value	--	Rs 9,33,52,000/- for every 0.1% (zero point one percent) shortfall in efficiency

S. No.	Variation Factor	Loading for evaluation of shortfall in performance	Penalty for shortfall in performance
1	2	3	4
	(GCV) basis iv) Rated excess air v) At 32 deg C DBT and 65% RH ambient air conditions.		

Note: All above loadings & penalties as mentioned in Col. 3 & 4 shall be calculated on pro-rata basis.
The penalty indicated above is in addition to the liquidated damages as stipulated in clause no.6.0 of this Section.

* The guaranteed auxiliary power consumption shall be furnished as per list enclosed in Schedule 15 A. Bidder shall list out any additional continuous working equipment in addition to the item listed , which are required for the plant to operate at 100% TMCR load.

26.0 FINAL ACCEPTANCE:

26.1 In case Performance Guarantee Test cannot be carried out at specified time due to reasons attributable to Owner, the Plant shall be taken over 180 days after the intimation from the Contractor provided the Owner is satisfied about his readiness for conducting the Performance Guarantee Test. In such case, the Owner shall give an adhoc final acceptance certificate for the purpose of triggering the Guarantee/Defect Liability period which will be subject to revision based on actual PG test results. In such an eventuality, the Owner shall give a notice to the Contractor of

his readiness to give necessary inputs to enable the Contractor to do the Performance Guarantee Test, in which case the Contractor shall arrange the Performance Guarantee Test within 30 days on receipt of such notice without any additional financial implication to the Owner.

26.2 On conducting the Performance Guarantee Test, if it is established to the satisfaction of the Owner that the equipment is performing as specified in the Technical Specifications, the Owner shall issue to the Contractor a final acceptance certificate indicating the date from which the equipment has been taken over.

26.3 Such a certificate shall be given within 30 days after satisfactory completion of the performance guarantee test and PG test results are furnished by the Contractor to prove the achievement of the assured PG values. Owner shall not delay the issuance thereof on account of minor omissions or defects which do not affect the safe and reliable operation and/or cause any risk to the equipment. Such certificate shall, however, not relieve the Contractor of any of his obligations which otherwise survive by the terms and conditions of the contract.

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SCHEDULE 15 - FUNCTIONAL GUARANTEES

(in Section 5.0 - Formats & Schedules of Volume I)

This schedule is modified and shall be read as below:-

A. GUARANTEES UNDER CATEGORY-I -PERFORMANCE GUARANTEES UNDER PENALTY

Sl. No.	Particular	Value inclusive of design, manufact
1.0	Minimum Gross Turbine cycle heat rate at 100% TMCR after subtracting excitation power and power of TG integral auxiliaries with following conditions: 1. Cycle make-up : 0 % makeup 2. Cooling water inlet temperature of 33 deg.C 3. TDBFP's in operation 4. Generator power factor of 0.85 (Gross Turbine cycle heat rate at 100% TMCR condition is guaranteed after accounting for pressure drop in main steam piping, Reheater system and all extraction steam piping from steam turbine to feed water heaters & deaerator)	.....kCal/ kWh
2.0	Steam generator efficiency with following conditions: i) 100% TMCR ii) Firing design coal iii) On Gross Calorific value (GCV) basis iv) At 32 deg C DBT and 65% RH ambient air conditions. v) Excess air at economizer outlet at 100% TMCR load) 20% (min.) vi) Corrected flue gas temperature at air preheater outlet (at 100% TMCR) 125°C or as predicted by the Bidder whichever is higher vii) Unburnt fuel at all guaranteed efficiency load i.e. 1.0% (min.) or actual whichever is higher	.....%

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Sl. No.	Particular	Value inclusive of design, manufacture
3.0	Gross continuous TG power output at 100% TMCR after subtracting excitation power and power of TG integral auxiliaries with following conditions: (i) Cycle make-up : 0 % makeup (ii) Cooling water inlet temperature of 33 Deg C. (iii) Generator power factor of 0.85	.....MW
4.0	Total Auxiliary power consumption for the plant (1320 MW) including balance of plant at 100% TMCR condition after subtracting excitation power and power of TG integral auxiliaries with following conditions: 1. Cycle make-up : 0% makeup 2. Cooling water inlet temperature of 33 deg.C 3. TDBFP's in operation 4. Generator power factor of 0.85	.....kW
5.0	Transformer losses (at rated capacity transformers) Loss figures should be inclusive of Tolerances <u>Generator Transformer</u> a) Iron Losses b) Copper Losses c) Cooler Pump / Fan Losses <u>Unit Auxiliary Transformer</u> a) Iron Losses b) Copper Losses c) Cooler Pump / Fan Losses <u>Station Transformer</u> a) Iron Losses b) Copper Losses c) Cooler Pump / Fan Losses	 .....kW .....kW .....kW .....kW .....kW .....kW .....kW

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Sl. No.	Particular	Value inclusive of design, manufact
	Standby maintenance Transformers a) Iron Losses b) Copper Losses c) Cooler Pump / Fan Losses Auxiliary Transformers a) Iron Losses b) Copper Losses c) Cooler Pump / Fan Losses Service Transformers a) Iron Losses b) Copper Losses c) Cooler Pump / Fan Losses	.....kW .....kW .....kW .....kW .....kW .....kW .....kW

Note : Refer Volume I - Section 4 vide Clause 25.0 for penalty

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B. GUARANTEES UNDER CATEGORY –II (PERFORMANCE GUARANTEES UNDER REJECTION.

Sl.No.	Particular	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
1.0	NOx emission		
a)	While firing design coal	..... mg/nm³	
b)	While firing worst coal	..... mg/nm³	
2.0	Particulate Emission		
a)	Particulate emission at Electrostatic precipitator outlet at BMCR condition while firing design coal and any one field in each pass out of service.	..... mg/nm³	
b)	Particular emission at Electrostatic precipitator outlet at BMCR condition while firing worst coal and any one field in each pass out of service.	..... mg/nm³	
3.0	Noise Level		
a)	Far field noise level measured at any point at plant boundary	....dBA	
4.0	Effluent discharge at outlet of CMB		
a)	pH		
b)	Residual chlorine	.....ppm	
c)	TDS	.....ppm	
d)	TSS	.....ppm	
5.0	Sea water outfall		
a)	pH		
b)	TDS	---------- ppm	
c)	TSS	---------- ppm	
d)	Temperature	---------- ^{o}C	

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C. GUARANTEES UNDER CATEGORY–III (PERFORMANCE GUARANTEES UNDER COMPULSORY CORRECTION)

Sl. No.	Particular	Unit	Value inclusive of design, manufacture	Applicable Test Codes
1.0	**Noise and Vibration**			
1.1	Sound pressure shall be measured all around the equipment (to be done for all drives/equipment) at a distance of 1.0 m horizontally from the nearest surface of any equipment/ machine and at a height of 1.5 m above the floor level in elevation			
1.2	Vibration for all equipment and drives			
2.0	**Steam Generator Capacity**			
2.1	The Steam Generating Capacity (in T/hr of steam) at the rated steam parameters at the super heater outlet & rated steam temperature at reheater outlet (with any combination of mills working as per Owner's discretion) with the coal being fired from within the range specified at the following conditions. i) BMCR condition ii) TMCR conditions iii) TMCR with all HP heaters out of service condition.			

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Sl. No.	Particular	Unit	Value inclusive of design, manufacture	Applicable Test Codes
2.2	The total attemperation water flow quantity for super heater steam temperature control	T / H		
a)	100% TMCR condition while firing design Coal			
b)	100% TMCR condition while firing Worst Coal			
c)	80% TMCR condition under sliding pressure operation while firing design Coal			
d)	80% TMCR condition under sliding pressure operation while firing worst Coal			
2.3	The total attemperation water flow quantity for reheater steam temperature	T / h		

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Sl. No.	Particular	Unit	Value inclusive of design, manufacture	Applicable Test Codes
	control with rated excess air			
a)	100% TMCR condition while firing design Coal			
b)	100% TMCR condition while firing Worst Coal			
c)	80% TMCR condition under sliding pressure operation while firing design Coal			
d)	80% TMCR condition under sliding pressure operation while firing worst Coal			
e)	It shall also be demonstrated that the RH temperature is maintained at the rated value without any spray water requirement under normal operating conditions (100% TMCR)			
2.4	The super heater steam temperature at the high pressure (HP) turbine inlet under the following conditions: a) Range of Coal specified b) Steam Generator load 60% TMCR to 100% BMCR	°C		

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Sl. No.	Particular	Unit	Value inclusive of design, manufacture	Applicable Test Codes
	under sliding pressure operation			
2.5	The reheat steam temperature at the intermediate pressure (IP) turbine inlet under the Following conditions: a. Range of coal specified b. Steam Generator load 60% TMCR to 100% BMCR under sliding pressure operation	°C		
2.6	Steam temperature imbalance: It shall be demonstrated at SH and RH outlets (in case of more than one outlet) that the temperature imbalance between the outlets does not exceed 10°C under all loads including transients.			
2.7	Furnace exit gas temperature (FEGT): It shall be demonstrated that maximum furnace	°C		

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Sl. No.	Particular	Unit	Value inclusive of design, manufacture	Applicable Test Codes
	exit gas temperature (FEGT) shall be as specified. A comprehensive thermal performance test (TPT) shall be conducted for this purpose on one unit only. FEGT shall be demonstrated through such TPT by indirect measurement.			
2.8	Minimum stable load on the Steam Generator without oil support under the following condition: a. Range of coal specified b. Both Load ramp-up & ramp down c. Any combination of mills in operation.	%		
2.9	Coal consumption at 100% BMCR based on the following i) Gross Calorific value (GCV) of design coal ii) Ambient air temperature 32°C iii) Relative Humidity 65%	T / H		

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Sl. No.	Particular	Unit	Value inclusive of design, manufacture	Applicable Test Codes
2.10	Coal consumption at 100% TMCR based on the following: i) Gross Calorific value (GCV) of design coal ii) Ambient air temperature 32°C iii) Relative Humidity 65%	T / H		
2.11	Coal consumption at 100% BMCR based on the following: i) Gross Calorific value (GCV) of worst coal ii) Ambient air temperature 32°C iii) Relative humidity – 65%	T / H		
2.12	Coal consumption at 100% TMCR based on the following i) Gross Calorific value (GCV) of worst coal ii) Ambient air temperature 32°C iii)Relative humidity – 65%	T / H		
2.13	**Coal Mills**			
a)	Capacity, efficiency and power consumption of each mill while firing design coal: i) New Condition	T / H % K		

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Sl. No.	Particular	Unit	Value inclusive of design, manufacture	Applicable Test Codes
	ii) at 50% wear life iii) at worn out condition			
b)	Capacity, efficiency and power consumption of each mill while firing worst coal; i) New condition ii) at 50% wear life iii) at worn out condition	T / H % K W		
c)	Loading of each mill when steam generator operating at BMCR condition while firing design coal:	%		
d)	Loading of each mill when steam generator operating at 100% TMCR condition while firing design coal:	%		
e)	Loading of each mill when Steam Generator operating at BMCR condition while firing worst coal:	%		
f)	Loading of each mill when Steam Generator operating at 100% TMCR condition while firing worst coal	%		
g)	Coal fineness for the range of coal			

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Sl. No.	Particular	Unit	Value inclusive of design, manufacture and	Applicable Test Codes
	specified			
i)	Through 200 mesh screen	%		
ii)	Through 50 mesh screen	%		
2.14	**Primary Air fans**			
a)	Capacity	m³/h		
b)	Head developed	mWC		
c)	Fan efficiency	%		
d)	Power consumption	kW		
e)	Margins envisaged on capacity and head	%		
2.15	**Forced Draft Fans**			
a)	Capacity	m³/h		
b)	Head developed	mWC		
c)	Fan Efficiency	%		
d)	Power consumption	kW		
e)	Margins envisaged on capacity and head	%		
2.16	**Induced Draft Fans**			
a)	Capacity	m³/h		
b)	Head developed	mWC		
c)	Fan efficiency	%		
d)	Power consumption	kW		
e)	Margins envisaged on capacity and head	%		
2.17	**Seal Air Fans**			
a)	Capacity	m³/h		
b)	Head developed	mWC		

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Sl. No.	Particular	Unit	Value inclusive of design, manufacture and	Applicable Test Codes
c)	Fan Efficiency	%		
d)	Power consumption	k W		
e)	Margins envisaged on capacity and head	%		
2.18	**Fuel Oil Firing System**			
a)	Percentage load for which High Speed Diesel (HSD) firing system is designed	% BMCR		
b)	Percentage load for which Heavy Fuel Oil (HFO) firing system is designed	% BMCR		
2.19	**Air Pre-heater**			
a)	Air heater leakage	%		
b)	Maximum drift in air leakage	%		
2.20	**Run back capabilities**			
	The automatic runback capability of the unit shall be demonstrated on loss of critical auxiliary equipment (such as tripping of one ID/FD/PA / air heater etc) shall be demonstrated ensuring smooth and stable runback operation			
2.21	CO emission at 100% TMCR at rated excess air for specified range			

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Sl. No.	Particular	Unit	Value inclusive of design, manufacture and	Applicable Test Codes
	of coal			
2.22	Flue gas temperature at APH outlet (maximum) while firing design coal at 100% TMCR without considering air leakage.	°C		
2.23	Unburnt carbon in bottom ash while firing design coal at 100% TMCR	%		
2.24	Unburnt carbon in fly ash while firing design coal at 100% TMCR	%		
2.25	Total unburnt carbon loss while firing design coal at 100% TMCR	%		
2.26	Surface temperature of thermal insulation with ambient temperature of 45°C at surface velocity of 0.25 m/s.	°C		
2.27	**Boiler recirculation pump any other pumps**			
a)	Capacity	m^3/h		
b)	Head	m		
c)	Efficiency	%		
d)	Power consumption	kW		
2.28	**Electrostatic**			

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Sl. No.	Particular	Unit	Value inclusive of design, manufacture and	Applicable Test Codes
	precipitator			
a)	Particulate emission at Electrostatic precipitator outlet at TMCR condition while firing design coal and any one field in each pass out of service and its corresponding ESP efficiency	mg/nm³ %		
b)	The ESP air in leakage shall not be more than 1% of total gas flow at ESP inlet at the guarantee point condition and shall be demonstrated.	**%**		
c)	The maximum pressure drop through the ESP at the guarantee point flow condition shall not exceed 20 mm WC, which shall be demonstrated.			
d)	The gas distribution in the various stream and fields shall be demonstrated.			
e)	Any other			
3.0	**Steam Turbine & Auxiliaries**			
3.1	Gross power output at 100% TMCR after subtracting excitation power	MW		

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Sl. No.	Particular	Unit	Value inclusive of design, manufacture and	Applicable Test Codes
	and power of TG integral auxiliaries with following conditions: i) Cycle make-up : 1.0% make-up ii) Cooling water inlet temperature of 33°C iii) Generator power factor - 0.85			
3.2	Gross Power output at VWO on continuous basis after subtracting excitation power and power of TG integral auxiliaries with following conditions: i) Cycle make-up: 1.0 % makeup ii) Cooling water inlet temperature of 33 deg.C (iii) Generator power factor -0.85	MW		
3.3	Gross power output after subtracting excitation power and power of TG integral auxiliaries with following conditions: i) Cycle make-up : 1.0 % makeup ii) Cooling water inlet temperature of	MW		

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Sl. No.	Particular	Unit	Value inclusive of design, manufacture and	Applicable Test Codes
	33 Deg.C iii) Generator power factor - 0.85 iv) All HP heaters out of service.			
3.4	Gross power output excluding excitation power and power of TG integral auxiliaries with following conditions: i) Cycle make-up : 1.0 % makeup ii) Cooling water inlet temperature of 33 Deg.C iii) Generator power factor - 0.85 iv) At 47.5 Hz to 51.5 Hz	MW		
3.5	Continuous TG output of 693 MW unit load (i.e. 105% of rated load) under rated steam conditions excluding Excitation and power of TG integral auxiliaries. i) Cycle make-up : 1% makeup ii) Cooling water inlet temperature of 33 Deg.C iii) Generator power factor - 0.85	MW		

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Sl. No.	Particular	Unit	Value inclusive of design, manufacture and	Applicable Test Codes
	iv) At 47.5 Hz to 51.5 Hz			
3.6	Turbine cycle heat rate at 100% TMCR excluding excitation power and power of TG integral auxiliaries with following conditions: i) Cycle make-up : 1.0 % makeup ii) Cooling water inlet temperature of 33 Deg.C iii) Generator power factor - 0.85			
	Note: the condenser pressure measurement while conducting the above (3.1 to 3.6) guarantee tests shall be measured at 300 mm above the top row of condenser tubes.			
3.7	Turbine- generator capability The steam turbine generator shall be capable of delivering at generator terminals the output as indicated in the heat			

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Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
	balances under the conditions mentioned in functional guarantees.			
3.8	Upon sudden total loss of all external loads units will not trip on over speed but shall continue to be in operation to supply power for plant auxiliary load (house load).	Yes/No		
3.9	Run Back capabilities of the SG and STG upon loss of critical auxiliary equipment, shall ensure smooth and stable run back operation.	Yes/No		
3.10	HP-LP bypass shall automatically come into operation under the following conditions: i) Total external load throw off ii) Turbine trip condition	Yes/No		
3.11	Variable pressure operating range	% TMCR		
3.12	**Condenser**			
a)	Total pressure drop in condenser tube side with design cooling water flow and temperature	mWC		

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Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
b)	Total cooling water temperature rise in condenser with design cooling water flow and CW inlet temperature of 33 deg.C			
i)	Unit operating at 100% TMCR condition	°C		
ii)	Unit operating at VWO condition	°C		
iii)	Unit operating with all HP Heaters out condition and generating 100% TMCR power output	°C		
iv)	Unit operating under house load and HP & LP bypass operating at rated capacity.	°C		
c)	Re-cooled water temperature at Outlet of cooling tower based on the following design conditions:			
i)	Rated Cooling Water Flow	m3/h		
ii)	Design Ambient Wet Bulb Temperature	°C		
iii)	Design Inlet Wet Bulb Temperature	°C		
iv)	Design Relative Humidity	%		
v)	Design Cooling Range	°C		
d)	Condenser pressure in mm Hg	mm Hg (abs)		

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Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
	(abs) measured at 300 mm above the top row of condenser tubes under VWO conditions, 1% make up, design CW temperature and CW flow.			
e)	The following to be demonstrated			
i)	Temperature of condensate, at outlet of condenser, shall not be less than saturation temperature corresponding to the condenser pressure at all loads.	°C		
ii)	Air leakage in the condenser under full load condition shall not exceed more than 50% of design value taken for sizing the condenser air evacuation system	%		
iii)	When one half of the condenser is isolated, condenser shall be capable of taking at least 60% TG load under TMCR conditions.			
iv)	The capacity of each vacuum			

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Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
	pump in free dry air under standard conditions at a condenser pressure of 25.4 mm Hg (abs) and sub cooled to 4.17°C below the temperature corresponding to absolute suction pressure shall not be less than 30 SCFM. Correction curves for establishing the capacity at site conditions shall also be furnished.			
v)	The air and vapour mixture from air cooling zone of condenser shall be 4.17°C below the saturation temperature corresponding to 25.4 mm Hg (abs) suction pressure. Correction curves for establishing the same at site conditions shall also be furnished			
3.13	**Condensate Extraction Pump (CEP)**			
a)	Rated capacity	m^3/h		
b)	Rated Total Dynamic Head (TDH)	mWC		

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Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
c)	Pump efficiency	%		
d)	Power consumption	kW		
e)	Satisfactory operation of CEPs without undue noise and vibration while operating in isolation or in parallel with other pumps shall be demonstrated at site			
3.14	**Booster pump of CEP (If applicable)**			
a)	Rated capacity	m^3/h		
b)	Rated Total Dynamic Head (TDH)	mWC		
c)	Pump efficiency	%		
d)	Power consumption	kW		
3.15	**Condensate Polishing Unit (CPU)**			
a)	Effluent quality of outlet of each vessel at its rated design flow and design service length between two regenerations			
b)	Chemical consumption for regeneration			
c)	Pressure drop across the polisher service vessel ,as specified ,in clean and dirty condition	mWC		

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
	of resin at rated design flow			
d)	Condensate water quality			
3.16	**Feed Water Heaters**			
a)	Pressure drop on the tube side of the individual LP heaters (Maximum)	mWC		
b)	Pressure drop on the tube side of the individual HP heaters (maximum)	mWC		
3.17	**Deaerator**			
	The following to be demonstrated			
a)	TTDs and DCAs of feed water heaters shall be demonstrated as per guaranteed heat balance diagram for 100% TMCR condition			
b)	Outlet temperature from final feed water heaters.	°C		
c)	Dissolved O2 content in Deaerator effluent at deaerator outlet without chemical dosing at all loads, not to exceed 0.005 CC/litre determined as per ASTM-D-888 – Reference method-A or Indigo Carmine	Ppm		

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
	method.			
d)	Difference between saturation temperature of steam entering the deaerator and temperature of feed water leaving the deaerator shall be demonstrated as per guaranteed heat balance diagram for 100% TMCR condition.			
e)	Continuous and efficient operation and performance of feed heating plant without undue noise and vibrations at all loads and duty conditions			
3.18	**Boiler Feed Water Pump (BFP)**			
a)	Rated capacity	m^3/h		
b)	Rated Total Dynamic Head (TDH)	mWC		
c)	Pump efficiency	%		
d)	Satisfactory operation of BFPs without undue noise and vibration while operating in isolation or in parallel with other pumps shall be demonstrated at site			
e)	Power consumption	kW		

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Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
3.19	**Booster pump of BFP**			
a)	Rated capacity	m^3/h		
b)	Rated Total Dynamic Head (TDH)	mWC		
c)	Pump efficiency	%		
d)	Vibration noise level at the rated duty point shall be demonstrated at site			
3.20	**Equipment cooling water system**			
a)	Capacity Head Power consumption Pump efficiency of all the pumps with the respective job (own) motors to be demonstrated at shop.	m^3/h mWC kW %		
b)	Vibration, parallel operation and noise level of all the pumps at the rated duty point shall be demonstrated at site.			
c)	Design heat load of plate type heat exchangers Inlet & Outlet temperatures of the Plate type heat exchangers on the primary and secondary side to be demonstrated	kW °C mWC		

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
	at site. Pressure drop across the Plate type heat exchanger on the primary & secondary water circuit to be demonstrated at site.			
3.21	**Condenser On Load Tube Cleaning System**			
a)	Life of sponge rubber balls and number of balls lost during 1000 hours of plant operation shall be as indicated by Bidder in the offer			
3.22	**HP & LP Bypass System Capability**			
a)	The HP & LP bypass system should satisfy the following functional requirements under automatic interlock action. It should come into operation automatically under the following conditions a) Generator circuit breaker opening b) HP & IP stop valves			

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
	closing due to turbine tripping c) Sudden reduction in demand to house load Under all above conditions, while passing the required steam flows as per the relevant heat balances, the condenser should be able to swallow the entire steam without increasing the exhaust hood temperature and condenser pressure beyond the maximum permissible values. The same shall be demonstrated.			
3.23	**TDBFP**			
a)	Flow	m^3/h		
b)	Head	MWC		
c)	Efficiency	%		
3.24	**Lube oil purification system**			
a)	Capacity	m^3/h		
b)	Lube oil quality-outlet			
3.25	**Control oil purification system**			
a)	Capacity	m^3/h		
b)	control oil quality-outlet			
3.26	**Any other**			

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Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
4.0	**Generator**			
4.1	Generator Maximum Continuous Rating	MVA		
4.2	Generator Efficiency (minimum)	%		
4.3	Hydrogen Make-up per day	m^3/day		
4.4	**Excitation system**			
a)	Capacity of excitation transformer for static excitation	kVA		
b)	Total loss of excitation transformer	kW		
c)	Total loss of static excitation system (if applicable)	kW		
d)	Total loss of brushless excitation system (if applicable)	kW		
5.0	**Unit start-up time (from light-up to synchronization)**	Minutes		
a)	Cold start-up : >72 hours			
b)	Warm start-up : 10-72 hours			
c)	Hot start-up : <10 hours			
d)	Very hot start-up : <1.5 hours			
6.0	**Unit Ramp up / Ramp down**	% per minute		

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Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
	rates			
a)	<50% TMCR			
b)	50%-100% TMCR			
7.0	**Step Load Change**	%		
a)	<50% TMCR			
b)	50%-100% TMCR			
8.0	**Balance of Plant (BOP) Equipment**			
8.1	**Coal Handling Plant System**			
8.1.1	**Number of hours of CHP operation**			
8.1.2	**Guaranteed capacity of each equipment indicated below**			
a)	Belt conveyors - capcity and power consumption	tph kW		
b)	Crushers- capcity and power consumption	tph kW		
c)	Screens- capcity and power consumption	tph kW		
d)	Stacker cum reclaimer–capcity and power consumption	tph kW		
e)	Belt feeder–capcity and power consumption	tph kW		
f)	Vibrating feeder–capcity and power consumption	tph kW		

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Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances		Applicable Test Codes	
g)	Screen efficiency	%				
h)	Any other					
8.1.3	Maximum moisture in coal up to which crusher & screen will be capable of handling	%				
8.1.4	Water requirement for dust suppression system	m^3/h				
8.1.5	Dust emission at each of the dust extraction system	mg/Nm^3				
8.1.6	Belt weigh scale - accuracy	±				
8.1.7	**Pumps**		**Cap. (m^3/h)**	**Head (m)**	**Power (kW)**	**Efficiency (%)**
a)	Coal run-off pit pump					
b)	Dust suppression pump					
c)	Service water pump					
d)	Any other					
e)	Vibration, parallel operation (if applicable) and noise level of all the above pumps at the rated duty point shall be demonstrated					
8.2	**Ash Handling Plant**					
8.2.1	Conveying capacity / Evacuation time					
a)	**Bottom ash evacuation system**					

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Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances		Applicable Test Codes	
i)	Capacity of Scraper chain conveyors	tph				
ii)	Capacity of clinker grinder	tph				
iii)	Capacity of jet pump	tph				
iv)	Any other					
b)	**Fly ash evacuation system**					
i)	Evacuation time per 8 h shift from fly ash hopper to fly ash silo	h				
ii)	Evacuation system capacity	tph				
iii)	Capacity of recovery water system	m^3/h				
8.2.2	**Ash pumps**		**Cap** (m^3/h)	**Head** (m)	**Power** (kW)	**Efficiency** (%)
a)	BA slurry pumps					
b)	FA slurry pumps					
c)	HP pumps					
d)	LP pumps					
e)	BA overflow pump					
f)	Recovery water pumps					
g)	Any other					
h)	Vibration, parallel operation (if applicable) and noise level of all the above pumps at the rated duty point shall be demonstrated					
8.2.3	**Sea water requirement**					

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances		Applicable Test Codes	
i)	Max water requirement in a 8 h shift for ash disposal	m³/h				
ii)	Required sea water in 8 h shift basis as make-up for AHS sea water tank	m³/h				
iii)	Any other					
8.2.4	**Desal water requirement**					
i)	Max water requirement in a 8 hrs shift	m³/h				
ii)	Required water in 8 hrs shift basis as make-up for AHS clarified water tank	m³/h				
8.3	**Water system**		**Cap. (m³/h)**	**Head (m)**	**Power (kW)**	**Efficiency (%)**
8.3.1	Seawater intake pumps – Desalination feed					
8.3.2	Seawater intake pumps – Cooling Tower make-up					
8.3.3	Condenser cooling water pumps					
8.3.4	Auxiliary cooling water pumps					
8.3.5	Closed Cooling water (DMCW) pumps					
8.3.6	Cycle make-up pumps					
8.3.7	Sea water outfall pumps					
8.3.8	**Other Miscellaneous Pumps**					

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances		Applicable Test Codes	
a)	Service water pumps					
b)	CHP dust suppression plant feed pump					
c)	DM water transfer pump					
d)	Potable water transfer pump					
e)	Ash water make-up transfer pump					
f)	APH/ESP wash pump					
g)	DMCW make-up pump					
h)	Boiler initial filling pump					
i)	CT blow down pump					
j)	Any other pumps 1. 2. 3.					
8.3.9	Vibration, parallel operation (if applicable) and noise level of all the above pumps at the rated duty point shall be demonstrated at site.					
8.3.10	Demonstration of Debris filter flushing system					
8.3.11	Clarifier (per unit) – capacity	m^3/h				
8.3.12	Pressure sand filters – capacity	m^3/h				
8.3.13	Desalination plant – Capacity	m^3/h				

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
8.3.14	RO STAGE II – capacity	m^3/h		
8.3.15	DM plant net output	m^3/h		
8.3.16	Mixed Bed OBR	m^3/h		
8.3.17	Water quality at PT Plant outlet			
a)	Pressure sand filter outlet turbidity	NTU		
b)	Gravity filter turbidity	NTU		
c)	Ultra filter outlet	SDI		
8.3.18	**Water quality at RO STAGE I outlet (upon completion of three years from COD without replacement of membrane)**			
a)	Permeate conductivity @ 27 deg.C	Micro mho/cm		
b)	Permeate conductivity @33 deg. C	Micro mho/cm		
c)	Permeate TDS	ppm		
8.3.19	**Water quality at RO STAGE II outlet upon completion of three years from COD without replacement of membrane**			
a)	Permeate conductivity @ 27 deg C	Micro mho/cm		
b)	Permeate conductivity @ 33 deg C	Micro mho/cm		

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
c)	Permeate TDS	ppm		
8.3.20	**Water Quality at Mixed Bed Unit outlet**			
a)	Conductivity @ 25 deg C	Micro mho/cm		
b)	Total Silica	ppb		
c)	pH			
8.3.21	**Water Quality at DM Storage Tank outlet**			
a)	Conductivity @ 25 Deg.C	Micro mho/cm		
b)	Total Silica	ppb		
8.3.22	**Water quality at Potable Water outlet**			
a)	TDS	ppm		
b)	pH			
c)	Boron	ppm		
8.4	**Chemical consumption for water treatment**	kg/day		
	Contractor to list the chemicals type and quantities used			
a)	Pre-treatment plant			
b)	Desalination plant			
c)	DM Plant			
8.5	Chlorination Plant			
a)	Capacity	kg/h		
8.6	**Fuel Oil System**		**Heavy Fuel Oil (tph)**	**High speed Diesel (tph)**
a)	Unloading period	h		
i)	HFO unloading period for 10 road			

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes	
	tankers simultaneously with one standby pump				
ii)	HSD unloading period for 5 road tankers simultaneously with one standby pump				
b)	**Pumps**		**Cap(m^3/h)**	**Head (mWC)**	**Power (kW)**
i)	HFO unloading pump				
ii)	HSD unloading pump				
iii)	Any other				
iv)	Vibration, parallel operation (if applicable) and noise level of all the above pumps at the rated duty point shall be demonstrated				

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances		Applicable Test Codes
8.7	**Fire Fighting System**		**capacity m³/h)**	**Head (mWC)**	**Power Req. (kw)**
a)	Fire water pumps – Hydrant system				
b)	Fire water pumps – spray system				
c)	Fire water booster pumps				
d)	Foam system - pumps				
e)	Jockey pumps				
f)	Any other				
g)	Air compressor Capacity Pressure Power consumption	**Nm³/min** **Bar** **kW**			
h)	Vibration, parallel operation (if applicable) and noise level of all the above pumps at the rated duty point shall be demonstrated at site.				
i)	Any other				
8.8	**Compressed Air System**				
a)	Free air delivery at site conditions per each compressor	Nm³/min	50 Nm3/min @ 8 Kg/cm2(g), however the test shall be conducted at mfg. works.		
b)	Power consumption at site rated parameters per each compressor (kW)	kW	444 KW, however same shall be demonstrated at manufacturer's works		
c)	Max. capacity of each air dryer at min working	Nm³/min	50 Nm3/min @ 7 Kg/cm2(g), however the test shall be conducted at mfg. works.		

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes	
	pressure and max. temp at after cooler outlet (Nm³/min)				
d)	Parallel operation of air compressor shall be demonstrated at site.		Yes.		
e)	Pressure drop across Air Drying Plant, Capacity and outlet dew point of each air drying plant shall be demonstrated at site.	Bar	Pressure Drop: 1.0 Kg/cm2 Capacity : 50 Nm3/min Atmospheric Dew point : -20 deg. C		
f)	Vibration level and noise level of each air compressor, blowers and any other rotating equipments of each air drying plant shall be demonstrated at site.		Vibration shall be limited to 18 mm/sec (r.m.s) Noise shall be limited to 85 dB (A) at 1.5 M from equipment edge under free field condition. However, since free field conditions cannot be achieved at site a background noise correction factor of 12 dB(A) shall be applied.		VDI 3836 ISO 2154:2004 and ISO9614-2
g)	Instrument air quality		Shall be as per Instrument society of American standards S7.3.		
h)	Any other		NA		
8.9	**Elevators**				
8.9.1	**Steam Generator Elevator**				
	Carrying capacity	kg			
8.9.2	**Turbine Building Elevator**				
	Carrying capacity	kg			

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes	
8.9.3	**Crusher house Elevator**				
	Carrying capacity	kg			
8.9.4	**Chimney Elevator**				
	Carrying capacity	kg			
8.9.5	**Any other Elevator**				
a)	**Carrying capacity**	**kg**			
8.10	**Cranes & Hoists**				
8.10.1	Turbine Building Main EOT Crane (AB bay)				
a)	Safe Working Load	T			
b)	Operating speed	(meters per minute)			
i)	Hoisting				
ii)	Long Travel				
iii)	Cross Travel				
8.10.2	Turbine Building BFP EOT Crane (BC bay)				
a)	Safe Working Load	(T)			
b)	Operating speed	(meters per minute)			
i)	Hoisting				
ii)	Long Travel				
iii)	Cross Travel				
8.10.3	CW Pump house EOT crane				
a)	Safe Working Load	(T)			
b)	Operating speed	(meters per minute)			

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes	
i)	Hoisting				
ii)	Long Travel				
iii)	Cross Travel				
8.10.4	Seawater intake pump house EOT crane				
a)	Safe Working Load	(T)			
b)	Operating speed	(meters per minute)			
i)	Hoisting				
ii)	Long Travel				
iii)	Cross Travel				
C)	Any other area requiring Cranes 1. 2. 3.				
8.11	**Mill Reject System**				
a)	Conveying capacity	tph			
b)	Compressor capacity / numbers	Nm3/min			
c)	Continuous effective discharge and conveying at the rated capacity of the mill rejects without spillage or blockage in the system shall be demonstrated.				
8.12	**Air conditioning System**		Cap (TR)	Inside Dry Bulb Temp. °C	Inside Relative Humidity %

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes	
a)	Main Control room in TG Building				
b)	Control room in following aux buildings.				
c)	ESP control building				
d)	Switchyard control building				
e)	DM plant control room				
f)	Coal handling control building				
g)	Ash handling control building				
h)	Service building Floor wise: 1. 2.				
i)	Any other area requiring air conditioning 1. 2.				
8.13	**Ventilation system**		**Capacity (m^3/h)**	**Pressure (mmWc)**	
a)	TG Hall				
b)	Switchgear room in TG building				
c)	Cable spreader room in TG building				
d)	SWAS room in TG building				
e)	Switchgear room in ESP building				
f)	Cable spreader room in ESP building				
g)	DG set room				

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
h)	Air compressor house			
i)	Battery room			
j)	Switchgear room			
k)	Cable spreader room			
l)	Filtered water pump house			
m)	CW pump house			
n)	Chemical house			
o)	Fire water booster pump house			
p)	Fuel oil pump house			
q)	AC plant room			
r)	Chlorination room & associated areas			
s)	GIS Switchyard			
t)	Any other area requiring ventilation 1. 2. 3.			
8.14	**Road Weigh Bridge**			
a)	Weighing capacity	T		
b)	Platform size	m x m		
c)	Accuracy	%		
d)	Load cell	OIML R60 edition 2000		

8.15	**Hydrogen generation plant**			
a)	Capacity Discharge pressure of hydrogen gas compressors at its rated duty point with its job (own) motor shall be demonstrated and proved at shop.	Nm3/h bar(g)	10Nm3/h each stream 150 Kg/cm2. The same shall be proven at site with its job motor.	
b)	Parallel operation of two streams shall be demonstrated at site. Purity level and moisture content of Hydrogen shall be demonstrated at site.		Yes	
c)	Hydrogen generation plant capacity (stream wise) shall be demonstrated at site	Nm3/h	10	

SIGNATURE OF

CONTRACTOR_____

NAME_____

DESIGNATION_____

COMPANY SEAL **DATE** _____

Anshul S A Khan Praveen Kishore

Amendment to

Schedule 15A in Section5.0 -Formats & Schedules of Volume I

Anshul S A Khan Praveen Kishore

SCHEDULE 15A - GUARANTEED AUXILIARY POWER CONSUMPTION

(in Section 5.0 - Formats & Schedules of Volume I)

This schedule is modified and shall be read as below:-

Complete list of auxiliary power consumption at input to motor including design, manufacture and all other tolerances shall be guaranteed by the Contractor as given below for 0% make-up condition:

SCHEDULE OF AUXILIARY POWER CONSUMPTION

Sl. No.	Particulars	Total number provided (Working + Standby) for each unit	Power consumption for each motor / equipment at 100 % TMCR condition	Total Power consumption in kW at 100% TMCR condition for each unit	Total Power consumption in kW at 100% TMCR condition for 1320 MW
(1)	(2)	(3)	(4)	(5)	(6)
1.0	**Steam Generator and Auxiliaries**				
1.1	**Total auxiliary power consumption of the following HT and LT drives for the Steam Generator & Auxiliaries at 100 % TMCR while firing design coal**				
a)	Primary Air (PA) Fans including its lube oil pumps.				
b)	Coal Feeders				
c)	Seal air fans				
d)	Coal mills including its lube oil pumps.				
e)	Forced Draft (FD) Fans including its lube oil pumps.				
f)	Regenerative Air Preheater including its lube oil pumps.				
g)	Electrostatic precipitators (ESP)				
h)	Induced Draft (ID)				

Anshul S A Khan Praveen Kishore

Sl. No.	Particulars	Total number provided (Working + Standby) for each unit	Power consumption for each motor / equipment at 100 % TMCR condition	Total Power consumption in kW at 100% TMCR condition for each unit	Total Power consumption in kW at 100% TMCR condition for 1320 MW
(1)	(2)	(3)	(4)	(5)	(6)
	Fans including its lube oil pumps.				
i)	Boiler circulation pumps				
j)	Pressurising pumps of fuel oil system				
k)	Scanner air fans				
l)	Electrical Heat Tracing (if applicable)				
m)	Any Other Items (Contractor to list any other continuously running equipment) 1 2 3				
1.2	**Grand total value (Sum of Items for 1.1 (a) to (m)**	-	-		
2.0	**TURBINE GENERATOR AND AUXILIARIES**				
2.1	**Total auxiliary power consumption of the following HT and LT drives for the Turbine Generator and Auxiliaries at 100 % TMCR while firing design coal**				
a)	Booster pumps for TDBFP				
b)	TDBFP lube. Oil pumps				
c)	Electric oil heater of TDBFP lube. Oil pumps				
d)	Oil purifiers of TDBFP including feed and discharge pumps				

Anshul S A Khan Praveen Kishore

Sl. No.	Particulars	Total number provided (Working + Standby) for each unit	Power consumption for each motor / equipment at 100 % TMCR condition	Total Power consumption in kW at 100% TMCR condition for each unit	Total Power consumption in kW at 100% TMCR condition for 1320 MW
(1)	(2)	(3)	(4)	(5)	(6)
e)	MDBFP Auxiliary Oil pump				
f)	Condensate Extraction Pumps (CEP).				
g)	Oil pumps for HP & LP bypass system				
h)	Condenser air evacuation equipment (Vacuum pumps)				
i)	Condenser online tube cleaning pumps				
j)	LP drain condensate pump (if applicable)				
k)	Chemical Dosing pumps				
l)	Any Other Items (Contractor to list any other continuously running equipment) 1 2 3				
2.2	**Grand total value (Sum of Items for 2.1 (a) to (l)**				
3.0	**Balance of Plant - Unitised Systems**				
3.1	**Total auxiliary power consumption of the following HT and LT drives combined together for the Balance of Plant - Unitised Systems at 100 % TMCR while firing design coal.**				
a)	Main Cooling Water pumps				
b)	Auxiliary cooling water				

Anshul S A Khan Praveen Kishore

Sl. No.	Particulars	Total number provided (Working + Standby) for each unit	Power consumption for each motor / equipment at 100 % TMCR condition	Total Power consumption in kW at 100% TMCR condition for each unit	Total Power consumption in kW at 100% TMCR condition for 1320 MW
(1)	(2)	(3)	(4)	(5)	(6)
	booster pumps (ACW)				
c)	Closed cooling water pumps (DMCW)				
d)	Cycle make-up pumps				
e)	DM transfer pumps				
f)	Any Other Items (Contractor to list any other continuously running equipment) 1 2 3				
3.2	**Grand total value (Sum of Items 3.1 (a) to (f)**				

Sl. No.	Particulars	Factor (Refer Note 2)	Total Power consumption at rated load of respective system for 1320 MW	Total Power consumption in kW for 1320 MW for guaranteed auxiliary power computation
(1)	**(2)**	**(3)**	**(4)**	**(5) = (3) x (4)**
4.0	**Balance of Plant-Common Systems**			
4.1	**Total auxiliary power consumption of the following Balance of Plant Systems common for 1320 MW while firing design coal.**			
a)	Coal Handling System – Maximum of the below option	**0.6**		
i)	Path 1: JTB-3 → JTB-4 → TH-1 → CRH-1 → TT-1 → TT-2 → TT-3 → TT-4 → TT-5 → TT-6 → TT-7 → TT-8 →			

Anshul S A Khan Praveen Kishore

Sl. No.	Particulars	Factor (Refer Note 2)	Total Power consumption at rated load of respective system for 1320 MW	Total Power consumption in kW for 1320 MW for guaranteed auxiliary power computation
(1)	(2)	(3)	(4)	(5) = (3) x (4)
	TT-9 → TT-10 → TT-11 → TT-12→ Last bunker of Unit 2.			
ii)	Path 2: JTB-3 → JTB-4 → TH-1 → CRH-1 → TT-1 → TT-7 → TT-8 → TT-9 → TT-10 → TT-11 → TT-12→ Last bunker of Unit 2.			
b)	Ash handling system			
i)	Bottom ash Evacuation System	**1.0**		
ii)	Fly ash Evacuation System	**0.7**		
iii)	Bottom ash disposal System	**1.0**		
iv)	Fly Ash disposal System	**1.0**		
v)	Recovery water system	**1.0**		
c)	Mill Reject system	**0.5**		
d)	Fuel oil system			
i)	Fuel oil unloading system	**0.1**		
ii)	Fuel oil forwarding system	**0.1**		
e)	Seawater intake system	**1.0**		
f)	Seawater outfall system	**1.0**		
g)	Pre-treatment plant	**0.9**		
h)	Desalination plant (RO STAGE I, RO STAGE II, DM Plant) Water treatment plant	**0.9**		
i)	Chlorination Plant	**0.9**		
j)	Auxiliary water system	**0.9**		
k)	Effluent treatment plant	**0.5**		
l)	Air conditioning system	**1.0**		
m)	Ventilation system	**1.0**		
n)	Compressed air system	**0.75**	1810 kW	1357 kW

Anshul S A Khan Praveen Kishore

Sl. No.	Particulars	Factor (Refer Note 2)	Total Power consumption at rated load of respective system for 1320 MW	Total Power consumption in kW for 1320 MW for guaranteed auxiliary power computation
(1)	**(2)**	**(3)**	**(4)**	**(5) = (3) x (4)**
o)	Plant lighting	**0.6**		
p)	STP	**0.5**		
q)	Hydrogen generation Plant	**0.6**	140 kW	84 kW
r)	Fire fighting system	**0.4**		
s)	Any Other Items (Contractor to list any other continuously running equipment) 1 2 3			
4.2	**Grand total value (Sum of Items under Column (5) for 4.1 (a) to (s)**			
5.0	**Electrical System**			
5.1	**Total auxiliary power consumption of the following Electrical Systems at 100 % TMCR**			
a)	Generator Transformer losses (at Unit rated Load Condition)			
b)	Unit Transformer losses (at Unit rated load conditions)			
c)	Station Transformer losses (at Unit rated load conditions)			
d)	Losses in all other transformers (at Unit rated load conditions)			
e)	Losses in Bus ducts (at unit rated load conditions) • Isolated Phase Bus Duct • Phase segregated Bus Duct			
f)	UPS power consumption (at Unit rated load condition)			
g)	DC System power consumption (at unit rated load condition)			

Anshul S A Khan Praveen Kishore

Sl. No.	Particulars	Factor (Refer Note 2)	Total Power consumption at rated load of respective system for 1320 MW	Total Power consumption in kW for 1320 MW for guaranteed auxiliary power computation
(1)	**(2)**	**(3)**	**(4)**	**(5) = (3) x (4)**
h)	Any Other Items (Contractor to list any other continuously running equipment) 1 2 3			
5.2	**Grand total value (Sum of Items under Column (5) for 5.1 (a) to (h)**			
6.0	**Total Guaranteed auxiliary power consumption for 1320 MW** **(Sum of Items under column (6) for 1.2+2.2+3.2+4.2+5.2).** **[Refer Note 2.]**			

1. Common Balance of Plant (BOP) auxiliaries will not be working continuously. Hence the applicable factors indicated shall be considered on the total rated load of the respective system excluding the standby equipment for arriving at the guaranteed auxiliary power consumption for each system.

2. Contractors to note that the grand total value under Sl No 6.0 will be considered for evaluation, Performance Guarantees and for penalty.

SIGNATURE OF CONTRACTOR _____ NAME
DESIGNATION _____
SEAL OF THE COMPANY _____
DATE _____

Anshul S A Khan Praveen Kishore

AMENDMENT TO

VOLUME II - SCHEDULE C (PERFORMANCE PARAMTERS)

as

a) Schedule C 1- FUNCTIONAL GUARANTEES

b) Schedule C 2- GUARANTEED AUXILIARY POWER CONSUMPTION

c) Schedule C 3- FUNCTIONAL GUARANTEES REQUIREMENTS

Note : The above requirement will also replace the Chapter 1 in Section 4 (Page 126) of Volume III and Section 4 (Page 233) in Chapter 2 of Volume III

Anshul S A Khan Praveen Kishore

Vol.II – SCHEDULE C (PERFORMANCE PARAMETERS)

is amended as below:

a) Schedule C 1- FUNCTIONAL GUARANTEES

b) Schedule C 2- GUARANTEED AUXILIARY POWER CONSUMPTION

c) Schedule C 3- FUNCTIONAL GUARANTEES REQUIREMENTS

Note : The above requirement will also replace the Chapter 1 in Section 4 (Page 126) of Volume III and Section 4 (Page 233) in Chapter 2 of Volume III

SCHEDULE C 1- FUNCTIONAL GUARANTEES

A. GUARANTEES UNDER CATEGORY I -PERFORMANCE GUARANTEES UNDER PENALTY

Sl. No.	Particular	Value inclusive of design, manufacture and all other Tolerances	Acceptable Shortfall limit with Penalty	Applicable Test Codes
1.0	Minimum Gross Turbine cycle heat rate at 100% TMCR after subtracting excitation power with following conditions: 1. Cycle make-up : 0% makeup 2. Cooling water inlet temperature of 33 deg.C 3. TDBFP's in operation 4. Generator power factor of 0.85 (Gross Turbine cycle heat rate at 100% TMCR condition is guaranteed after accounting for pressure drop in main steam piping, Reheater system and all extraction steam piping from steam turbine to feed water heaters & deaerator)	.....kCal / kWh	(+) 2.5% of the Guaranteed Gross Turbine Cycle Heat Rate subject to maximum of 1850 kcal/kWh	

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Value inclusive of design, manufacture and all other Tolerances	Acceptable Shortfall limit with Penalty	Applicable Test Codes
2.0	Steam generator efficiency with following conditions: i) 100% TMCR ii) Firing design coal iii) On Gross Calorific value (GCV) basis iv) At 32 deg C DBT and 65% RH ambient air conditions. v) Excess air at economizer outlet (at 100% TMCR load) 20% (min.) vi) Corrected flue gas temperature at air preheater outlet (at 100% TMCR) 125°C or as predicted by the Bidder whichever is higher vii) Unburnt fuel at all guaranteed efficiency load i.e. 1.0% (min.) or actual whichever is higher	.....%	(-) 0.25% point from the guaranteed efficiency.	
3.0	Gross continuous TG power output at 100% TMCR after subtracting excitation power and power of TG integral auxiliaries with following conditions: (i) Cycle make-up : 0 % makeup (ii) Cooling water inlet temperature of 33 Deg C. (iii) TDBFPs in operation (iv) Generator power factor of 0.85	.....MW	(-) 1.0% of the Guaranteed Gross Power Output	

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Value inclusive of design, manufacture and all other Tolerances	Acceptable Shortfall limit with Penalty	Applicable Test Codes
4.0	Total Auxiliary power consumption (as per Schedule 2) for the plant (1320 MW) at 100% TMCR after subtracting excitation power and power of TG integral auxiliaries with following conditions: 1. Cycle make-up : 0% makeup 2. Cooling water inlet temperature of 33 deg.C 3. TDBFP's in operation 4. Generator power factor of 0.85	.....kW	------	
5.0	Transformer losses (at rated capacity transformers) Loss figures should be inclusive of Tolerances <u>Generator Transformer</u> a) Iron Losses b) Copper Losses c) Cooler Pump / Fan Losses <u>Unit Auxiliary Transformer</u> a) Iron Losses b) Copper Losses c) Cooler Pump / Fan Losses <u>Station Transformer</u> a) Iron Losses b) Copper Losses c) Cooler Pump / Fan Losses <u>Standby maintenance Transformers</u> a) Iron Losses b) Copper Losses c) Cooler Pump / Fan Losses	 .....kW .....kW .....kW .....kW .....kW .....kW .....kW .....kW .....kW .....kW .....kW .....kW	-----	

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Value inclusive of design, manufacture and all other Tolerances	Acceptable Shortfall limit with Penalty	Applicable Test Codes
	Auxiliary Transformers a) Iron Losses b) Copper Losses c) Cooler Pump / Fan Losses Service Transformers a) Iron Losses b) Copper Losses c) Cooler Pump / Fan Losses	 .....kW .....kW .....kW .....kW .....kW .....kW		

Note : **Refer Volume I Section 4,Clause 25.0 for penalty.**

Anshul S A Khan Praveen Kishore

B. GUARANTEES UNDER CATEGORY II -PERFORMANCE GUARANTEES UNDER REJECTION

Sl. No.	Particular	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
1.0	**NOx emission**		
a)	While firing design coal	..... mg/nm³	
b)	While firing worst coal	..... mg/nm³	
2.0	**Particulate Emission**		
a)	Particulate emission at Electrostatic precipitator outlet at BMCR condition while firing design coal and any one field in each pass out of service.	..... mg/nm³	
b)	Particular emission at Electrostatic precipitator outlet at BMCR condition while firing worst coal and any one field in each pass out of service.	..... mg/nm³	
3.0	**Noise Level**		
a)	Far field noise level measured at any point at plant boundary	.....dBA	
4.0	**Effluent discharge at outlet of CMB**		
a)	pH		
b)	Residual chlorine	.....ppm	
c)	TDS	.....ppm	
d)	TSS	.....ppm	
5.0	**Sea water outfall**		
a)	pH		
b)	TDS	---------- ppm	
c)	TSS	---------- ppm	
d)	Temperature	---------- ^{o}C	

Anshul S A Khan Praveen Kishore

C.GUARANTEES UNDER CATEGORY III - PERFORMANCE GUARANTEES UNDER COMPULSORY CORRECTION

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
1.0	**Noise and Vibration**			
1.1	Sound pressure shall be measured all around the equipment (to be done for all drives /equipment) at a distance of 1.0 m horizontally from the nearest surface of any equipment/ machine and at a height of 1.5 m above the floor level in elevation			
1.2	Vibration for all equipment and drives			
2.0	**Steam Generator Capacity**			
2.1	The Steam Generating Capacity (in T/hr of steam) at the rated steam parameters at the super heater outlet & rated steam temperature at reheater outlet (with any combination of mills working as per Owner's discretion) with the coal being fired from within the range specified at the following conditions. ii) BMCR condition ii) TMCR conditions iii) TMCR with all HP heaters out of service condition			
2.2	The total attemperation water flow quantity for super heater steam temperature control	T/h		
a)	100% TMCR condition while firing design Coal			
b)	100% TMCR condition while firing Worst Coal			
c)	80% TMCR condition under			

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
	sliding pressure operation while firing design Coal			
d)	80% TMCR condition under sliding pressure operation while firing worst Coal			
2.3	The total attemperation water flow quantity for reheater steam temperature control with rated excess air	T/h		
a)	100% TMCR condition while firing design Coal			
b)	100% TMCR condition while firing Worst Coal			
c)	80% TMCR condition under sliding pressure operation while firing design Coal			
d)	80% TMCR condition under sliding pressure operation while firing worst Coal			
e)	It shall also be demonstrated that the RH temperature is maintained at the rated value without any spray water requirement under normal operating conditions (100% TMCR)			
2.4	The super heater steam temperature at the high pressure (HP) turbine inlet under the following conditions: a) Range of Coal specified b) Steam Generator load 60% TMCR to 100% BMCR under sliding pressure operation	°C		
2.5	The reheat steam temperature at the intermediate pressure (IP) turbine inlet under the Following conditions: a. Range of coal specified b. Steam Generator load	°C		

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
	60% TMCR to 100% BMCR under sliding pressure operation			
2.6	Steam temperature imbalance It shall be demonstrated at SH and RH outlets (in case of more than one outlet) that the temperature imbalance between the outlets does not exceed 10°C under all loads including transients.			
2.7	Furnace exit gas temperature (FEGT) It shall be demonstrated that maximum furnace exit gas temperature (FEGT) shall be as specified. A comprehensive thermal performance test (TPT) shall be conducted for this purpose on one unit only. FEGT shall be demonstrated through such TPT by indirect measurement.	°C		
2.8	Minimum stable load on the Steam Generator without oil support under the following condition: a. Range of coal specified b. Both Load ramp-up & ramp down c. Any combination of mills in operation.	%		
2.9	Coal consumption at 100% BMCR based on the following i) Gross Calorific value (GCV) of design coal ii) Ambient air temperature 32°C	T/h		

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
	iii) Relative Humidity 65%			
2.10	Coal consumption at 100% TMCR based on the following: i) Gross Calorific value (GCV) of design coal ii) Ambient air temperature 32°C iii) Relative Humidity 65%	T/h		
2.11	Coal consumption at 100% BMCR based on the following: i) Gross Calorific value (GCV) of worst coal ii) Ambient air temperature 32°C iii) Relative humidity – 65%	T/h		
2.12	Coal consumption at 100% TMCR based on the following i) Gross Calorific value (GCV) of worst coal ii) Ambient air temperature 32°C iii)Relative humidity – 65%	T/h		
2.13	**Coal Mills**			
a)	Capacity ,efficiency and power consumption of each mill while firing design coal: i) New Condition ii) at 50% wear life iii) at worn out condition	T/h % KW		
b)	Capacity, efficiency and power consumption of each mill while firing worst coal; i) New condition (ii) at 50% wear life (iii)at worn out condition	T/h % KW		
c)	Loading of each mill when steam generator operating at BMCR condition while firing design coal:	%		
d)	Loading of each mill when steam generator operating at	%		

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
	100% TMCR condition while firing design coal:			
e)	Loading of each mill when Steam Generator operating at BMCR condition while firing worst coal:	%		
f)	Loading of each mill when Steam Generator operating at 100% TMCR condition while firing worst coal	%		
g)	**Coal fineness for the range of coal specified**			
i)	Through 200 mesh screen	%		
ii)	Through 50 mesh screen	%		
2.14	**Primary Air fans**			
a)	Capacity	m^3/h		
b)	Head developed	mWC		
c)	Fan efficiency	%		
d)	Power consumption	kW		
e)	Margins envisaged on capacity and head	%		
2.15	**Forced Draft Fans**			
a)	Capacity	m^3/h		
b)	Head developed	mWC		
c)	Fan Efficiency	%		
d)	Power consumption	kW		
e)	Margins envisaged on capacity and head	%		
2.16	**Induced Draft Fans**			
a)	Capacity	m^3/h		
b)	Head developed	mWC		
c)	Fan efficiency	%		
d)	Power consumption	kW		
e)	Margins envisaged on capacity	%		

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
	and head			
2.17	**Seal Air Fans**			
a)	Capacity	m^3/h		
b)	Head developed	mWC		
c)	Fan Efficiency	%		
d)	Power consumption	kW		
e)	Margins envisaged on capacity and head	%		
2.18	**Fuel Oil Firing System**			
a)	Percentage load for which High Speed Diesel (HSD) firing system is designed	% BMCR		
b)	Percentage load for which Heavy Fuel Oil (HFO) firing system is designed	% BMCR		
2.19	**Air Pre-heater**			
a)	Air heater leakage	%		
b)	Maximum drift in air leakage	%		
2.20	**Run back capabilities**			
	The automatic runback capability of the unit shall be demonstrated on loss of critical auxiliary equipment (such as tripping of one ID/FD/PA / air heater etc) shall be demonstrated ensuring smooth and stable runback operation			
2.21	CO emission at 100% TMCR at rated excess air for specified range of coal			
2.22	Flue gas temperature at APH outlet (maximum) while firing design coal at 100% TMCR without considering air leakage.	°C		
2.23	Unburnt carbon in bottom ash	%		

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
	while firing design coal at 100% TMCR			
2.24	Unburnt carbon in fly ash while firing design coal at 100% TMCR	%		
2.25	Total unburnt carbon loss while firing design coal at 100% TMCR	%		
2.26	Surface temperature of thermal insulation with ambient temperature of 45°C at surface velocity of 0.25 m/s.	°C		
2.27	Boiler recirculation pump any other pumps			
a)	Capacity	m^3/h		
b)	Head	m		
c)	Efficiency	%		
d)	Power consumption	kW		
2.28	**Electrostatic precipitator**			
a)	Particulate emission at Electrostatic precipitator outlet at TMCR condition while firing design coal and any one field in each pass out of service and its corresponding ESP efficiency	mg/nm^3 %		
b)	The ESP air in leakage shall not be more than 1% of total gas flow at ESP inlet at the guarantee point condition and shall be demonstrated.	**%**		
c)	The maximum pressure drop through the ESP at the guarantee point flow condition shall not exceed 20 mm WC, which shall be demonstrated.			
d)	The gas distribution in the various stream and fields shall be demonstrated.			

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
e)	Any other			
3.0	**Steam Turbine & Auxiliaries**			
3.1	Gross power output at 100% TMCR after subtracting excitation power and power of TG integral auxiliaries with following conditions: i) Cycle make-up : 1.0% make-up ii) Cooling water inlet temperature of 33°C iii) Generator power factor - 0.85	MW		
3.2	Gross Power output at VWO on continuous basis after subtracting excitation power and power of TG integral auxiliaries with following conditions: i) Cycle make-up: 1.0 % makeup ii) Cooling water inlet temperature of 33 deg.C (iii) Generator power factor - 0.85	MW		
3.3	Gross power output after subtracting excitation power and power of TG integral auxiliaries with following conditions: i) Cycle make-up : 1.0 % makeup ii) Cooling water inlet temperature of 33 Deg.C iii) Generator power factor - 0.85 iv) All HP heaters out of service.	MW		
3.4	Gross power output excluding excitation power and power of TG integral auxiliaries with	MW		

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
	following conditions: i) Cycle make-up : 1.0 % makeup ii) Cooling water inlet temperature of 33 Deg.C iii) Generator power factor - 0.85 iv) At 47.5 Hz to 51.5 Hz			
3.5	Continuous TG output of 693 MW unit load (i.e. 105% of rated load) under rated steam conditions excluding excitation and power of TG integral auxiliaries. i) Cycle make-up : 1% makeup ii) Cooling water inlet temperature of 33 Deg.C iii) Generator power factor - 0.85 iv) At 47.5 Hz to 51.5 Hz	MW		
3.6	Turbine cycle heat rate at 100% TMCR excluding excitation power and power of TG integral auxiliaries with following conditions: i) Cycle make-up : 1.0 % makeup ii) Cooling water inlet temperature of 33 Deg.C iii) Generator power factor - 0.85			
	Note: the condenser pressure measurement while conducting the above (3.1 to 3.6) guarantee tests shall be measured at 300 mm above the top row of condenser tubes.			
3.7	Turbine- generator capability The steam turbine generator			

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
	shall be capable of delivering at generator terminals the output as indicated in the heat balances under the conditions mentioned in functional guarantees.			
3.8	Upon sudden total loss of all external loads units will not trip on over speed but shall continue to be in operation to supply power for plant auxiliary load (house load).	Yes/No		
3.9	Run Back capabilities of the SG and STG upon loss of critical auxiliary equipment, shall ensure smooth and stable run back operation.	Yes/No		
3.10	HP-LP bypass shall automatically come into operation under the following conditions: i) Total external load throw off ii) Turbine trip condition	Yes/No		
3.11	Variable pressure operating range	% TMCR		
3.12	**Condenser**			
a)	Total pressure drop in condenser tube side with design cooling water flow and temperature	mWC		
b)	Total cooling water temperature rise in condenser with design cooling water flow and CW inlet temperature of 33 deg.C			
i)	Unit operating at 100% TMCR condition	°C		
ii)	Unit operating at VWO condition	°C		
iii)	Unit operating with all HP	°C		

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
	Heaters out condition and generating 100% TMCR power output			
iv)	Unit operating under house load and HP & LP bypass operating at rated capacity.	°C		
c)	Re-cooled water temperature at Outlet of cooling tower based on the following design conditions:			
i)	Rated Cooling Water Flow	m3/h		
ii)	Design Ambient Wet Bulb Temperature	°C		
iii)	Design Inlet Wet Bulb Temperature	°C		
iv)	Design Relative Humidity	%		
v)	Design Cooling Range	°C		
d)	Condenser pressure in mm Hg (abs) measured at 300 mm above the top row of condenser tubes under VWO conditions, 1% make up, design CW temperature and CW flow.	mm Hg (abs)		
e)	The following to be demonstrated			
i)	Temperature of condensate, at outlet of condenser, shall not be less than saturation temperature corresponding to the condenser pressure at all loads.	°C		
ii)	Air leakage in the condenser under full load condition shall not exceed more than 50% of design value taken for sizing the condenser air evacuation system	%		

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
iii)	When one half of the condenser is isolated, condenser shall be capable of taking at least 60% TG load under TMCR conditions.			
iv)	The capacity of each vacuum pump in free dry air under standard conditions at a condenser pressure of 25.4 mm Hg (abs) and sub cooled to 4.17°C below the temperature corresponding to absolute suction pressure shall not be less than 30 SCFM. Correction curves for establishing the capacity at site conditions shall also be furnished.			
v)	The air and vapour mixture from air cooling zone of condenser shall be 4.17°C below the saturation temperature corresponding to 25.4 mm Hg (abs) suction pressure. Correction curves for establishing the same at site conditions shall also be furnished			
3.13	**Condensate Extraction Pump (CEP)**			
a)	Rated capacity	m^3/h		
b)	Rated Total Dynamic Head (TDH)	mWC		
c)	Pump efficiency	%		
d)	Power consumption	kW		
e)	Satisfactory operation of CEPs without undue noise and vibration while operating in isolation or in parallel with			

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
	other pumps shall be demonstrated at site			
3.14	**Booster pump of CEP (If applicable)**			
a)	Rated capacity	m^3/h		
b)	Rated Total Dynamic Head (TDH)	mWC		
c)	Pump efficiency	%		
d)	Power consumption	kW		
3.15	**Condensate Polishing Unit (CPU)**			
a)	Effluent quality of outlet of each vessel at its rated design flow and design service length between two regenerations			
b)	Chemical consumption for regeneration			
c)	Pressure drop across the polisher service vessel ,as specified ,in clean and dirty condition of resin at rated design flow	mWC		
d)	Condensate water quality			
3.16	**Feed Water Heaters**			
a)	Pressure drop on the tube side of the individual LP heaters (Maximum)	mWC		
b)	Pressure drop on the tube side of the individual HP heaters (maximum)	mWC		
3.17	**Deaerator**			
	The following to be demonstrated			
a)	TTDs and DCAs of feed water heaters shall be demonstrated as per guaranteed heat balance diagram for 100% TMCR condition			
b)	Outlet temperature from final	°C		

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
	feed water heaters.			
c)	Dissolved O2 content in Deaerator effluent at deaerator outlet without chemical dosing at all loads, not to exceed 0.005 CC/litre determined as per ASTM-D-888 – Reference method-A or Indigo Carmine method.	Ppm		
d)	Difference between saturation temperature of steam entering the deaerator and temperature of feed water leaving the deaerator shall be demonstrated as per guaranteed heat balance diagram for 100% TMCR condition.			
e)	Continuous and efficient operation and performance of feed heating plant without undue noise and vibrations at all loads and duty conditions			
3.18	**Boiler Feed Water Pump (BFP)**			
a)	Rated capacity	m^3/h		
b)	Rated Total Dynamic Head (TDH)	mWC		
c)	Pump efficiency	%		
d)	Satisfactory operation of BFPs without undue noise and vibration while operating in isolation or in parallel with other pumps shall be demonstrated at site			
e)	Power consumption	kW		
3.19	**Booster pump of BFP**			
a)	Rated capacity	m^3/h		
b)	Rated Total Dynamic Head (TDH)	mWC		

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
c)	Pump efficiency	%		
d)	Vibration noise level at the rated duty point shall be demonstrated at site			
3.20	**Equipment cooling water system**			
a)	Capacity Head Power consumption Pump efficiency of all the pumps with the respective job (own) motors to be demonstrated at shop.	m^3/h mWC kW %		
b)	Vibration, parallel operation and noise level of all the pumps at the rated duty point shall be demonstrated at site.			
c)	Design heat load of plate type heat exchangers Inlet & Outlet temperatures of the Plate type heat exchangers on the primary and secondary side to be demonstrated at site. Pressure drop across the Plate type heat exchanger on the primary & secondary water circuit to be demonstrated at site.	kW °C mWC		
3.21	**Condenser On Load Tube Cleaning System**			
a)	Life of sponge rubber balls and number of balls lost during 1000 hours of plant operation shall be as indicated by Bidder in the offer			
3.22	**HP & LP Bypass System Capability**			
a)	The HP & LP bypass system should satisfy the following functional requirements under			

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
	automatic interlock action. It should come into operation automatically under the following conditions a) Generator circuit breaker opening b) HP & IP stop valves closing due to turbine tripping c) Sudden reduction in demand to house load Under all above conditions, while passing the required steam flows as per the relevant heat balances, the condenser should be able to swallow the entire steam without increasing the exhaust hood temperature and condenser pressure beyond the maximum permissible values. The same shall be demonstrated.			
3.23	**TDBFP**			
a)	Flow	m^3/h		
b)	Head	MWC		
c)	Efficiency	%		
3.24	**Lube oil purification system**			
a)	Capacity	m^3/h		
b)	Lube oil quality-outlet			
3.25	**Control oil purification system**			
a)	Capacity	m^3/h		
b)	control oil quality-outlet			
3.26	**Any other**			
4.0	**Generator**			
4.1	Generator Maximum Continuous Rating	MVA		
4.2	Generator Efficiency	%		

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
	(minimum)			
4.3	Hydrogen Make-up per day	m^3/day		
4.4	**Excitation system**			
a)	Capacity of excitation transformer for static excitation	kVA		
b)	Total loss of excitation transformer	kW		
c)	Total loss of static excitation system (if applicable)	kW		
d)	Total loss of brushless excitation system (if applicable)	kW		
5.0	**Unit start-up time (from light-up to synchronization)**	**Minutes**		
a)	Cold start-up : >72 hours			
b)	Warm start-up : 10-72 hours			
c)	Hot start-up : <10 hours			
d)	Very hot start-up : <1.5 hours			
6.0	**Unit Ramp up / Ramp down rates**	**% per minute**		
a)	<50% TMCR			
b)	50%-100% TMCR			
7.0	**Step Load Change**	**%**		
a)	<50% TMCR			
b)	50%-100% TMCR			
8.0	**Balance of Plant (BOP) Equipment**			
8.1	**Coal Handling Plant System**			
8.1.1	**Number of hours of CHP operation**			
8.1.2	**Guaranteed capacity of each equipment indicated below**			

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances		Applicable Test Codes	
a)	Belt conveyors -capcity and power consumption	**tph** **kW**				
b)	Crushers- capcity and power consumption	**tph** **kW**				
c)	Screens- capcity and power consumption	**tph** **kW**				
d)	Stacker cum reclaimer–capcity and power consumption	**tph** **kW**				
e)	Belt feeder–capcity and power consumption	**tph** **kW**				
f)	Vibrating feeder–capcity and power consumption	**tph** **kW**				
g)	Screen efficiency	%				
h)	Any other					
8.1.3	Maximum moisture in coal up to which crusher & screen will be capable of handling	%				
8.1.4	Water requirement for dust suppression system	m^3/h				
8.1.5	Dust emission at each of the dust extraction system	mg/Nm^3				
8.1.6	Belt weigh scale-accuracy	±				
8.1.7	**Pumps**		**Cap. (m^3/h)**	**Head (m)**	**Power (kW)**	**Efficiency (%)**
a)	Coal run-off pit pump					
b)	Dust suppression pump					
c)	Service water pump					
d)	Any other					
e)	Vibration, parallel operation (if applicable) and noise level of all the above pumps at the rated duty point shall be demonstrated					

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances		Applicable Test Codes	
8.2	**Ash Handling Plant**					
8.2.1	Conveying capacity / Evacuation time					
a)	Bottom ash evacuation system					
i)	Capacity of Scraper chain conveyors	tph				
ii)	Capacity of clinker grinder	tph				
iii)	Capacity of jet pump	tph				
iv)	Any other					
b)	**Fly ash evacuation system**					
i)	Evacuation time per 8 h shift from fly ash hopper to fly ash silo	h				
ii)	Evacuation system capacity	tph				
iii)	Capacity of recovery water system	m^3/h				
8.2.2	**Ash pumps**		**Cap (m^3/h)**	**Head (m)**	**Power (kW)**	**Efficiency (%)**
a)	BA slurry pumps					
b)	FA slurry pumps					
c)	HP pumps					
d)	LP pumps					
e)	BA overflow pump					
f)	Recovery water pumps					
g)	Any other					
h)	Vibration, parallel operation (if applicable) and noise level of all the above pumps at the rated duty point shall be demonstrated					
8.2.3	**Sea water requirement**					
i)	Max water requirement in a 8 h shift for ash disposal	m^3/h				
ii)	Required sea water in 8 h shift basis as make-up for AHS sea	m^3/h				

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances		Applicable Test Codes	
	water tank					
iii)	Any other					
8.2.4	**Desal water requirement**					
i)	Max water requirement in a 8 h shift	m^3/h				
ii)	Required water in 8 h shift basis as make-up for AHS clarified water tank	m^3/h				
8.3	**Water system**		**Cap. (m^3/h)**	**Head (m)**	**Power (kW)**	**Efficiency (%)**
8.3.1	Seawater intake pumps – Desalination feed					
8.3.2	Seawater intake pumps – Cooling Tower make-up					
8.3.3	Condenser cooling water pumps					
8.3.4	Auxiliary cooling water pumps					
8.3.5	Closed Cooling water (DMCW) pumps					
8.3.6	Cycle make-up pumps					
8.3.7	Sea water outfall pumps					
8.3.8	**Other Miscellaneous Pumps**					
a)	Service water pumps					
b)	CHP dust suppression plant feed pump					
c)	DM water transfer pump					
d)	Potable water transfer pump					
e)	Ash water make- up transfer pump					
f)	APH/ESP wash pump					
g)	DMCW make-up pump					
h)	Boiler initial filling pump					
i)	CT blow down pump					
j)	Any other pumps					

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances		Applicable Test Codes	
	1. 2. 3.					
8.3.9	Vibration, parallel operation (if applicable) and noise level of all the above pumps at the rated duty point shall be demonstrated at site.					
8.3.10	Demonstration of Debris filter flushing system					
8.3.11	Clarifier (per unit) – capacity	m^3/h				
8.3.12	Pressure sand filters – capacity	m^3/h				
8.3.13	Desalination plant – Capacity	m^3/h				
8.3.14	RO STAGE II – capacity	m^3/h				
8.3.15	DM plant net output	m^3/h				
8.3.16	Mixed Bed OBR	m^3/h				
8.3.17	Water quality at PT Plant outlet					
a)	Pressure sand filter outlet turbidity	NTU				
b)	Gravity filter turbidity	NTU				
c)	Ultra filter outlet	SDI				
8.3.18	**Water quality at RO STAGE I outlet (upon completion of three years from COD without replacement of membrane)**					
a)	Permeate conductivity @ 27 deg.C	Micro mho/cm				
b)	Permeate conductivity @33 deg. C	Micro mho/cm				
c)	Permeate TDS	ppm				

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes
8.3.19	**Water quality at RO STAGE II outlet upon completion of three years from COD without replacement of membrane**			
a)	Permeate conductivity @ 27 deg C	Micro mho/cm		
b)	Permeate conductivity @ 33 deg C	Micro mho/cm		
c)	Permeate TDS	ppm		
8.3.20	**Water Quality at Mixed Bed Unit outlet**			
a)	Conductivity @ 25 deg C	Micro mho/cm		
b)	Total Silica	ppb		
c)	pH			
8.3.21	**Water Quality at DM Storage Tank outlet**			
a)	Conductivity @ 25 Deg.C	Micro mho/cm		
b)	Total Silica	ppb		
8.3.22	**Water quality at Potable Water outlet**			
a)	TDS	ppm		
b)	pH			
c)	Boron	ppm		
8.4	**Chemical consumption for water treatment**	kg/day		
	Contractor to list the chemicals type and quantities used			
a)	Pre-treatment plant			
b)	Desalination plant			
c)	DM Plant			
8.5	**Chlorination Plant**			
a)	Capacity	kg/h		

Anshul S A Khan Praveen Kishore

Sl. No.	Particular	Unit	Value inclusive of design, manufacture and all other Tolerances	Applicable Test Codes	
8.6	**Fuel Oil System**		**Heavy Fuel Oil (tph)**	**High speed Diesel (tph)**	
a)	Unloading period	h			
i)	HFO unloading period for 10 road tankers simultaneously with one standby pump				
ii)	HSD unloading period for 5 road tankers simultaneously with one standby pump				
b)	**Pumps**		**Cap(m^3/h)**	**Head (mWC)**	**Power (kW)**
i)	HFO unloading pump				
ii)	HSD unloading pump				
iii)	Any other				
iv)	Vibration, parallel operation (if applicable) and noise level of all the above pumps at the rated duty point shall be demonstrated				

Anshul S A Khan Praveen Kishore

8.7	**Fire Fighting System**		**capacity m³/h)**	**Head (mWC)**	**Power Req. (kw)**
a)	Fire water pumps – Hydrant system				
b)	Fire water pumps – spray system				
c)	Fire water booster pumps				
d)	Foam system - pumps				
e)	Jockey pumps				
f)	Any other				
g)	Air compressor Capacity Pressure Power consumption	**Nm³/min** **Bar** **kW**			
h)	Vibration, parallel operation (if applicable) and noise level of all the above pumps at the rated duty point shall be demonstrated at site.				
i)	Any other				
8.8	**Compressed Air System**				
a)	Free air delivery at site conditions per each compressor	Nm³/min			
b)	Power consumption at site rated parameters per each compressor (kW)	kW			
c)	Max. capacity of each air dryer at min working pressure and max. temp at after cooler outlet (Nm³/min)	Nm³/min			
d)	Parallel operation of air compressor shall be demonstrated at site.				
e)	Pressure drop across Air Drying Plant, Capacity and outlet dew point of each air drying plant shall be demonstrated at site.	Bar			
f)	Vibration level and noise level of each air compressor, blowers and any other				

Anshul S A Khan Praveen Kishore

	rotating equipments of each air drying plant shall be demonstrated at site.				
g)	Instrument air quality				
h)	Any other				
8.9	**Elevators**				
8.9.1	**Steam Generator Elevator**				
	Carrying capacity	kg			
8.9.2	**Turbine Building Elevator**				
	Carrying capacity	kg			
8.9.3	**Crusher house Elevator**				
	Carrying capacity	kg			
8.9.4	**Chimney Elevator**				
	Carrying capacity	kg			
8.9.5	**Any other Elevator**				
a)	**Carrying capacity**	**kg**			
8.10	**Cranes & Hoists**				
8.10.1	Turbine Building Main EOT Crane (AB bay)				
a)	Safe Working Load	T			
b)	Operating speed	(meters per minute)			
i)	Hoisting				
ii)	Long Travel				
iii)	Cross Travel				
8.10.2	Turbine Building BFP EOT Crane (BC bay)				
a)	Safe Working Load	(T)			
b)	Operating speed	(meters per minute)			
i)	Hoisting				
ii)	Long Travel				
iii)	Cross Travel				
8.10.3	CW Pump house EOT crane				

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a)	Safe Working Load	(T)			
b)	Operating speed	(meters per minute)			
i)	Hoisting				
ii)	Long Travel				
iii)	Cross Travel				
8.10.4	Seawater intake pump house EOT crane				
a)	Safe Working Load	(T)			
b)	Operating speed	(meters per minute)			
i)	Hoisting				
ii)	Long Travel				
iii)	Cross Travel				
C)	Any other area requiring Cranes 1. 2. 3.				
8.11	**Mill Reject System**				
a)	Conveying capacity	tph			
b)	Compressor capacity / numbers	Nm3/min			
c)	Continuous effective discharge and conveying at the rated capacity of the mill rejects without spillage or blockage in the system shall be demonstrated.				
8.12	**Air conditioning System**		Cap (TR)	Inside Dry Bulb Temp. °C	Inside Relative Humidity %
h)	Main Control room in TG Building				
i)	Control room in following aux buildings.				

j)	ESP control building				
k)	Switchyard control building				
l)	DM plant control room				
m)	Coal handling control building				
n)	Ash handling control building				
h)	Service building Floor wise: 1. 2.				
i)	Any other area requiring air conditioning 1. 2.				
8.13	**Ventilation system**		**Capacity (m^3/h)**	**Pressure (mmWc)**	
a)	TG Hall				
b)	Switchgear room in TG building				
c)	Cable spreader room in TG building				
d)	SWAS room in TG building				
e)	Switchgear room in ESP building				
f)	Cable spreader room in ESP building				
g)	DG set room				
h)	Air compressor house				
i)	Battery room				
j)	Switchgear room				
k)	Cable spreader room				
l)	Filtered water pump house				
m)	CW pump house				
n)	Chemical house				
o)	Fire water booster pump house				
p)	Fuel oil pump house				
q)	AC plant room				
r)	Chlorination room & associated areas				

s)	GIS Switchyard			
t)	Any other area requiring ventilation 1. 2. 3.			
8.14	**Road Weigh Bridge**			
a)	Weighing capacity	T		
b)	Platform size	m x m		
c)	Accuracy	%		
d)	Load cell	OIML R60 edition 2000		
8.15	**Hydrogen generation plant**			
a)	Capacity Discharge pressure of hydrogen gas compressors at its rated duty point with its job (own) motor shall be demonstrated and proved at shop.	Nm3/h bar(g)		
b)	Parallel operation of two streams shall be demonstrated at site. Purity level and moisture content of Hydrogen shall be demonstrated at site.			
c)	Hydrogen generation plant capacity (stream wise) shall be demonstrated at site	Nm3/h		

SIGNATURE OF CONTRACTOR_____

NAME _____

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SCHEDULE – C 2

GUARANTEED AUXILIARY POWER CONSUMPTION

Complete list of auxiliary power consumption at input to motor including design, manufacture and all other tolerances shall be guaranteed by the Contractor as given below for 0% make-up condition:

SCHEDULE OF AUXILIARY POWER CONSUMPTION

Sl. No.	**Particulars**	**Total number provided (Working + Standby) for each unit**	**Power consumption for each motor / equipment at 100 % TMCR condition**	**Total Power consumption in kW at 100% TMCR condition for each unit**	**Total Power consumption in kW at 100% TMCR condition for 1320 MW**
(1)	(2)	(3)	(4)	(5)	(6)
1.0	**Steam Generator and Auxiliaries**				
1.1	**Total auxiliary power consumption of the following HT and LT drives for the Steam Generator & Auxiliaries at 100 % TMCR while firing design coal**				
a)	Primary Air (PA) Fans including its lube oil pumps.				
b)	Coal Feeders				
c)	Seal air fans				
d)	Coal mills including its lube oil pumps.				
e)	Forced Draft (FD) Fans including its lube oil pumps.				
f)	Regenerative Air Preheater including its lube oil pumps.				
g)	Electrostatic				

Sl. No.	Particulars	Total number provided (Working + Standby) for each unit	Power consumption for each motor / equipment at 100 % TMCR condition	Total Power consumption in kW at 100% TMCR condition for each unit	Total Power consumption in kW at 100% TMCR condition for 1320 MW
(1)	(2)	(3)	(4)	(5)	(6)
	precipitators (ESP)				
h)	Induced Draft (ID) Fans including its lube oil pumps.				
i)	Boiler circulation pumps				
j)	Pressurising pumps of fuel oil system				
k)	Scanner air fans				
l)	Electrical Heat Tracing (if applicable)				

Anshul S A Khan Praveen Kishore

Sl. No.	Particulars	Total number provided (Working + Standby) for each unit	Power consumption for each motor / equipment at 100 % TMCR condition	Total Power consumption in kW at 100% TMCR condition for each unit	Total Power consumption in kW at 100% TMCR condition for 1320 MW
(1)	(2)	(3)	(4)	(5)	(6)
m)	Any Other Items (Contractor to list any other continuously running equipment) 1 2 3				
1.2	**Grand total value (Sum of Items for 1.1 (a) to (m)**	-	-		
2.0	**TURBINE GENERATOR AND AUXILIARIES**				
2.1	**Total auxiliary power consumption of the following HT and LT drives for the Turbine Generator and Auxiliaries at 100 % TMCR while firing design coal**				
a)	Booster pumps for TDBFP				
b)	TDBFP lube. Oil pumps				
c)	Electric oil heater of TDBFP lube. Oil pumps				
d)	Oil purifiers of TDBFP including feed and discharge pumps				
e)	MDBFP				

Sl. No.	Particulars	Total number provided (Working + Standby) for each unit	Power consumption for each motor / equipment at 100 % TMCR condition	Total Power consumption in kW at 100% TMCR condition for each unit	Total Power consumption in kW at 100% TMCR condition for 1320 MW
(1)	(2)	(3)	(4)	(5)	(6)
	Auxiliary Oil pump				
f)	Condensate Extraction Pumps (CEP).				
g)	Oil pumps for HP & LP bypass system				
h)	Condenser air evacuation equipment (Vacuum pumps)				
i)	Condenser online tube cleaning pumps				
j)	LP drain condensate pump (if applicable)				
k)	Chemical Dosing pumps				
l)	Any Other Items (Contractor to list any other continuously running equipment) 1 2 3				

Anshul S A Khan Praveen Kishore

Sl. No.	Particulars	Total number provided (Working + Standby) for each unit	Power consumption for each motor / equipment at 100 % TMCR condition	Total Power consumption in kW at 100% TMCR condition for each unit	Total Power consumption in kW at 100% TMCR condition for 1320 MW
(1)	(2)	(3)	(4)	(5)	(6)
2.2	**Grand total value (Sum of Items for 2.1 (a) to (l)**				
3.0	**Balance of Plant - Unitised Systems**				
3.1	**Total auxiliary power consumption of the following HT and LT drives combined together for the Balance of Plant - Unitised Systems at 100 % TMCR while firing design coal.**				
a)	Main Cooling Water pumps				
b)	Auxiliary cooling water booster pumps (ACW)				
c)	Closed cooling water pumps (DMCW)				
d)	Cycle make-up pumps				
e)	DM transfer pumps				
f)	Any Other Items (Contractor to list any other continuously running equipment) 1 2 3				
3.2	**Grand total value (Sum of Items 3.1 (a) to (f)**				

Sl. No.	Particulars	Factor (Refer Note 2)	Total Power consumption at rated load of respective system for 1320 MW	Total Power consumption in kW for 1320 MW for guaranteed auxiliary power computation
(1)	(2)	(3)	(4)	(5) = (3) x (4)
4.0	**Balance of Plant-Common Systems**			
4.1	**Total auxiliary power consumption of the following Balance of Plant Systems common for 1320 MW while firing design coal.**			
a)	Coal Handling System – Maximum of the below option	**0.6**		
i)	Path 1: JTB-3 → JTB-4 → TH-1 → CRH-1 → TT-1 → TT-2 → TT-3 → TT-4 → TT-5 → TT-6 → TT-7 → TT-8 → TT-9 → TT-10 → TT-11 → TT-12→ Last bunker of Unit 2			
ii)	Path 2: JTB-3 → JTB-4 → TH-1 → CRH-1 → TT-1 → TT-7 → TT-8 → TT-9 → TT-10 → TT-11 → TT-12→ Last bunker of Unit 2			
b)	Ash handling system			
i)	Bottom ash Evacuation System	**1.0**		
ii)	Fly ash Evacuation System	**0.7**		
iii)	Bottom Ash disposal System	**1.0**		
iv)	Fly Ash disposal System	**1.0**		
v)	Recovery water system	**1.0**		
c)	Mill Reject system	**0.5**		
d)	Fuel oil system			
i)	Fuel oil unloading system	**0.1**		
ii)	Fuel oil forwarding system	**0.1**		
e)	Seawater intake system	**1.0**		
f)	Seawater outfall system	**1.0**		

Sl. No.	Particulars	Factor (Refer Note 2)	Total Power consumption at rated load of respective system for 1320 MW	Total Power consumption in kW for 1320 MW for guaranteed auxiliary power computation
(1)	(2)	(3)	(4)	(5) = (3) x (4)
g)	Pre-treatment plant	**0.9**		
h)	Desalination plant (RO STAGE I, RO STAGE II, DM Plant)Water treatment plant	**0.9**		
i)	Chlorination Plant	**0.9**		
j)	Auxiliary water system	**0.9**		
k)	Effluent treatment plant	**0.5**		
l)	Air conditioning system	**1.0**		
m)	Ventilation system	**1.0**		
n)	Compressed air system	**0.75**		
o)	Plant lighting	**0.6**		
p)	STP	**0.5**		
q)	Hydrogen generation Plant	**0.6**		
r)	Fire fighting system	**0.4**		
s)	Any Other Items (Contractor to list any other continuously running equipment) 1 2 3			
4.2	**Grand total value (Sum of Items under Column (5) for 4.1 (a) to (s)**			
5.0	**Electrical System**			
5.1	**Total auxiliary power consumption of the following Electrical Systems at 100 % TMCR**			
a)	Generator Transformer losses (at Unit rated Load Condition)			
b)	Unit Transformer losses (at Unit rated load conditions)			
c)	Station Transformer losses (at			

Anshul S A Khan Praveen Kishore

Sl. No.	Particulars	Factor (Refer Note 2)	Total Power consumption at rated load of respective system for 1320 MW	Total Power consumption in kW for 1320 MW for guaranteed auxiliary power computation
(1)	**(2)**	**(3)**	**(4)**	**(5) = (3) x (4)**
	Unit rated load conditions)			
d)	Losses in all other transformers (at Unit rated load conditions)			
e)	Losses in Bus ducts (at unit rated load conditions) • Isolated Phase Bus Duct • Phase segregated Bus Duct			
f)	UPS power consumption (at Unit rated load condition)			
g)	DC System power consumption (at unit rated load condition)			
h)	Any Other Items (Contractor to list any other continuously running equipment) 1 2 3			
5.2	**Grand total value (Sum of Items under Column (5) for 5.1 (a) to (h)**			
6.0	**Total Guaranteed auxiliary power consumption for 1320 MW** **(Sum of Items under column (6) for 1.2+2.2+3.2+4.2+5.2).** **[Refer Note 2.]**			

1. Common Balance of Plant (BOP) auxiliaries will not be working continuously. Hence the applicable factors indicated shall be considered on the total rated

Anshul S A Khan Praveen Kishore

load of the respective system excluding the standby equipment for arriving at the guaranteed auxiliary power consumption for each system.

2. Contractors to note that the grand total value under Sl No 6.0 will be considered for evaluation, Performance Guarantees and for penalty.

SIGNATURE _____
OF CONTRACTOR

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Anshul S A Khan Praveen Kishore

SCHEDULE – C 3

FUNCTIONAL GUARANTEES REQUIREMENTS

GENERAL

1.1 The term "Performance Guarantees" wherever appears in the technical specification shall have the same meaning and shall be synonymous to "Functional Guarantees". Similarly the term "Performance Tests" wherever appears in the technical specification shall have the same meaning and shall be synonymous to "Guarantee Test(s)".

PERFORMANCE GUARANTEES / PERFORMANCE TESTS

GENERAL REQUIREMENTS

i) The Contractor shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in the specifications.

ii) The guaranteed performance parameters furnished by the Bidder in his offer, shall be without any tolerance values whatsoever. All margins required for instrument inaccuracies and other uncertainties shall be deemed to have been included in the guaranteed figures.

iii) The Contractor shall conduct performance test and demonstrate all the guarantees covered herein under Category I, II & III. The various tests which are to be carried out during performance guarantee tests are listed in this Sub-section. The guarantee tests shall be conducted by the Contractor at site in presence of Owner on each unit individually.

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

v) The performance tests shall be performed using only the normal number of Owner supplied operating staff. Contractor, vendor or other subcontractor personnel shall be used only for instructional purposes or data collection. At all times during the Performance Tests the emissions and effluents from the Plant shall not exceed the Guaranteed Emission and Effluent Limits.

vi) It shall be responsibility of the Contractor to make the plant ready for the performance guarantee tests.

Anshul S A Khan Praveen Kishore

vii) **Test Instrumentation, Flow Measurement and their Calibration**

All instruments required for performance testing shall be of the type and accuracy required by the code and prior to the test, the Contractor shall get these instruments calibrated in an independent test Institute approved by the Owner. All test instrumentation required for performance tests shall be supplied by the Contractor and shall be retained by him upon satisfactory completion of all such tests at site. All calibration procedures and standards shall be subject to the approval of the Owner. The protecting tubes, pressure connections and other test connections required for conducting guarantee test shall conform to the relevant codes.

Tools and tackles, thermowells (both screwed and welded) instruments/devices including flow devices, matching flanges, impulse piping & valves etc. and any special equipment, required for the successful completion of the tests, shall be provided by the contractor free of cost.

viii) The P&G test procedures shall be submitted for equipments/ system & subsystem under Contractor's scope for all Guarantees under category I, II & III as mentioned below, as per latest International codes / standard including correction curves, meeting the specification requirements along with sample calculations & detailed activity plan of preparation (including test instrumentation), conductance and evaluation of Guarantees.

ix) The contractor shall submit for Owner's approval the detailed Performance Test procedure containing the following:

(a) Object of the test
(b) Various guaranteed parameters & tests as per contract.
(c) Method of conductance of test and test code.
(d) Duration of test, frequency of readings & number of test runs.
(e) Method of calculation.
(f) Correction calculations & curves.
(g) Instrument list consisting of range, accuracy, least count, and location of instruments.
(h) Scheme showing measuring points.
(i) Sample calculation
(j) Acceptance criteria.
(k) Any other information required for conducting the test.

The Performance test shall be carried out as per the agreed procedure.

x) **Test Reports**

After the conductance of Performance test, the Contractor shall submit the test evaluation report of Performance test results to Owner promptly but not later than one month from the date of conductance of Performance test. Preliminary test reports shall be submitted to the Owner after completing each test run. Six

Anshul S A Khan Praveen Kishore

(6) hard copies and two (2) soft copies on CD-ROM of each test report of final conducted test on each equipment/plant/system shall be submitted to Owner for approval.

xi) The performance guarantee test will be carried out within three months after the successful completion of Initial Operation of facilities or as per the time frame specified for a particular equipment/ plant/ system in the Technical specifications. Delay in conductance of the test beyond this period will not be normally permitted by the OWNER. In the event of OWNER agreeing to conductance of such tests after three months, for reasons not attributable to the OWNER, as assessed by the Owner, no factor for ageing shall be considered for computing performance of the equipment.

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

xiii) If, the Functional Guarantees are not met, either in whole or in part, the Owner may, at its sole discretion, provide the Contractor notice, setting forth particulars of such defects or failure. The Contractor shall, forthwith upon receipt of such notice, at its cost and expense, make such changes, modifications and/or additions to the Plant and Equipment or any component thereof, as may be necessary to meet the Functional Guarantees. The Contractor shall notify the Owner upon completion of the necessary replacement, changes, modifications and/or additions, shall request the Owner to facilitate the repetition of the Guarantee Tests until the Functional Guarantees have been met. If, the Functional Guarantees are not attained either in the whole or in part, even after the expiry of any additional time granted by the Owner (after carrying out necessary changes, modifications, and/or additions), the Owner may, at its sole discretion, exercise anyone of the following options:

(i) For Category-I Guarantees- Performance Guarantees under Penalty.

Reject the equipment / system / plant and recover from the Contractor the payments already made, if the level of tested Functional Guarantees is beyond the acceptable shortfall limits as per clause 25.0, Section 4, Volume 1;

(or)

Accept the equipment / system / plant with penalty as per clause 25.0, Section 4, Volume 1, if the level of tested Functional Guarantees is within the acceptable shortfall limits. The penalty for shortfall in performance shall be levied separately for each unit. The penalty values and acceptable shortfall limits are applicable for per unit basis except for total auxiliary power consumption (as total auxiliary power consumption shall be guaranteed for the two units). The penalty shall be pro-rated for the fractional parts of the deficiencies. The performance guarantees coming under this category shall be called 'Category-I' Guarantees.

(ii) For Category-II Guarantees – Performance Guarantee under Rejection

Anshul S A Khan Praveen Kishore

Reject the equipment / system/ plant and recover from the Contractor the payments already made. The performance guarantees under this category shall be called 'Category-II' Guarantees. Conformance to the performance requirements under Category-II is mandatory.

(iii) For Category-III Guarantees - Performance Guarantee under Compulsory Correction

Reject the equipment /system / plant and recover from the Contractor the payments already made.

(or)

Accept the equipment/system after assessing the deficiency in respect of the various ratings, performance parameters and capabilities and recover from the contract price an amount equivalent to the damages as determined by the Owner. Such damages shall, however be limited to the cost of replacement of the equipment(s) / system(s), replacement of which shall remove the deficiency so as to achieve the guaranteed performance. These parameters/capacities shall be termed as Category-III Guarantees

GUARANTEES UNDER CATEGORY- I – (PERFORMANCE GUARANTEES UNDER PENALTY)

THE PERFORMANCE GUARANTEES WHICH ATTRACT PENALTY ARE AS FOLLOWS:

GROSS TURBINE CYCLE HEAT RATE

Minimum Gross Turbine cycle heat rate at 100% TMCR after subtracting excitation power and power of TG integral auxiliaries with following conditions:

1. Cycle make-up : 0% makeup
2. Cooling water inlet temperature of 33 deg.C
3. TDBFP's in operation
4. Generator power factor of 0.85

(Gross Turbine cycle heat rate at 100% TMCR condition shall be guaranteed after accounting for pressure drop in main steam piping, Reheater system and all extraction steam piping from steam turbine to feed water heaters & deaerator)

Turbine Cycle Heat Rate shall be calculated as follows & indicated in all computed heat balance diagrams :

$$\text{HEAT RATE} = \frac{M1\,(H1-h1) + M2\,(H3-H2) + Mis\,(h1-his) + Mir\,(H3 - hir)}{Pg}$$

The expression "Mis (h1-his)" in the numerator of the formula is not applicable if spray water to superheater is completely internal to the boiler (i.e. tapped from a location downstream of economizer inlet).

Where,

M1 - Quantity of live steam entering the turbine stop valve including any live steam supplied to valve stems, or glands etc. in Kg/hr.
M2 - Quantity of steam from turbine to reheater in Kg/hr.
Mir - Quantity of desuperheating water flowing into reheater system for regulation of steam temperature in Kg/hr.
Mis - Superheater desuperheating spray flow in Kg/hr.
H1 - Enthalpy in kcal/kg of live steam.
H2 - Enthalpy in kcal/kg of steam to reheat.
H3 - Enthalpy in kcal/kg of reheated steam.
h1 - Enthalpy of feed water in kcal/kg at the downstream of the junction of feed flow and bypass flow of HP heaters.
hir - Enthalpy of desuperheating water flowing into reheat system in Kcal/Kg.
his - Enthalpy of superheater desuperheating spray water in Kcal/Kg.
Pg - Unit output after deducting the power consumption by auxiliaries as listed below and the same shall be 693MW, and 660MW respectively for 105%, and 100% TMCR unit load:

(a) Power taken by Excitation system (KW) including transformer losses, as applicable for various guarantee points, in case of static excitation system is offered. (The transformer losses at various points shall be based on factory test to be conducted).

(b) Power required for ventilation of oil and control fluid tanks, if ventilating fans are separately driven (KW).

(c) Power required for lubrication, if lubricating pumps are separately driven (KW).

(d) Power required for control fluid pumps, if control fluid pumps are separately driven (KW).

(e) Power required for hydrogen, seal oil auxiliaries, if separately driven (KW).

(f) Power required for stator water cooling system, if cooling pumps are driven separately (KW).

(g) Power required for motors, heaters etc. of any other auxiliary service for the turbine generator (KW).

It may be noted that the heat balance diagrams and guarantees shall be furnished considering zero spray water quantity for superheater and reheater spray. During Performance Guarantee Testing, in case water is required for superheater and/or

Anshul S A Khan Praveen Kishore

reheater temperature control, the contractor shall be entitled to heat rate correction as per correction curves to be submitted by him with his offer.

STEAM GENERATOR EFFICIENCY

STEAM GENERATOR EFFICIENCY WITH FOLLOWING CONDITIONS:

a) 100% TMCR
b) Firing design coal
c) On Gross Calorific value (GCV) basis
d) At 32 deg C DBT and 65% RH ambient air conditions
e) Excess air at economizer outlet (at 100% TMCR load) 20% (min.)
f) Corrected flue gas temperature at air preheater outlet (at 100% TMCR) 125°C or as predicted by the Bidder whichever is higher
g) Unburnt fuel at all guaranteed efficiency load i.e. 1.0% (min.)

Bidder/Contractor to note that no credit shall be given in the bid evaluation or in the evaluation of the results of the guarantee tests for performance predictions/ guarantees etc. if the values considered by the Bidder/Contractor for parameters indicated at e), f) & g) above are lower than those specified above.

MAJOR REQUIREMENTS/ METHOD OF STEAM GENERATOR EFFICIENCY TESTS

i.	**Test Code**	**As per PTC 4 / B S EN12952-15,2003 (by loss method)**
ii.	**Test Loads**	105% TMCR (VWO unit Load) 100% TMCR (660 MW unit Load)
iii.	**Test Conditions**	Boiler operating with rated excess air, coal fineness and firing design coal.
iv.	**Ambient air condition**	Dry bulb temperature and Relative humidity shall be same as the design parameters specified for steam generator.. The reference air temperature for the efficiency guarantee/ testing shall be taken as the temperature of air (as the design temperature of air) entering PA and FD fans.
v.	**No. of readings**	Two sets of consistent readings for each of test loads. Average of the test efficiencies based on above two readings for each load shall be considered for guaranteed efficiency.
vi.	Correction to tested efficiency shall be applicable for variation in following parameter only :	
a)	Ambient air temperature.	
b)	Relative humidity of ambient air.	
c)	Hydrogen in coal.	
d)	Moisture in coal.	
e)	GCV of coal.	

Anshul S A Khan Praveen Kishore

f)	Percentage of ash in coal.
xiii.	The number, location, type and accuracy of the test grade thermocouples and pressure gauges shall be to Owner's approval
xiv.	The Steam Generator efficiency testing shall be carried out with any combination of mills in operation to Owner's choice, with fineness of pulverized coal not exceeding 70% through 200 mesh.
xv.	Steam generator efficiency shall be with guaranteed or actual air heater leakages, whichever is higher.

GROSS CONTINUOUS TG POWER OUTPUT

Gross continuous TG power output at 100% TMCR after subtracting excitation power and power of TG integral auxiliaries with following conditions:

1. Cycle make-up : 0 % makeup
2. Cooling water inlet temperature of 33 Deg C.
3. Generator power factor of 0.85

TOTAL AUXILIARY POWER CONSUMPTION

TOTAL AUXILIARY POWER CONSUMPTION FOR THE PLANT (1320 MW) AT 100% TMCR CONDITION AFTER SUBTRACTING EXCITATION POWER AND POWER OF TG INTEGRAL AUXILIARIES WITH FOLLOWING CONDITIONS:

1. Cycle make-up: 0% makeup
2. Cooling water inlet temperature of 33 deg.C
3. TDBFP's in operation
4. Generator power factor of 0.85

The unit auxiliary power consumption shall be calculated using the following relationship.

Pa = Pu + TL
Pa = Guaranteed Auxiliary Power Consumption.
Pu = Power consumed by the auxiliaries of the unit under test.
TL = Losses of the transformers supplied by bidder based on works test reports. While guaranteeing the auxiliary power consumption the bidder shall necessarily include all continuously operating unit auxiliaries. The auxiliaries to be considered shall include but not be limited to the following:

UNIT AUXILIARIES (TO BE CONSIDERED FOR CALCULATING PU)

1) TURBINE GENERATOR AND AUXILIARIES

a) Booster pumps for TDBFP
b) TDBFP lube. Oil pumps
c) Electric oil heater of TDBFP lube. Oil pumps
d) Oil purifiers of TDBFP including feed and discharge pumps
e) MDBFP Auxiliary Oil pump
f) Condensate Extraction Pumps (CEP).

Anshul S A Khan Praveen Kishore

g) Oil pumps for HP & LP bypass system

h) Condenser air evacuation equipment (Vacuum pumps)

i) Condenser online tube cleaning pumps

j) LP drain condensate pump (if applicable)

k) Chemical Dosing pumps

l) Any Other Items (Contractor to list any other continuously running equipment)

Bidder shall note that the above shall not include the power consumption of the turbine generator integral auxiliaries which are included in TG output as specified.

2) STEAM GENERATOR AND AUXILIARIES

a) Primary Air (PA) Fans including its lube oil pumps.

b) Coal Feeders

c) Seal air fans

d) Coal mills including its lube oil pumps.

e) Forced Draft (FD) Fans including its lube oil pumps.

f) Regenerative Air Preheater including its lube oil pumps.

g) Electrostatic precipitators (ESP)

h) Induced Draft (ID) Fans including its lube oil pumps.

i) Boiler circulation pumps

j) Pressurising pumps of fuel oil system

k) Scanner air fans

l) Electrical Heat Tracing (if applicable)

m) Any Other Items (Contractor to list any other continuously running equipment)

3) BALANCE OF PLANT - UNITISED SYSTEMS

a) Main Cooling Water pumps

b) Auxiliary cooling water booster pumps (ACW)

c) Closed cooling water pumps (DMCW)

d) Hotwell make up pumps

e) DM transfer pumps

f) Any Other Items (Contractor to list any other continuously running equipment)

4) BALANCE OF PLANT-COMMON SYSTEMS

	Coal Handling System – Maximum of the mentioned flow path in the specification	**0.6**
	Ash handling system	
i.	Bottom Ash Evacuation System	**1.0**

ii.	Fly Ash Evacuation System	**0.70**
iii.	Bottom ash disposal System	**1.0**
iv.	Fly Ash disposal System	**1.0**
v.	Recovery water system	**1.0**
	Mill Reject system	**0.5**
	Fuel oil system	
i.	Fuel oil unloading system	**0.1**
ii.	Fuel oil forwarding system	**0.1**
	Seawater intake system	**1.0**
	Seawater outfall system	**1.0**
	Pre-treatment plant	**0.9**
	Desalination plant (RO STAGE I, RO STAGE II, DM Plant)	**0.9**
	Chlorination Plant	**0.9**
	Auxiliary water system	**0.9**
	Effluent treatment plant	**0.5**
	Air conditioning system	**1.0**
	Ventilation system	**1.0**
	Compressed air system	**0.75**
	Plant lighting	**0.6**
	STP	**0.5**
	Hydrogeneration Plant	**0.6**
	Fire fighting system	**0.4**
	Any Other Items (Contractor to list any other continuously running equipment) 1 2 3	

5) <u>ELECTRICAL SYSTEM</u>

Total auxiliary power consumption of the following Electrical Systems at 100 % TMCR

a) Generator Transformer losses (at rated Load Condition)
b) Unit auxiliary transformer losses (at rated load conditions)
b) Station transformer losses (at Unit rated load conditions)
c) Losses in all other transformers (at rated load conditions)
e) Losses in Bus ducts (at rated load conditions)
- Isolated Phase Bus Duct
- Phase segregated busduct

f) UPS power consumption (at rated load condition)
g) DC System power consumption (at rated load condition)
j) Any Other Items (Contractor to list any other continuously running equipment)

<u>TRANSFORMER LOSSES</u>

Transformer losses (at rated capacity transformers (UAT, ST, GT & service transformer individually)

a. Iron loss
b. Copper loss
c. Cooler Pump / fan loss

GUARANTEES UNDER CATEGORY-II – (PERFORMANCE GUARANTEE UNDER REJECTION)

THE PERFORMANCE GUARANTEES, CONFORMANCE TO WHICH ARE MANDATORY ARE AS FOLLOWS:

A NOx Emission

Contractor shall guarantee that maximum total NOx emission from the unit shall not be more than 260 grams of NOx (from thermal as well as fuel) per giga joule of heat input to the boiler during the entire operating range of steam generator for the range of coals specified.

The emission shall be measured during steam generating capacity test. The bidder shall furnish the methodology of measurement and demonstration of variations w.r.t. load upto 50% of total load.

B Particulate Emission

a) Particulate emission at Electrostatic precipitator outlet at BMCR condition while firing design coal and any one field in each pass out of service.

b) Particulate emission at Electrostatic precipitator outlet at BMCR condition while firing worst coal and any one field in each pass out of service.

C Noise Level

a) Far field noise level measured at any point at plant boundary

D Effluent at outlet of CMB

a) pH
b) Residual chlorine
c) TDS
d) TSS

E Sea water outfall

a) pH
b) TDS
c) TSS
d) Temperature

Anshul S A Khan Praveen Kishore

GUARANTEES UNDER CATEGORY-III – (PERFORMANCE GUARANTEE UNDER COMPULSORY CORRECTION)

The parameters/capabilities to be demonstrated for various systems/equipment shall include but not be limited to the following:

NOISE

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

Noise level measurement shall be carried out using applicable and internationally acceptable standards. The measurement shall be carried out with a calibrated integrating sound level meter meeting the requirement of IEC 651 or BS 5969 or IS 9779.

Sound pressure shall be measured all around the equipment at a distance of 1.0 m horizontally from the nearest surface of any equipment/ machine and at a height of 1.5 m above the floor level in elevation.

A minimum of 6 points around each equipment shall be covered for measurement. Additional measurement points shall be considered based on the applicable standards and the size of the equipment. The measurement shall be done with slow response on the A - weighting scale. The average of A-weighted sound pressure level measurements expressed in decibels to a reference of 0.0002 micro bar shall not exceed the guaranteed value. Corrections for background noise shall be considered in line with the applicable standards. All the necessary data for determining these corrections, in line with the applicable standards, shall be collected during the tests.

STEAM GENERATOR & AUXILIARIES

5.2.1 **Steam Generating Capacity**

Steam generating capacity in T/hr of steam at rated steam parameters at superheater outlet & rated steam temperature at reheater outlet(with any combination of mills working as per Owner's discretion) with the coal being fired from within the range specified at the following conditions with heaters out of service condition

a) BMCR condition
b) TMCR conditions
c) TMCR with all HP with all HP heaters out of service condition.

5.2.2 The total attemperation water flow quantity for super heater steam temperature control T/hr
a) 100% TMCR condition while firing design Coal
b) 100% TMCR condition while firing Worst Coal
c) 80% TMCR condition under sliding pressure operation while firing design Coal
d) 80% TMCR condition under sliding pressure operation while firing worst Coal

Anshul S A Khan Praveen Kishore

5.2.3 The total attemperation water flow quantity for reheater steam temperature control with rated excess air

a) 100% TMCR condition while firing design Coal
b) 100% TMCR condition while firing Worst Coal
c) 80% TMCR condition under sliding pressure operation while firing design Coal
d) 80% TMCR condition under sliding pressure operation while firing worst Coal

It shall also be demonstrated that the RH temperature is maintained at the rated value without any spray water requirement under normal operating conditions (100% TMCR)

5.2.4 The super heater steam temperature at the high pressure (HP) turbine inlet under the following conditions(°C)

a) Range of Coal specified
b) Steam Generator load
60% TMCR to 100% BMCR under sliding pressure Operation

5.2.5 The reheat steam temperature at the intermediate pressure (IP) turbine inlet under the following conditions (°C):

a. Range of coal specified
b. Steam Generator load
60% TMCR to 100% BMCR under sliding pressure operation

5.2.6 Steam temperature imbalance

It shall be demonstrated at SH and RH outlets (in case of more than one outlet) that the temperature imbalance between the outlets does not exceed 10°C under all loads including transients.

5.2.7 Furnace exit gas temperature (FEGT)

It shall be demonstrated that maximum furnace exit gas temperature (FEGT) shall be as specified. A comprehensive thermal performance test (TPT) shall be conducted for this purpose on one unit only. FEGT shall be demonstrated through such TPT by indirect measurement.

5.2.8 Minimum stable load on the Steam Generator without oil support under the following condition (%):
a) Range of coal specified
b) Both Load ramp-up & ramp down
c) Any combination of mills in operation.

It shall be guaranteed that oil support for flame stabilisation shall not be required beyond 30% of BMCR load when firing the coals from the range identified. It shall be demonstrated that with any combination of mills/adjacent mills in service (to Owner's

Anshul S A Khan Praveen Kishore

choice), the steam generator does not require any oil firing for stable and efficient boiler operation at and above 30% BMCR loads.

5.2.9 Coal consumption at 100% BMCR, and 100% TMCR for design coal and worst coal based on the following (T/h)

a) Ambient air temperature 32°C
b) Relative Humidity 65%

5.2.10 Coal Mills

i) Capacity, efficiency and power consumption of each mill while firing design coal and worst coal (tph) at:

- New Condition
- at 50% wear life
- at worn out condition

Performance testing shall be done on coal mills toward establishing its guaranteed capacity specified at the rated fineness, applying corrections for the variation in coal characteristics i.e., HGI (Hardgrove Grindability Index) and total moisture.

Capacity demonstration test shall be carried out for the following conditions:

a. Capacity output of one coal pulveriser (of Owner's choice) of each Steam Generator shall be demonstrated for establishing its capacity at 100% mill loading, at rated pulverized coal fineness with specified design coal with new set of grinding elements.

b. Capacity output shall also be demonstrated on four coal pulverisers (of Owner's choice) of each Steam Generator, not less than the 90% of guaranteed value of a) above, at 100% mill loading with the originally installed grinding elements in nearly worn-out condition or at the end of guaranteed wear life of grinding elements, whichever is earlier.

Capacity test as mentioned at a & b above shall be demonstrated at the following conditions occurring simultaneously during testing:

Rated pulverised coal fineness	(a) not less than 70% through 200 mesh and (b) not less than 99% through 50 mesh screen
Test Coal	Any available coal from the specified range

In case the guaranteed capacity of coal pulverisers as stated above are successfully demonstrated, remaining coal pulverisers of corresponding steam generator will also be considered to have successfully met the above capacity guarantee requirement. However, in the event of any of the coal pulverisers not meeting the guarantee test, all the coal pulverisers of corresponding steam generator will have to be tested to demonstrate guaranteed capacity.

Anshul S A Khan Praveen Kishore

During the demonstration of the pulverizer capacity output, manufacturer's operating instructions will be followed and pulverizer will be operated with the specified range of coals without any such readjustment that requires a shutdown of the pulverizer or reduction of the load and/or any replacement of any pulverizer wear parts. For the purpose of testing to demonstrate the capacity, if HGI (grindability) and total moisture vary from those given in coal characteristics, the above pulverizer measured capacity shall be corrected using the capacity correction curves furnished by the Contractor and approved by the Owner. HGI versus coal pulverizer capacity curve shall be furnished for HGI variation upto a value above which the capacity remain constant.

ii) Loading of each mill when steam generator operating at 100% BMCR and 100% TMCR condition while firing design coal and worst coal

iii) Coal fineness for the range of coal specified

- Through 200 mesh screen
- Through 50 mesh screen

iv) Life of mill wear parts warranty

The Contractor shall warrant the wear life of all wear parts of the coal pulverizer when grinding the specified range of coal(s). Pulverizer wear parts are defined as those parts of the pulverizer which are in contact with coal or coal dust and are likely to wear out during the operation of the pulverizer. The guarantee/warrantee shall be demonstrated on each pulverizer during the Guarantee Trial Period (GTP).

Minimum Guaranteed Life for various coal pulverizer wear parts shall be as indicated.

The wear parts shall be considered to have passed their warranted operating life when they have successfully demonstrated their capability to meet the full load rated capacity of the pulverizer (as per requirements of Technical Specification) during the guaranteed life of the wear part. No weld buildup or reversing of grinding elements will be permitted for achieving the guaranteed wear life.

5.2.11 Primary Air fans

a) Capacity(m^3/h)
b) Head developed(mWC)
c) Fan efficiency(%)
d) Power consumption (kW)
e) Margins envisaged on capacity and head

5.2.12 Forced Draft Fans

a) Capacity(m^3/h)
b) Head developed(mWC)

Anshul S A Khan Praveen Kishore

c) Fan Efficiency(%)
d) Power consumption (kW)
e) margins envisaged on capacity and head

5.2.13 Induced Draft Fans

a) Capacity(m^3/h)
b) Head developed (mWC)
c) Fan efficiency(%)
d) Power consumption (kW)
e) margins envisaged on capacity and head

5.2.14 Seal Air Fans

a) Capacity (m^3/h)
b) Head developed (mWC)
c) Fan Efficiency (%)
d) Power consumption (kW)
e) margins envisaged on capacity and head

5.2.15 Fuel Oil Firing System

a) Percentage load for which High Speed Diesel (HSD) firing system is designed (% BMCR)
b) Percentage load for which Heavy Fuel Oil (HFO) firing system is designed (% BMCR)

5.2.16 Air Pre-heater leakage

It shall be demonstrated that the air-heater air-in-leakage and maximum drift in air leakage do not exceed the guaranteed value or specified value (whichever is lower) of Technical specifications. Above requirement needs to be complied with recirculation of flue gas from downstream of ESP.

5.2.17 Run back capabilities

The automatic runback capability of the unit (boiler- turbine-generator) on loss of critical auxiliary equipment (such as tripping of one ID/FD/PA fan/ air heater etc.) shall be demonstrated ensuring smooth and stable runback operation.

5.2.18 CO emission at 100% TMCR at rated excess air for specified range of coal.

5.2.19 Flue gas temperature at APH outlet (maximum) while firing design coal at 100% TMCR without considering air leakage.(°C)

5.2.20 Unburnt carbon in bottom ash while firing design coal at 100% TMCR(%)

5.2.21 Unburnt carbon in fly ash while firing design coal at 100% TMCR(%)

Anshul S A Khan Praveen Kishore

5.2.22 Total unburnt carbon loss while firing design coal at 100% TMCR (%)

5.2.23 Surface temperature of thermal insulation with ambient temperature of 45°C at surface velocity of 0.25 m/s. (°C)

5.2.24 Electrostatic Precipitator

The performance/acceptance tests shall be carried out in accordance with method-17 of EPA (Environmental Protection Agency of USA) code ASME PTC.

The particulate emission from ESP shall not be more than 50 mg/Nm^3 under guarantee point condition at TMCR load with design coal firing. The corresponding ESP efficiency shall be worked out.

The ESP air in leakage shall not be more than 1% of total gas flow at ESP inlet at the guarantee point condition and shall be demonstrated.

The maximum pressure drop through the ESP at the guarantee point flow condition shall not exceed 20 mm WC, which shall be demonstrated.

The gas distribution in the various stream and fields shall be demonstrated.

METHOD OF COMPUTING TEST EFFICIENCY OF ESP

1. The performance test on electrostatic precipitator will commence after a minimum period of three thousand (3000) hours of continuous operation after completion of initial operation. During the interval between the commencement of initial operation and the commencement of performance test only routine maintenance shall be carried out. No physical or chemical cleaning of ESP shall be permitted during this period or immediately before the conductance of the performance tests.

2 The test efficiency shall be based on the overall performance of the electrostatic precipitator over a mutually agreed period of operation under the conditions given in this specification and allowing the normal operation of the unit including rapping and normal soot blowing and/or when fuel oil is being fired in the igniters and/or warm up guns.

The overall test efficiency and test temperature/inlet dust burden for one set of ESP passes (stream) serving one Steam Generator shall be worked out as follows:-

a) Vm (guarantee point test flow) shall be the total of inlet gas flows to the all the gas streams at the time of test.
b) Test inlet dust burden (Di) shall be weighted mean of the inlet dust burdens for the individual streams i.e.:

$$Di = \frac{(Vm1 \times Di1)+(Vm2 \times Di2)+ (Vm3 \times Di3)+(Vm4 \times Di4)+(Vm5 \times Di5)+(Vm6 \times Di6)}{(Vm1 + Vm2 + Vm3 + Vm4 + Vm5 + Vm6)}$$

Where suffix 1, 2, 3, 4, 5 & 6 represent the six gas stream.

Anshul S A Khan Praveen Kishore

Page 262 of 624

Similarly the test outlet dust burden (Do) will be calculated based on outlet gas flow

c) The weighted test inlet gas temperature (Ti) shall also be worked out in a similar manner i.e.

$$Ti = \frac{(Ti1 \times Vm1)+(Ti2 \times Vm2)+ (Ti3 \times Vm3)+(Ti4 \times Vm4)+(Ti5 \times Vm5)+(Ti6 \times Vm6)}{(Vm1 + Vm2 + Vm3 + Vm4 + Vm5 + Vm6)}$$

d) The measured test efficiency shall be

$$EM = \frac{Di-Do}{Di} \times 100(\%)$$

a) The corrections for the variation in flue gas flow, inlet dust burden and ESP inlet flue gas temp. shall be based on the above computed test values and the procedure indicated in the next para.

Note: 5th & 6th gas stream if applicable

3 At the time of performance testing if the inlet flue gas conditions are not consistent with the specified conditions, due to variation in coal characteristics from the design coal and boiler operating conditions the precipitator performance conforming to this specification, shall be determined using performance curves and correction factors accepted at the time of award of contract. However, the test efficiency shall be corrected to the guarantee point conditions in the following manner:

1. $Ec = 1-e^{Z}$

Where Ec = Corrected test efficiency to guarantee point conditions.

$Z = C. Ln (1-Eg)$

$$C = \frac{1}{Ca.\ Cb.\ Cc.\ etc.}$$

Ca.Cb.Cc are Correction factors for flue gas at temperature, ESP inlet dust loading & sulphur based on correction curves furnished by the Bidder and approved by the Owner

2 $Eg = 1 - e^{Y}$

Where $Y = (Vm/Vg)^{0.5} Ln (1-Em)$

Eg=Measured test efficiency corrected to the specified guarantee point flow.
Vg =Specified Guarantee point gas flow (m3/sec).

Anshul S A Khan Praveen Kishore

Vm = Measured gas flow (m3/sec)
Em = Measured test efficiency
Ln = Logarithm, natural base

The correction curves should be realistic for expected range of operation and variation in characteristics specified.

The test efficiency shall be the average of at least two corrected test efficiencies.

4. The Performance tests shall be carried out in accordance with method-17 of EPA (Environmental Protection Agency of USA) code. The details of the test shall, however be mutually agreed upon between the Owner and the Bidder.

STEAM TURBINE & AUXILIARIES

5.3.1 Gross power output at 100% TMCR and VWO condition after subtracting excitation power and TG integral auxiliaries with following conditions(MW):

i) Cycle make-up : 1% make-up
ii) Cooling water inlet temperature of 33°C
iii) Generator power factor -0.85

5.3.2 Gross power output after subtracting excitation power and TG integral auxiliaries with following conditions(MW):

i) Cycle make-up : 1% makeup
ii) Cooling water inlet temperature of 33 Deg.C
iii) Generator power factor -0.85
iv) All HP heaters out of services.

5.3.3 Gross power output after subtracting excitation power and TG integral auxiliaries with following conditions (MW):

i) Cycle make-up : 1% makeup
ii) Cooling water inlet temperature of 33 Deg.C
iii) Generator power factor -0.85
iv) At 47.5 Hz to 51.5 Hz

5.3.4 Continuous TG output

Continuous TG output of 693 MW unit load (i.e. 105% of rated load) under rated steam conditions after subtracting excitation power and TG integral auxiliaries

i) Cycle make-up : 1% makeup
ii) Cooling water inlet temperature of 33 Deg.C
iii) Generator power factor -0.85
iv) At 47.5 Hz to 51.5 Hz

Anshul S A Khan Praveen Kishore

5.3.5 Turbine cycle heat rate at 100% TMCR after subtracting excitation power and TG integral auxiliaries with following conditions (MW):

i) Cycle make-up : 1% makeup
ii) Cooling water inlet temperature of 33 Deg.C
iii) Generator power factor -0.85

Note: The condenser pressure measurement while conducting the guarantee tests shall be measured at 300 mm above the top row of condenser tubes.

5.3.6 Turbine-generator set capability

The steam turbine generator shall be capable of delivering at generator terminals the output as indicated in the heat balances under the following conditions:

Continuous TG output of 100% TMCR under rated steam conditions at 89 mm Hg (a) worst condenser pressure with 1% make up. While conducting this test, the condenser pressure measurement shall be done at 300 mm above the top row of condenser tubes.

The automatic runback capability of the unit (boiler- turbine-generator) on loss of critical auxiliary equipment (such as tripping of one BFP/CEP etc.) shall be demonstrated ensuring smooth and stable runback operation

5.3.7 Upon sudden total loss of all external loads units will not trip on over speed but shall continue to be in operation to supply power for plant auxiliary load (house load).

5.3.8 Run Back capabilities of the SG and STG upon loss of critical auxiliary equipment, shall ensure smooth and stable run back operation.

5.3.9 Variable pressure operating range (% TMCR)

5.3.10 Condenser

a) Total pressure drop in condenser tube side with design cooling water flow and temperature (mWC)

b) Total cooling water temperature rise in condenser with design cooling water flow and CW inlet temperature of 33 deg.C under the following condition.

i) Unit operating at 100% TMCR condition (°C)
ii) Unit operating at VWO condition (°C)
iii) Unit operating with all HP Heaters out condition and generating 100% TMCR power output (°C)
iv) Unit operating under house load and HP & LP bypass operating at rated capacity. (°C)

Anshul S A Khan Praveen Kishore

c) Re-cooled water temperature at Outlet of cooling tower based on the following design conditions:

i) Rated Cooling Water Flow (m3/h)
ii) Design Ambient Wet Bulb Temperature (°C)
iii) Design Inlet Wet Bulb Temperature (°C)
iv) Design Relative Humidity(%)
v) Design Cooling Range(°C)

d) **Condenser pressure**

Condenser pressure in mm Hg (abs) measured at 300 mm above the top row of condenser tubes under VWO conditions, 1% make up, design CW temperature and CW flow.

The condenser vacuum shall be measured with a vacuum grid utilizing ASME basket tips.

Temperature of condensate, at outlet of condenser, shall not be less than saturation temperature corresponding to the condenser pressure at all loads.

Air leakage in the condenser under full load condition shall not exceed more than 50% of design value taken for sizing the condenser air evacuation system.

When one half of the condenser is isolated, condenser shall be capable of taking at least 60% TG load under TMCR conditions.

The capacity of each vacuum pump in free dry air under standard conditions at a condenser pressure of 25.4 mm Hg (abs) and sub cooled to 4.17°C below the temperature corresponding to absolute suction pressure shall not be less than 30 SCFM. Correction curves for establishing the capacity at site conditions shall also be furnished.

The air and vapour mixture from air cooling zone of condenser shall be 4.17°C below the saturation temperature corresponding to 25.4 mm Hg (a) suction pressure. Correction curves for establishing the same at site conditions shall also be furnished.

PERFORMANCE TEST FOR THE CONDENSERS

(i) Performance test for design condenser pressure shall be conducted in accordance with latest edition of ASME PTC- 12.2.

(ii) Condenser pressure will be measured at 300 mm above the top row of tubes under VWO conditions, 1% make-up and design C.W. flow & design temperature. The condenser pressure shall be measured with a vacuum grid utilizing ASME basket tips. The grid is fitted at 300 mm above top row of condenser tubes.

Anshul S A Khan Praveen Kishore

(iii) Tube plug margin of 5%, as per design condition, shall be considered for condenser performance calculation at design condition.

(iv) If tube side fouling resistance for actual test condition is not measured as per methodology given in PTC 12.2, the tube cleanliness factor corresponding to the same shall be appropriately assessed considering the aspect of actual tube cleaning prior to conducting the test

5.3.11 Condensate Extraction Pump (CEP)

a) Rated capacity (m^3/h)
b) Rated Total Dynamic Head (TDH) (mWC)
c) Pump efficiency(%)

5.3.12 Booster pump of CEP (If applicable)

a) Rated capacity (m^3/h)
b) Rated Total Dynamic Head (TDH) (mWC)
c) Pump efficiency (%)

5.3.13 Condensate Polishing Unit (CPU)

a) Effluent quality of outlet of each vessel at its rated design flow and design service length between two regenerations
b) Chemical consumption for regeneration
c) Pressure drop across the polisher service vessel, as specified, in clean and dirty condition of resin at rated design flow.
d) Condensate water quality.

5.3.14 Feed Water Heaters

a) Pressure drop on the tube side of the individual LP heaters (Maximum) (mWC)
b) Pressure drop on the tube side of the individual HP heaters (maximum)(mWC)

5.3.15 Deaerator

The following parameters shall be demonstrated:

a) TTDs and DCAs of feed water heaters shall be demonstrated as per guaranteed heat balance diagram for 100% TMCR condition.

b) Outlet temperature from final feed water heater(s)

c) Dissolved O2 content in Deaerator effluent at deaerator outlet without chemical dosing at all loads, not to exceed 0.005 CC/litre determined as per ASTM-D-888 – Reference method-A or Indigo Carmine method.

d) Difference between saturation temperature of steam entering the deaerator and temperature of feed water leaving the deaerator shall be demonstrated as per guaranteed heat balance diagram for 100% TMCR condition.

Anshul S A Khan Praveen Kishore

Page 267 of 624

e) Continuous and efficient operation and performance of feed heating plant without undue noise and vibrations at all loads and duty conditions

5.3.16 Boiler Feed Water Pump (BFP)

a) Rated capacity (m^3/h)
b) Rated Total Dynamic Head (TDH) (mWC)
c) Pump efficiency (%)

5.3.17 Booster pump of BFP

a) Rated capacity (m^3/h)
b) Rated Total Dynamic Head (TDH) (mWC)
c) Pump efficiency (%)

5.3.18 Equipment cooling water system

(i) Capacity, head & power consumption of all the pumps with the respective job (own) motors to be demonstrated at shop. For the pumps which are included under "Unit Auxiliaries for calculation of Pu" as defined elsewhere the power consumption value (at rated duty point) during shop testing shall be considered for computation.

(ii) Vibration, parallel operation and noise level of all the pumps at the rated duty point shall be demonstrated at site

(iii) Design heat load of plate type heat exchangers and Inlet & Outlet temperatures of the Plate type heat exchangers on the primary and secondary side to be demonstrated at site. Pressure drop across the Plate type heat exchanger on the primary & secondary water circuit to be demonstrated at site.

5.3.19 Condenser On Load Tube Cleaning System

Life of sponge rubber balls and number of balls lost during 1000 hours of plant operation shall be as indicated by Bidder in the offer and accepted by the Owner.

5.3.20 HP & LP Bypass System Capability

The HP & LP bypass system should satisfy the following functional requirements under automatic interlock action. It should come into operation automatically under the following conditions:

a) Generator circuit breaker opening
b) HP & IP stop valves closing due to turbine tripping
c) Sudden reduction in demand to house load

Under all above conditions, while passing the required steam flows as per the relevant heat balances, the condenser should be able to swallow the entire steam without increasing the exhaust hood temperature and condenser pressure beyond the maximum permissible values. The same shall be demonstrated.

Anshul S A Khan Praveen Kishore

5.3.21 Power Cycle Pumps

Satisfactory operation of BFPs and CEPs without undue noise and vibration while operating in isolation or in parallel with other pumps shall be demonstrated at site.

5.3.22 Power Cycle Piping

Actual hanger readings under cold and hot condition (at rated parameters) to match with those of design cold and hot hanger readings for MS/CRH/HRH/HP & LP bypass piping system

GENERATOR

a) Generator Maximum Continuous Rating (MVA)

b) Generator Efficiency (minimum) (%)

c) Hydrogen Make-up per day (m^3/day)

d) Excitation system
   i) Capacity of excitation transformer for static excitation (kVA)
   ii) Total loss of excitation transformer (kW)
   iii) Total loss of static excitation system (kW)
   iv) Total loss of brushless excitation system (kW)

UNIT START-UP TIME (FROM LIGHT-UP TO SYNCHRONIZATION) (MINUTES)

a) Cold start-up : >72 hours

b) Warm start-up : 10-72 hours

c) Hot start-up : <10 hours

d) Very hot start-up : <1.5 hours

UNIT RAMP UP / RAMP DOWN RATES (% PER MINUTE)

a) <50% TMCR

b) 50%-100% TMCR

c) Rate of change of load and sudden load change withstand capability

STEP LOAD CHANGE

Anshul S A Khan Praveen Kishore

BALANCE OF PLANT (BOP) EQUIPMENT

COAL HANDLING PLANT SYSTEM

a) Number of hours of CHP operation

b) Guaranteed parameters of each equipment indicated below

i) Belt conveyors (tph)
ii) Crushers (tph)
iii) Screens (tph)
iv) Screen efficiency (%)
v) Stacker cum reclaimer (t/h)
vi) Belt feeder
vii) Vibrating feeder

c) Maximum moisture in coal up to which crusher & screen will be capable of handling (%)

d) Water requirement for dust suppression system (m^3/h)

e) Dust emission at each of the dust extraction system (mg/Nm^3)

f) Belt weigh scale (±)

g) Capacity, head and power consumption of all the pumps shall be guaranteed. Vibration and noise level of all the pumps at the rated duty point shall be demonstrated at site

h) Power consumption of all equipment shall be guaranteed. Vibration and noise level of all the equipment at the rated duty point shall be demonstrated at site

ASH HANDLING PLANT

5.8.2.1 **Conveying capacity / Evacuation time**

a) **Bottom ash evacuation system**

i) Capacity of Scraper chain conveyors (tph)
ii) Capacity of clinker grinder (tph)

b) Fly ash evacuation system

i) Evacuation time per 8 h shift from fly ash hopper to fly ash silo (h)
ii) Evacuation system capacity (tph)
iv) Capacity of recovery water system (m3/h)

5.8.2.2 **Sea water requirement**

i) Max water requirement in a 8 h shift for ash disposal (m^3/h)

Anshul S A Khan Praveen Kishore

ii) Required sea water in 8 h shift basis as make-up for AHS sea water tank (m^3/h)

5.8.2.3 **Desal water requirement**

i) Max water requirement in a 8 hr shift (m^3/h)
ii) Required water in 8 h shift basis as make-up for AHS clarified water tank (m^3/h)

5.8.2.4 Capacity, head and power consumption of all the pumps shall be guaranteed. Vibration and noise level of all the pumps at the rated duty point shall be demonstrated at site.

5.8.2.5 Power consumption of all equipment shall be guaranteed. Vibration and noise level of all the equipment at the rated duty point shall be demonstrated at site

WATER SYSTEM

Capacity, head and power consumption of all the pumps shall be guaranteed. Vibration and noise level of all the pumps at the rated duty point shall be demonstrated at site

5.8.3.1 Seawater intake pumps – Desalination feed

5.8.3.2 Seawater intake pumps – Cooling Tower make-up

5.8.3.3 Condenser cooling water pumps

5.8.3.4 Auxiliary cooling water pumps

5.8.3.5 Cycle make-up pumps

5.8.3.6 Other Miscellaneous Pumps

a) Service water pumps
b) CHP dust suppression plant feed pump
c) DM water transfer pump
d) Potable water transfer pump
e) Ash water make- up transfer pump
f) APH/ESP wash pump
g) DMCW make-up pump
h) Boiler initial filling pump
i) Any other pumps

5.8.3.7 Clarifier (per unit) – capacity (m^3/h)

5.8.3.8 Pressure sand filters – capacity (m^3/h)

5.8.3.9 Desalination plant – Capacity (m^3/h)

Anshul S A Khan Praveen Kishore

5.8.3.10 RO STAGE II – capacity (m^3/h)

5.8..3.11 DM plant net output (m^3/h)

5.8..3.12 Mixed Bed OBR (m^3)

5.8.3.13 Water quality at PT Plant outlet

a) Clarifier outlet turbidity (NTU)
b) Pressure sand filter turbidity (NTU)
c) Ultra filter outlet (SDI)

5.8.3.14 Water quality at RO STAGE I outlet (upon completion of three years from COD without replacement of membrane)

a) Permeate conductivity @ 27 deg.C (Micro mho/cm)
b) Permeate conductivity @33 deg. C (Micro mho/cm)
c) Permeate TDS (ppm)

5.8.3.15 Water quality at RO STAGE II outlet upon completion of three years from COD without replacement of membrane

a) Permeate conductivity @ 27 deg C (Micro mho/cm)
b) Permeate conductivity @ 33 deg C(Micro mho/cm)
c) Permeate TDS (ppm)

5.8.3.16 Water Quality at Mixed Bed Unit outlet

a) Conductivity @ 25 deg C (Micro mho/cm)
b) Total Silica (ppb)
c) pH

5.8.3.17 Water Quality at DM Storage Tank outlet

a) Conductivity @ 25 Deg.C (Micro mho/cm)
b) Total Silica (ppb)

5.8.3.18 Water quality at Potable Water outlet

a) TDS (ppm)
b) pH
c) Boron (ppm)

CHEMICAL CONSUMPTION FOR WATER TREATMENT (KG/DAY)

a) Contractor to list the chemicals type and quantities used
b) Pre-treatment plant
c) Desalination plant
d) DM Plant

Anshul S A Khan Praveen Kishore

CHLORINATION PLANT

Capacity (kgh)

FUEL OIL SYSTEM (HFO/HSD (TPH)

a) Unloading period (h)
- HFO unloading period for 10 road tankers simultaneously with one standby pump
- HSD unloading period for 5 road tankers simultaneously with one standby pump

b) Capacity, head and power consumption of all the pumps shall be guaranteed. Vibration and noise level of all the pumps at the rated duty point shall be demonstrated at site

FIRE FIGHTING SYSTEM

Capacity, head and power consumption of all the pumps shall be guaranteed. Vibration and noise level of all the pumps at the rated duty point shall be demonstrated at site

a) Fire water pumps – Hydrant system
b) Fire water pumps – spray system
c) Fire water booster pumps
d) Foam system - pumps

COMPRESSED AIR SYSTEM

a) Free air delivery at site conditions per each compressor (Nm^3/min)

b) Power consumption at site rated parameters per each compressor (kW)

c) Max. capacity of each air dryer at min working pressure and max. temp at after cooler outlet (Nm^3/min)

d) Parallel operation of air compressor shall be demonstrated at site.

e) Pressure drop across Air Drying Plant, Capacity and outlet dew point of each air drying plant shall be demonstrated at site.

f) Vibration level and noise level of each air compressor, blowers and any other rotating equipments of each air drying plant shall be demonstrated at site.

PASSENGER & GOODS ELEVATORS

Carrying capacity (kg)

CRANES & HOISTS

Capacity and operating speed shall be guaranteed for the following cranes shall be guaranteed

a) Turbine Building Main EOT Crane (AB bay)

i) Safe Working Load (T)
ii) Operating speed (meters per minute)
- Hoisting
- Long Travel
- Cross Travel

b) Turbine Building BFP EOT Crane (BC bay)

i) Safe Working Load (T)
ii) Operating speed (meters per minute)
- Hoisting
- Long Travel
- Cross Travel

c) CW Pump house EOT crane

i) Safe Working Load (T)
ii) Operating speed (meters per minute)
- Hoisting
- Long Travel
- Cross Travel

d) Seawater intake pump house EOT crane

i) Safe Working Load (T)
ii) Operating speed (meters per minute)
- Hoisting
- Long Travel
- Cross Travel

e) Any other area requiring Cranes and hoists

MILL REJECT SYSTEM

a) Conveying capacity(tph)
b) Compressor capacity / numbers (Nm3/min)

Continuous effective discharge and conveying at the rated capacity of the mill rejects without spillage or blockage in the system shall be demonstrated.

AIR CONDITIONING SYSTEM

Capacity and auxiliary power consumption of all equipment and inside room conditions shall be guaranteed for the following areas

a) Main Control room in TG Building
b) Control room in following aux buildings.
c) ESP control building

d) Switchyard control building
e) DM plant control room
f) Coal handling control building
g) Ash handling control building
h) Service building Floor wise:
i) Any other area requiring air conditioning

VENTILATION SYSTEM

Capacity and auxiliary power consumption of all equipment shall be guaranteed for the following areas

a) TG Hall
b) Switchgear room in TG building
c) Cable spreader room in TG building
d) SWAS room in TG building
e) Switchgear room in ESP building
f) Cable spreader room in ESP building
g) DG set room
h) Air compressor house
i) Battery room
j) Switchgear room
k) Cable spreader room
l) Filtered water pump house
m) CW pump house
n) Chemical house
o) Fire water booster pump house
p) Fuel oil pump house
q) AC plant room
r) Chlorination room & associated areas
s) Any other area requiring ventilation

ROAD WEIGH BRIDGE

b) Weighing capacity (T)
c) Platform size (mxm)
d) Accuracy(%)
e) Load cell

HYDROGEN GENERATION PLANT

i) Capacity & discharge pressure of hydrogen gas compressors at its rated duty point with its job (own) motor shall be demonstrated and proved at shop.
ii) Parallel operation of two streams shall be demonstrated at site. Purity level and moisture content of Hydrogen shall be demonstrated at site.
iii) Hydrogen generation plant capacity (stream wise) shall be demonstrated at site.

AS APPLICABLE AND/OR AS SPECIFIED IN THE TECHNICAL SPECIFICATION IN MECHANICAL SUBSECTION.

ELECTRICAL SYSTEM

As applicable and/or as specified in the technical specification in electrical Subsection.

Anshul S A Khan Praveen Kishore

CONTROL AND INSTRUMENTATION SYSTEM REQUIREMENTS

Performance guarantee tests for closed loop control system shall be carried out at site to verify the integrated performance of the total plant C&I and to verify as to whether all the important parameters remain within stipulated permissible limits under all the operating conditions. In case during this tests or otherwise it is observed that the behavior/response of Contractor's system (drives actuators/ valves etc.) is not satisfactory/acts as a limitation/restriction in achieving the permissible limits, the contractor shall carry out all required modifications rectification etc., in his system whatsoever so that the permissible limits can be achieved. He shall also depute his experts for associating in the above tests and also for carrying out the necessary modifications, rectification etc.

Further the Performance guarantee tests shall be as applicable and/or as specified in the technical specification in Control & Instrumentation subsection.

AUTOMATIC ON-LINE TURBINE TESTING (ATT) SYSTEM

On-load testing of turbine protective equipment without disturbing normal operation and keeping all protective functions operative during the test

AS APPLICABLE AND/OR AS SPECIFIED IN THE TECHNICAL SPECIFICATION IN CONTROL & INSTRUMENTATION SUBSECTION.

TURBINE GENERATOR PERFORMANCE/ ACCEPTANCE TEST

1. Performance test for the turbine generator set will be conducted in accordance with the latest edition of ASME PTC-6. Such test shall be binding on the parties to the contract to determine compliance with the guaranteed heat balance conditions at 693 MW (105% TMCR) MW and 660 MW (100% TMCR) unit outputs corresponding to the conditions stipulated in the specification. Power consumed by the auxiliaries mentioned under in the Sub-section which is to be deducted from electrical power generated, shall be measured during the performance / Acceptance Test. Wherever the measurement is not possible, design values of power consumption by an auxiliary shall be considered.

2. The essential mandatory requirements for instruments, methods and precautions to be employed shall be in accordance with the requirements specified in the respective codes. All the necessary instruments (in duplicate) required for the tests shall be furnished by the contractor so as to meet the accuracies specified in the codes. Any advanced class instrument system such as those using electronic devices or mass flow technique shall be arranged by the contractor, if required. For determination of primary flow to the turbine, a calibrated low Beta-ratio throat-tap nozzle assembly including required machined straight lengths meeting the requirement of ASME PTC-6 shall be provided. The test procedures, Calibration Standards, Calibration procedures etc., shall be subject to Owner's approval. All the instruments including the flow nozzle shall be calibrated by the contractor before and after the test, in a reputed international institute as approved by the Owner. However, post test calibration of flow nozzle shall not be mandatory. These calibrations shall be performed in the presence of the Owner. All calibrations shall be made available prior to the test and calibration certificates

Anshul S A Khan Praveen Kishore

in original submitted to Owner at least 15 days before conductance of the test for Owner's approval.

The instruments shall be sealed after calibration by calibrating lab. The percentage calibration error/deviation should not be more than accuracy class of the instrument. Calibration low beta ratio throat tap nozzle assembly including flow straightner, upstream and down stream machined straight lengths, for main condensate flow measurements shall be as per ASME PTC6.

Secondary flow devices shall be calibrated flow nozzle / orifice plate as per ASME PTC 19.5.

3. Corrections to the test results for steam turbine shall be applied as per the correction curves listed in technical specification. When the system is properly isolated for a performance test, the unaccounted for leakages should not be more than 0.1% of the design throttle flow at that load. To achieve the above value of unaccounted for leakages, the Bidder shall prepare the unit during pretest available shutdown. However, during the test, if it is found that the unaccounted for leakage is more than 0.1% of design throttle flow at that load, then heat rate will be increased by an amount equal to half the difference between actual unaccounted for leakage expressed as percentage of design throttle flow at that load and 0.1% (allowed by the code).

4. The performance guarantee test will be carried out after successful completion of initial operation. Ageing allowance will be given during evaluation of PG test results and hence guaranteed heat rates shall be increased by the amount calculated as per the formula given in Cl. No. 3.07, Sub-Section-3 of ASME-PTC-6 Report 1985 (Reaffirmed 1991). Period of ageing shall be considered from the date of successful completion of initial operation to the date of conductance of PG test, In calculating the above factor any period(s) during which the turbine has not been in operation at a stretch for more than a week shall not be considered.

5. The tests shall be arranged in a manner that the OWNER's operation is not disrupted Duplicate test runs shall be performed at 693 MW and 660 MW unit loads. The results of corrected heat rate shall agree within 0.25%. If they differ by more than 0.25%, third test shall be run at the same point. The corrected result of any one of the three test runs, which deviates from the corrected averaged result of all the runs by more than 0.25%, shall be eliminated; otherwise the results of all the three tests runs shall be accepted.
6. During Performance/ Acceptance test, following tests shall be carried out for T.G. set with test grade instruments as per ASME code.

   (i) Guarantee Turbine Cycle Heat rate test at 693MW (105% rated load) corresponding to the heat balance diagram specified in tender specification
   (ii) Guarantee Turbine Cycle Heat rate test at 660MW corresponding to the heat balance diagram specified in tender specification
   (iii) Guarantee Output test of 693 MW (105% rated load) corresponding to the heat balance diagram specified in tender specification
   (v) Maximum continuous output corresponding to both strings of HP heaters out of operation, under rated steam conditions at a condenser pressure of 77 mm Hg (abs) and 1% makeup.

Anshul S A Khan Praveen Kishore

SECTION: C 2C

CUSTOMER SPECIFICATIONS

PAINTING SPECIFICATIONS

CHAPTER - 6

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 color coating wherever required.
e. Painted equipment like blowers, pumps, valves etc. with finishing coats in good condition and with matching color 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 enamels
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 1100C. Blasting activity shall be performed at temperatures 30C above due point and substrata temperature between 50C & 500C 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 (aluminum 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

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
a)	Dust, Loose deposits	Vacuum cleaning, brushing
b)	Adhesive deposits	Power brushing
c)	Oils, greasy impurities	Wet Blasting, Use of Detergent Additives by agreement
d)	Salt deposits	Rinsing
e)	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 shall be + 5^0C and the relative humidity shall not exceed 80%. The temperature of the work piece shall be at least 3^0C 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 manufacturers 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 upto 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 upto 120^0C as per clause 6.1 & 6.3. However

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^{0}C, upto 200^{0}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

Pretreatment

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^{0}C, upto 400^{0}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

Pretreatment

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 upto < 400^{0}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^{0}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

Pretreatment

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

Pretreatment

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 upto 60^0C 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.

Pretreatment

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.

6.6.2 Rubber Lining of Pipes, Valves and Tanks for DM Water

Pretreatment

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

Rubber Lining

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

6.7 Painting for Electrical items

6.7.1 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.

6.7.2 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.

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

6.8 SUGGESTED COLOUR CODES FOR PAINTING

SL. NO.	ITEM/SERVICE	COLOUR	IS-5	COLOUR (BAND)	IS-5
1.	Structures, platforms, galleries, ladders and handrails	Dark Admirality Grey	632	-	-
2.	Boiler casing, ducting	Nut Brown	413	-	-

SL. NO.	ITEM/SERVICE	COLOUR	IS-5	COLOUR (BAND)	IS-5
3.	Crane				
3.1	Crane structure	Golden Yellow	356	Black	-
3.2	Trolley & hook	Crimson	540	-	-
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)	631/70 78 of IS 1650	-	-
9.	Turbines	Light Grey	631	-	-
10.	Generators & Exciter	Light Grey	631	-	-
11.	Transformers	Aluminum	-	-	-
12.	Machinery guards	Signal red	537	-	-
13.	Piping (without insulation and cladding)				
13.1	Water System				
a	Boiler feed	Sea Green	217	-	-

SL. NO.	ITEM/SERVICE	COLOUR	IS-5	COLOUR (BAND)	IS-5
b	Condenstae	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	-
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.

SECTION: C-3
TECHNICAL SPECIFICATION (ELECTRICAL PORTION)

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGES : VENTILATION SYSTEM

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

PROJECT: 2X660 MW ENNORE TPP

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	240 V AC (supply feeder)/415 V AC (3 PHASE 4 WIRE) supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	 BHEL BHEL BHEL	 BHEL Vendor BHEL	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.
4	FRP/Steel Junction box for control & instrumentation cable	Vendor	Vendor	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 10-12 mtrs) and trunk cable.
5	Any special type of cable like compensating, co-axial, prefab, MICC, optical fibre etc.	Vendor	Vendor	Refer C&I portion of specification for scope of fibre Optical cables if used between PLC/ microprocessor & DCS.
6	Cable trays, accessories & cable trays supporting system 100/ 50 mm cable trays/ Conduits/ Galvanised steel cable troughs for local cabling	BHEL Vendor	BHEL Vendor	Local cabling from nearby main route cable tray (BHEL scope) to equipment terminal (vendor's scope) shall be through 100/ 50 mm. cable trays/ conduits/ Galvanised steel cable troughs, as per approved layout drawing during contract stage. FRP cable trays shall be used for areas like intake raw water pump house, desalination plant, CHP, battery room, NDCT & chemical house.
7	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.
8	Conduit and conduit accessories for cabling between equipment supplied by vendor	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537.

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGES : VENTILATION SYSTEM

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

PROJECT: 2X660 MW ENNORE TPP

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
9	Lighting	BHEL	BHEL	
10	Equipment grounding (including electronic earthing) & lightning protection	BHEL	BHEL	Refer note no. 4 for electronic earthing
11	Below grade grounding	BHEL	BHEL	
12	LT Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
13	Mandatory spares	Vendor	-	Vendor to quote as per specification.
14	Recommended O & M spares	Vendor	-	As specified elsewhere in specification
15	Any other equipment/ material/ service required for completeness of system based on system offered by the vendor (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
16	a) Input cable schedules (Control & Screened Control Cables) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for Control and Instrumentation Cable and electronic earthing cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
17	Electrical Equipment & cable tray layout drawings	Vendor	-	For ensuring cabling requirements are met, vendor shall furnish Electrical equipment layout & cable tray layout drawings (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipment requiring cabling, and shall incorporate cable trays routing details marked on the drawing as per PEM interface comments. Cabling arrangement of the same (wherever overhead cable trays, trenches, cable ducts, conduits etc.) shall be decided during contract stage. Electrical equipment layout & cable tray layout drawing shall be subjected to BHEL/ customer approval without any commercial implications to BHEL.
18	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR ANNEXURE-1

PACKAGES : VENTILATION SYSTEM

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

PROJECT: 2X660 MW ENNORE TPP

NOTES:

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

SPECIFIC TECHNICAL REQUIREMENTS: ELECTRICAL

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER/ PURCHASER

1.1 Scope for supply, and erection & commissioning of various equipment forming part of electrical system for this package shall be as per Annexure–I to Section – C [Scope of Work (Electrical)].

1.2 Make of various equipment/ items in the scope of bidder shall be to approval of owner during detailed engineering stage without any commercial implications.

1.3 Bidder shall furnish all AC as well as DC loads required for the system at different voltage levels (eg. 415V AC, 240 V AC, 220 V DC etc.) of all types, such as motor feeders, supply feeders in PEM format along with the offer.

1.4 All electrical equipment shall be suitable for the power supplies, fault levels and climatic conditions indicated in project information enclosed with the specification.

1.5 All drawings, data sheets, Quality Plan, calculations, test reports, test certificates, etc. shall be submitted during detailed engineering stage as per formats enclosed. The same shall be subject to approval without any commercial implications.

1.6 In case of any discrepancy between Customer specification and BHEL standard specification, Customer specification shall prevail.

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

3.1 Bidder shall confirm total compliance to the electrical specification without any deviation from the technical/ quality assurance requirements stipulated. In line with this, the bidder as technical offer shall furnish two signed and stamped copies of the following:

a) A copy of this sheet “Electrical Equipment Specification for Ventilation System’ and sheet “Electrical Scope between BHEL and Vendor” with bidder’s signature and company stamp.
b) List of Erection and Commissioning spares.
c) List of Erection & Maintenance tools & tackles.
d) Electrical load requirement in the load data format.

3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

4.0 LIST OF ENCLOSURES

4.1 Electrical scope between BHEL & vendor (Annexure-I).
4.2 Electrical Section-C
4.3 Technical specification – Customer specification - Motors & Cabling system
4.4 BHEL standard specification for LT motors : PE-SS-999-506-E101 (Section-D)
4.5 Datasheets – A and C
4.6 Quality Plan for motors.
4.7 Load data format (Annexure-II).
4.8 Cable Schedule Format(Annexure-III)

CHAPTER – 12

MOTORS

1.00.00 DESIGN CRITERIA

1.00.01 For the purpose of design of equipments /systems, an ambient temperature of 50 °C and relative humidity of 85% shall be considered. The equipment shall operate in a highly polluted environment.

1.00.02 Transient voltage dip on starting of the largest motor with DOL shall be limited to 20% of the nominal system voltage at the voltage terminals.

1.00.03 Rating

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

All motors shall be continuously rated (S1 duty). However, crane motors shall be rated for S4 duty, 40% cyclic duration factor.

Whenever the basis for motor ratings are not specified in the corresponding mechanical specification sub-sections, maximum continuous motor ratings shall be at least 10% above the maximum load demand of the driven equipment under entire operating range including voltage and frequency variations.

1.00.04 Starting Voltage requirement for all motors (except mill motors):

1. 85 % of rated voltage for motors up to 1000 kW
2. 80 % of rated voltage for above 1000 kW and up to 4000 kW
3. 75 % of rated voltage for above 4000 kW

For Mill Motors:

1. 85 % of rated voltage for motors above 1000 kW
2. 90 % of rated voltage for motors up to 1000 kW

1.00.05 Canopy shall be provided for outdoor motors.

1.01.00 Contractor shall provide fully compatible electrical system, equipments, accessories and services.

1.02.00 All the equipment, material and systems shall, in general, conform to the latest edition of relevant National and international Codes & Standards, especially the Indian Statutory Regulations.

1.03.00 Voltage and frequency variations:

Frequency: (+) 3% and (-) 5%

Voltage : **i. AC**

a. ± 6% for 11 kV/3.3 kV

b. ±10% for 415 V

Combined 10 % (absolute sum)

ii. DC- +10% to -15% for 220 V DC

1.04.00 All LV motors above 10 kW with S1 duty shall be compulsorily of Energy efficient level IE 2 as per IS 12615: 2011.

1.05.00 The responsibility of coordination with electrical agencies and obtaining all necessary clearances shall be of the contractor.

1.06.00 Type

AC Motors:

(a.) Squirrel cage induction motor suitable for direct-on-line starting.

(b.) Crane duty motors shall be slip ring type induction motor

DC Motors

(a.) Shunt wound.

1.07.00 Temperature Rise

Air cooled motors

70°C by resistance method

Water cooled

80° C over inlet cooling water temperature mentioned elsewhere, by resistance method.

1.08.00 Degree of Protection

Degree of protection for various enclosures shall be as follows :

i) Indoor motors – IP 54

ii)	Outdoor motors	–	IP 55
iii)	CW motors (in case of screen prot. Drip proof)	–	IP 23
iv)	Cable box – indoor area	–	IP 54
v)	Cable box – outdoor area	–	IP 55

2.00.00 CODES AND STANDARDS

2.01.00 All motors shall confirm to the latest editions including all applicable amendment of relevant IS, IEC and CBIP standards/Publications. In case any other standard is followed that ensures equal or better quality, may be accepted. However the English version of the Standard adopted shall be submitted.

2.02.00 Major Standards, which shall be followed, are listed below. Any other applicable Indian standards for any component part even if not covered in the list shall also be followed

1.)	Three phase induction motors	:	IS:325, IEC:60034
2.)	Single phase AC motors	:	IS:996, IEC:60034
3.)	Crane duty motors	:	IS:3177, IEC:60034
4.)	DC motors/generators	:	IS:4722
5.)	Degree of protection by enclosures for rotating electrical machines	:	IS: 4691 IS: 4728 IS: 6362 IS: 2253
6.)	Noise levels for rotating electrical machines		IS: 12065
	Mechanical Vibrations for rotating electrical machines		IS: 12075

3.00.00 OPERATIONAL REQUIREMENTS

3.01.00 Starting Time

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

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

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

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

3.01.05 Motors shall be capable of restarting under full load after a momentary loss of voltage with the possibility of 150 % nominal voltage during fast bus transfer.

3.02.00 Torque Requirements

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

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

4.00.00 DESIGN AND CONSTRUCTIONAL FEATURES

4.00.01 Suitable single phase space heaters shall be provided on motors rated 30 kW and above to maintain windings in dry condition when motor is standstill. Separate terminal box for space heaters & RTDs shall be provided.

4.00.02 All motors shall be suitable for direct on line starting through any type of breaker.

L All motors shall be either totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or Closed air circuit air cooled (CACA) type. However, motors rated 3000KW or above can be Closed air circuit water cooled (CACW). CW motors can be screen protected drip proof (SPDP) type. Motors located in hazardous areas shall have flame proof enclosures conforming to IS: 2148 as detailed below

(a) Fuel oil area : Group - IIB

(b) Hydrogen generation plant area : Group - IIC

4.00.03 Winding and Insulation

(a) Type : Non-hygroscopic, oil resistant, flame resistant

(b)	Starting duty	:	Two hot starts in succession, with motor initially at normal running temperature
(c)	11 kV / 3.3 kV AC motors	:	Class F: with winding temperature rise limited to class B. They shall withstand 1.2/50 micro sec switching surges of 4U+5 KV (U=Line voltage in KV). The coil inter-turn insulation shall be suitable for 0.3/3 micro sec. surge of 32 KVp and 12 kVp for 11 kV ad 3.3 kV system respectively followed by 1 min power frequency high voltage test of appropriate voltage on inter turn insulation.
(d)	415V AC & 220V DC motors	:	Class 'F' with temperature rise limited to class 'B'

4.00.04 Motors rated above 1000 kW shall have insulated bearings to prevent flow of shaft currents.

4.00.05 Motors with heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate inlet and outlet primary air temperature.

4.00.06 Noise level and vibration shall be limited within the limits prescribed in IS: 12065 & IS: 12075 respectively. Motors shall withstand vibrations produced by driven equipment.

4.00.07 In MV/HV motors, 12 nos. simplex or 6 nos. duplex RTDs (two per phase), each having D.C. resistance of 100 ohms at 0°C, embedded in the stator winding at locations where highest temperatures may be expected, shall be provided. The material of the ETD's shall be platinum. Each bearing shall be provided with dial type thermometer with adjustable alarm contact and resistance type temperature detector. All HV motors shall be provided with shaft grounding rings for bearing protection and earthing shaft current.

4.00.08 MV/HV motors shall also be capable of satisfactory operation at full load at a supply voltage of 80% of the rated voltage and shall be capable of either two starts in quick succession with third start after 5 minutes in cold condition or two starts at 15 minutes intervals in hot condition, both cases with voltage and frequency variation within specified limits.

4.00.09 Locked rotor current of the MV motors shall be limited to 600% (subject to IS tolerance) of the full load current of the motors and for HV motor shall be limited to 450% (inclusive of IS tolerance) of full load current of the motor.

Locked rotor current of the LV motor shall not exceed 600% of full load current inclusive of IS tolerance.

4.00.10 MV Motors shall be provided with differential protection. These motors shall be provided with star connected stator windings. The 3 nos. current transformers, one for each phase shall be mounted in a separate compartment in the neutral side terminal box. The three phases shall be connected to form the star point after they pass through the CTs. These differential protection CTs shall be supplied loose by 11/ 3.3 kV switchgear manufacturer.

4.00.11 Motor body shall be grounded at two earthing points on opposite sides with two separate and distinct grounding pads complete with tapped holes, GI bolts and washers.

4.00.12 HV motors can be offered with either elastimould termination or dust tight phase separated double walled (metallic as well as insulated barrier) cable boxes. In case elastimould terminations are offered, then protective cover and trifurcating sleeves shall also be provided. Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non magnetic material for single core cables) shall be provided in case of cable boxes.

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

4.00.14 The motors shall be suitable for bus transfer schemes provided on the 11 kV, 3.3 kV/415V systems without any injurious effect on its life.

4.00.15 All motors below 15 kW shall be provided with sealed ZZ bearings.

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

4.00.17 All motors shall be provided with an emergency stop push button near the motor as per the Indian Statutory regulations.

4.00.18 The motor terminal box shall be suitable for withstanding the maximum system fault current for a duration of at least 0.25 seconds.

4.00.19 Neutral in case of HV motors shall be kept accessible.

4.00.20 Motors shall be designed to easy access for drilling holes through motor feed of mounting flange for installation of dowel pins after assembly of the motor and driven equipment.

4.00.21 Well spacious working platforms shall be provided around the motor area for carrying out maintenance & testing works. Platform shall be minimum of 300 mm below the level of motor base plate.

4.00.22 Flow switches shall be provided for monitoring oil flow of forced lubrication bearings, if used. Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 10 A at 230 V AC.

4.00.23 For bearing temperature measurement, duplex RTDs shall be provided for each bearing and shall be wired up to the terminal box..

4.00.24 Lube oil pressure transmitters shall be provided to DCS for remote monitoring. Lube oil pressure very low trip to HV equipment shall be 2 out of 3 logic.

4.00.25 Capillary type temperature gauge cum switch shall be provided for DE / NDE of HV Motors

4.00.26 Motors with CACA/CACW heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate the following:

-Hot and cold air temperatures of the closed air circuit for CACA motors.

-Hot and cold, air and water temperatures for CACW motors.

The Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 10 A at 230 V AC.

4.00.27 Lifting Provisions

Motor weighing 25 kg or more shall be provided with eye bolt or other adequate provision for shifting. Electrical hoists shall be provided for motors above 1000 kgs for maintenance of the same.

4.00.28 DC MOTORS

DC motors shall be provided where specified/required. DC Motors shall be sized for operation with fixed resistance starting for reliability. DC motors shall be shunt wound type. Motors shall be capable of delivering the rated output at 220 V DC with (+) 10% and (-) 15% variations without exceeding its guaranteed temperature limits. 220 V DC

system shall be unearthed. Starting current of the DC motors shall be limited to 200% of the full load current of the motor, and is subject to IS tolerance. DC Motors shall be similar to AC Motors with respect to other features like enclosure type, cooling and class of insulation

4.00.30 Painting

Motor including fan shall be painted with corrosion proof paints of colour shade Siemens grey (RAL 7032).

4.00.31 Local Push Button Stations

The LPBS shall be installed near the motors to be controlled. Individual channel supports shall be used for each LPBS. These shall be installed as per approved erection detail drawing. LPBS for hazardous areas shall be CMRS certified and CCE approved.

All LPBS shall have necessary canopies. Wiring of LPBS shall be checked before giving control supply.

5.00.00 LIST OF TESTS TO BE CONDUCTED FOR HV, MV and LV MOTORS

5.01.00 TYPE TESTS

(a) No load saturation and loss curves up to approximately 115% of rated voltage

(b) Momentary overload test

(c) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp., core temp., coolant flow and its temperature shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose.

(d) Surge withstand test on the sample coil after placing it in stator core at (4U + 5 KV) and with at least five impulse of 1.2/50 micro sec. wave, for HV motors only, where U is the line to line voltage in kV.

(e) Surge-withstand test with 0.3/3 micro sec. wave on each type of 3.3/11 kV motor coils with at least five such impulses, followed by one minute power frequency high voltage test on turn to turn insulation, after cutting the coil and bringing out

the turns suitably. The power frequency test voltage shall be decided during detailed engineering.

f) Dimensions (for motors covered by IS 1231:1974 and IS 2223:1983 only)
g) Measurement of resistance of windings of stator and wound rotor.
h) Reduced voltage running up test at no load (for squirrel cage motors up to 37kw only)
i) Full load test to determine efficiency, power factor and slip.
j) Insulation resistance test
k) Test for vibration severity of motor
l) Test for noise levels of motor
m) Test for degree of protection by enclosure
n) Temperature rise test at limiting values of voltage and frequency variations
o) Over speed test

5.02.00 ROUTINE TESTS

The following shall constitute the routine tests.

a) Insulation resistance test
b) Measurement of resistance of windings of stator and wound rotor.
c) No load test
d) Locked rotor readings of voltage, current and power input at a suitable reduced voltage
e) Reduced voltage running up test (for squirrel cage motor)
f) Open circuit voltage ratio of stator and rotor windings (for slip ring motors); rotor;
g) High voltage test

6.00.00 INSPECTION AND TESTING AT SITE

6.01.01 Insulation resistance of 415V motors shall be measured between the winding of the machine and its frame by means of a 500/1000V megger. A minimum value of 1 mega ohm for 415V motors shall be considered a safe value. In case of lower I.R. Value, the insulation value shall be brought up by any of the following methods as desired by the Site Engineer:

(a.) Blowing hot air in case of big motors.
(b.) Putting the motor in electric oven in case of smaller motors.
(c.) Placing heaters or lamps around and inside in case of small motors after making suitable guarding and covering arrangements so as to conserve the heat.

6.01.02 Site Test

(a.) Measurement of vibration.
(b.) Measurement of insulation resistance and polarization index.
(c.) Measurement of full load current.
(d.) Test running of the motors, checking the temperature rise and identifying the hot spot etc.

6.01.03 3.3 kV motors shall be tested for insulation by 500/1000V megger and its value should not be less than the safe minimum insulation of ≥ 20 MΩ resistance at 60 deg. C. In case the insulation is low, the following method of drying has to be adopted:

a. By locking the motor so that it cannot rotate and then applying such a low voltage to the stator terminals that full load current flows in the stator, keeping the stator winding temperature below 90 deg. C. In this a close watch shall be kept for any possible overheating and I.R. Values vs. temperature shall be plotted and heating continued till I.R. Value becomes steady.

b. By blasting hot air from external source, Maximum temperature of winding while drying should be 70 deg. C to 80 deg. C. (Thermometer) or 90 deg. C. to 95 deg. C. by resistance method. Heating should be done slowly till steady temperature of winding is reached after 4 to 5 hours and for large machines after 10 hours. A record has to be kept for drying process, with half an hour readings and, after steady temperature is reached, at an interval of 2 hours. In case it is essential, the drying process can be supplemented by blower.

CHAPTER – 17

CABLING SYSTEM

1.00.00 SCOPE OF SUPPLY

1.01.00 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 and offsite buildings like ICHS Stage I, Sea water intake plant, etc.

1.02.00 The equipments and materials within the scope of supply shall include but not limited to

i. Power & control cabling works (including that of special cables):
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

2.00.00 CODES AND STANDARDS

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards/ codes as applicable.

IS:513	Cold rolled low carbon steel sheets and strips.
IS:1079	Hot Rolled carbon steel sheet & strips
IS:1239	Mild steel tubes, tubular and other wrought steel fittings
IS:1255	Code of practice for installation and maintenance of power cables upto and including 33 KV rating
IS:1367 Part-13	Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).
IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS:9537	Conduits for electrical installation.
IS:9595	Metal – arc welding of carbon and carbon manganese steels - recommendations.
IS:13573	Joints and terminations for polymeric cables for working voltages from 3.3kv up to and including 33kv performance requirements and type tests.
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.

2.01.00 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.

3.00.00 DESIGN AND CONSTRUCTIONAL FEATURES

3.01.01 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. 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.

3.02.00 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.

3.03.00 Cable entry

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

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

3.05.00 Trenches

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

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

3.05.03 All field switches for equipments corresponding to a stream located within a radius of 4-5 m shall be wired out to a field junction box and from field junction box to control panel/Input – Output cabinet by screened instrumentation cables.

3.05.04 For CHP following shall also be applicable.

a) All cable routes shall be overhead along the route of the conveyor gallery by separate supporting structures and cables shall be laid in vertical trays. The bottom of the steel shall be such that the existing facilities, movement of trucks/human beings etc. does not get affected. The cable trestle shall have a minimum 600 mm clear walk way and shall have maintenance platforms as required. The bottom of the steel supporting structure shall be generally at 3.0 M above the grade level except for rail/road crossings where it shall be at 8.0 M above grade level. However in bunker area the bottom of the cable trestle shall be 10 to 14 M depending on boiler/bunker layout.

b) Cables shall not be routed through the conveyor galleries except for the equipment located in the conveyor galleries for a particular conveyor i.e. protection switches receptacles etc.

c) Cables for Pull cord switches and belt sway switches shall be taken in cable trays. The trailing cables of the mobile machines shall also be laid in cable trays.

3.05.05 Cable trench shall be allowed only between switchyard control room and 'A' row column of TG building.

4.00.00 EQUIPMENT DESCRIPTION

4.01.00 Cable trays, Fittings & Accessories

4.01.01 Cable trays shall be ladder/perforated type as specified complete with matching fittings (like brackets, elbows, bends, reducers, tees, crosses, etc.), accessories (like side coupler plates, etc.) and hardware (like bolts, nuts, washers, G.I. strap, hook etc.) as required. Cable tray shall be ladder type for power & control cables and perforated for instrumentation cables.

4.01.02 These shall be either prefabricated hot dip galvanized sheet steel trays or site fabricated angle iron trays free from flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per relevant IS.

4.01.03 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.

4.01.04 Cable troughs shall be required for branching out few cables from main cable route. These shall be U-shaped, fabricated of mild steel sheets of minimum thickness 2 mm and shall be hot dip galvanized as per relevant IS. Troughs shall be standard width of 50 mm & 75 mm with depth of 25 mm.

4.01.05 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.

4.01.06 Cable trays fabricated from standard rolled sections shall be 50x50x6/75x75x6 sections for runners for supporting spans limited to 2000 mm/more than 2000 mm respectively. Cross support shall be 32x6 mm / 50x6 flat for widths up to 500mm/more than 500mm respectively.

4.01.07 Separate coloured paint strips shall be applied for identification of different type of trays depending upon types of usage/applications/area as below:

High/ medium voltage cables: red strips, 2 inch width each, numbers

11kV/3.3kV		equally spaced at 5 metres interval
1.1kv power cables	: yellow strips	------- do -------
1.1kv control cables	: blue strips	------- do -------
Instrumentation cables	: green strips	------- do -------

4.02.00 Support System for Cable Trays

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

4.02.02 Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of two types: (i) C1:- having provision of supporting cable trays on one side and (ii) C2:- having provision of supporting cable trays on both sides. The support system shall be the type described hereunder

a. Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor plates, all hardware such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc.

b. The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardware's fittings and accessories shall be prefabricated factory galvanised.

c. The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc. to form various arrangements required to support the cable trays. Welding of the components shall not be allowed. However, welding of the bracket (to which the main support channel is bolted) to the overhead beams, structural steel, insert plates or reinforcement bars will be permitted. Any cutting or welding of the galvanized surface shall be brushed and red lead primer, oil primer & aluminium paint shall be applied.

d. All steel components, accessories, fittings and hardware shall be hot dip galvanized after completing welding, cutting, drilling and other machining operation.

e. The main support channel and cantilever arms shall be fabricated out of minimum 2.5 thick rolled steel sheets conforming to IS.

f. Cantilever arms of 300 mm, 600 mm and 750 mm in length are required. The arm portion shall be suitable for assembling the complete arm assembly on to component constructed of standard channel section. The back plate shall allow sufficient clearance for fixing bolt to be tightened with tray in position.

g. Cable trays in areas subjected to excessive coal dust or mechanical damage shall have hot dip galvanized sheet steel metal trays cover installed on front tray in vertical run and inverted 'V' type on upper tray in horizontal run with consideration for ventilation.

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

4.02.03 The size of structural steel members or thickness of sheet steel of main support channel and cantilever arms and other accessories as indicated above are indicative only. Nevertheless, the support system shall be designed by the contractor to fully meet the requirements of type tests as specified. In case the system fails in the tests, the components design modification shall be done by the Contractor without any

additional cost. The contractor shall submit the detailed drawings of the system offered by him along with the bid.

4.03.00 Pipes, Fittings & Accessories

4.03.01 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

4.03.02 GI Pipes shall be of medium duty as per IS: 1239

4.03.03 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.

4.04.00 Junction Boxes

4.04.01 Junction Boxes shall comprise of a case with hinged door constructed from cold rolled sheet steel of minimum thickness 2mm. Top of the boxes shall be arranged to slope towards rear of the box. Gland plate shall be 3 mm thick sheet steel with neoprene/synthetic rubber gaskets. All junction boxes shall be of adequate strength and rigidity, hot dip galvanised as per relevant IS, and suitable for mounting on wall, columns, structures etc. The boxes shall include brackets, bolts, nuts, screws M8 earthing stud etc. required for installation.

4.04.02 Glass Fibre Reinforced Junction Boxes

No. of Ways: 12/24/36/48 with 20% spares terminals.

4.04.03 Junction boxes shall be Glass Fibre Reinforced with saturated polyester conforming to standards like DIN 16911 type 803/16913 type 834, 5 self extinguishing in accordance with ASTM D635/UL 94 VO.

Junction boxes for use in outdoor or damp locations shall be sturdy construction. Temperature resistance shall be between – 10 to 100^{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 RAL 7032). Earth connection (studs size shall be M 6) shall be provided on the cover as well as door.

4.04.04 Doors

With integrated viewing window of 3mm resistant plexi glass or equivalent. The doors shall be industrial heavy duty hinges. The doors shall be easily but firmly lockable with quick release fastener.

4.04.05 Protection Class

Protection Category shall be IP 66 to EN 60529. There shall be guaranteed perfect seal to meet Protection class IP 66 providing arrangement like highly elastic foamed in special type seal like polyurethane/chloroprene. The sealing rubber shall not have aging effect and shall retain its sealing characteristics for more than 20 years. Contractor shall indicate this in data sheet. The rubber seal should be pasted at its place with pasting technology for like more than 20 years (double sealing arrangement is preferred).

4.04.06 Mounting clamps and accessories

Junction boxes shall be suitable for mounting on walls, columns and structure. Brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass. The accessories like mounting plates etc. of steel shall be powder coated. The support rails for terminal box shall be zinc coated.

4.04.07 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.

4.04.08 Steel Junction Boxes

4.04.09 No. of Ways

12/24/36/48 with 20% spares terminals.

4.04.10 Junction boxes shall be designed in accordance with NEC, article 370, paragraph 18, 19 & 20 or equivalent standards.

4.04.11 Enclosure

Junction boxes for use in outdoor or damp locations shall be sturdy steel construction. The enclosure and door cover shall be surface finished clean, degreased, phosphated, deep coated primed (preferably in RAL 7044) and electro-statically powder coated (preferably in RAL 7032). Earth connection (studs size shall be M6) shall be provided on the cover as well as door. The sheath steel thickness shall be more than 2 mm.

4.04.12 Doors

The doors shall be hinged and lockable. The doors shall have industrial heavy duty hinges. The doors shall be easily but firmly lockable with quick release fastener.

4.04.13 Protection Class

Protection Category shall be IP 66 to EN60529/1091 complies with NEMA 4. There shall be guaranteed perfect seal to meet Protection class IP 66 providing sealing arrangement like highly elastic foamed in special type seal like polyurethane. There shall be an arrangement like multifold protection channel for additional stability and prevention of ingress of dust and water when the enclosure is open.

The sealing rubber shall not have aging effect and shall retain its sealing characteristics for more than 20 years. Contractor shall indicate this in data sheet. The rubber seal should be pasted at its place with pasting technology for like more than 20 years (double sealing arrangement is preferred).

4.04.14 Mounting clamps and accessories

The mounting clamps and accessories shall be suitable for mounting on walls, columns and structure. Brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass.

4.04.15 General

i) JBs shall have small canopy at the top.

ii) There shall be rainwater collection arrangement from top and side of the outer ages to ensure that any leakage in to the junction box shall be avoided and it shall fall outside.

iii) Cable entry shall be from bottom side only.

iv) Ensure gland plate sealing perfect. It shall be of the same quality and arrangement as that of door to cover arrangement.

4.04.16 Junction boxes shall be provided with two nos. earthing terminals (externally available) suitable for connection of 8 SWG G.I. wire. Knockouts shall be provided at bottom and both sides. These shall be provided by fixing plates in order to make them detachable type with suitable neoprene gaskets. Bottom and side plates for cable/conduit connection shall be provided. All unused holes shall be sealed with suitable grommets.

4.04.17 Junction boxes shall be provided with external designation label. The label inscriptions shall be informed to the Contractor by the Owner. Junction boxes shall be provided with danger sign in case of 415V circuit.

4.04.18 Junction boxes shall be of two types, viz. One suitable for control cabling and the other suitable for power cabling.

Junction boxes for control cabling shall have 24 way/ 48 way terminal blocks suitable for up to 2.5 sq.mm. Cu. Cable. However, for instrumentation junction boxes there shall be 24/48 ways suitable for terminating cable of 0.5 sq.mm. Cu. Cable.

4.04.19 Junction boxes for power circuit cabling shall be suitable for 1 no. 3 core 16 sq.mm. Al. Incoming cable and 1 no. 3 core 2.5 sq.mm Cu. Outgoing cable.

4.05.00 Terminal blocks

Terminal blocks shall be 650 volts grade, rated for 10 Amps and in one piece, rigid, Bakelite moulded, with disconnecting /shorting link. It shall be complete with insulating barriers, Klip-on-type terminals and identification strips, terminal studs, washers, nuts, 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.

4.06.00 Terminations & Straight through Joints

4.06.01 Termination and jointing kits for 33/11/3.3 kV grade XLPE insulated cables shall be of proven design and make which have already been extensively used and type tested. Termination kits and jointing kits shall be pre-moulded type, taped type or heat shrinkable type. 33/11/3.3 kV grade joints and terminations shall be type tested as per IS: 13573. Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ESI specification. Kit contents shall be supplied from the same source as were used for type testing. The kit shall be complete with the aluminium solder less crimping type cable lugs & ferrule as per DIN standard.

4.06.02 Straight through joint and termination shall be capable of withstanding the fault level for 33kV, 11 kV and 3.3 kV systems.

4.06.03 1.1 KV grade straight through joints shall be of proven design.

4.07.00 Cable glands

4.07.01 Cable glands shall conform to BS: 6121 and be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating Rubber components shall be of neoprene and of tested quality. Necessary cable dimensions shall be furnished to the successful contractor.

4.07.02 Cable glands shall be single compression for indoor use, double compression type for outdoor use. Glands for classified hazardous areas shall be double compression type flameproof and weather proof duly certified by CMRS and approved by CCE.

4.08.00 Cable lugs/ferrules

4.08.01 The cables lugs shall be conforming to IS: 8309.

4.08.02 Machine ferruling shall be adopted.

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

4.08.04 The cable lugs for control/instrumentation/ telephone cables shall be provided with insulating sleeve and shall suit the type of terminals provided on the equipments.

Cable lugs shall be suitable for termination of different cross-sections of control/ instrumentation /telephone cables and shall be of following types.

i) Copper tubular terminal end for solder less crimping to copper conductors.
ii) Cable lugs for control cable termination shall be insulated type. These lugs shall be flat type/ring type/U type to suit the terminals provided in the 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.

4.09.00 Cable Clamps & Straps

4.09.01 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.

4.09.02 Trefoil clamps for single core cables shall be pressure die cast aluminum or fibre glass or nylon and shall include necessary fixing accessories like G.I. nuts, bolts, washers, etc. Trefoil clamps shall have adequate mechanical strength to withstand the forces generated by the system short circuit current of 105 KA peak.

4.10.00 Galvanizing

4.10.01 Galvanizing of steel components and accessories shall conform to IS: 2629 & IS: 2633. Additionally galvanizing shall be uniform, clean smooth, continuous and free from acid spots

4.10.02 The amount of zinc deposit over threaded portion of bolts, nuts, screws and washers shall be as per IS: 1367. The removal of extra zinc on threaded portion of components shall be carefully done to ensure that the threads shall have the required zinc coating on them as specified.

4.11.00 Welding

4.11.01 The welding shall be carried out in accordance with IS: 9595. All welding procedures and welders qualification shall also be followed strictly in line with IS: 9595

5.00.00 INSTALLATION

5.01.00 Cable tray and Support System Installation

5.01.01 Cables shall run in cable trays mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures. All cable trays shall be in vertical configuration in boiler, CHP & ESP areas.

5.01.02 Horizontally running cable trays shall be clamped by bolting to cantilever arms and vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 1500 mm. For vertical cable risers/shafts cable trays shall be supported at an interval of 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.

5.01.03 All cable way sections shall have identification, designations as per approved cable way layout as and painted/stenciled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 75 mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted/ stenciled with identification numbers at every floor.

5.01.04 In certain cases it may be necessary to site fabricate portions of trays, supports and other non standard bends where the normal prefabricated trays, supports and accessories may not be suitable. In such cases the Contractor shall fabricate at site suitable sections of trays, supports and accessories to make the installation complete for the specific purpose after obtaining owner's prior approval, which shall be neat in appearance and shall match with the prefabricated sections in the dimensions. They shall be applied with one coat of red lead primer, one coat of oil primer followed by two finishing coats of aluminium paint.

5.02.00 Conduits/Pipes/Ducts Installation

5.02.01 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.

5.02.02 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.

5.02.03 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.

5.02.04 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.

5.02.05 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

5.02.06 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.

5.02.07 All G.I. pipes shall be laid as per approved layout drawings and site requirements. Before fabrication of various profiles of pipe by hydraulically operated bending machine (which is to be arranged by the contractor), all the burrs from the pipes shall be removed. The bends formed shall be smooth. GI Pipes with bends shall be buried

in oil/concrete in such way that that the bends shall be totally concealed. For GI pipes shall be undertaken well before paving is completed and necessary co-ordination with paving agency shall be the responsibility of Electrical Contractor. The open ends of pipes shall be suitably plugged with G.I. plugs after they are laid in final position. G.I. plugs shall be supplied by the contractor at no extra cost.

5.03.00 Junction Boxes Installation

5.03.01 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.

5.04.00 Cable Laying and Installation

5.04.01 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.

5.04.02 Cable installation shall be carried out as per IS: 1255 and other applicable standards. Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall be drum be stored flat i.e. with flange horizontal. Rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cables. For unreeling the cable, the drum shall be mounted on suitable jacks or on cable wheels and shall be rolled slowly so that cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.

5.04.03 Laying of cables directly buried in ground is not acceptable.

5.04.04 For coal handling plant the cables shall not be routed along conveyor galleries. The cables shall be routed on independent cable trestles.

5.04.05 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.

5.04.06 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.

5.04.07 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.

5.04.08 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.

5.05.00 Laying of cables in cable trays

5.05.01 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.

5.05.02 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.

5.05.03 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

5.05.04 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.

5.05.05 Bending radii for cables shall be as per manufacturer's recommendations and IS: 1255.

5.05.06 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.

5.05.07 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.

5.05.08 Where cables cross roads/rail tracks, the cables shall be laid in Hume pipe/PVC pipe. At road crossing and other places where cables enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends.

5.05.09 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.

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

5.05.11 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.

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

5.05.13 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.

5.05.14 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.

5.05.15 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.

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

5.05.17 Electrical cable trays exposed to hazardous process fluid shall be covered with detachable G.I. covers. The covers shall be suitable to resist wind forces.

For cables laid above ground in cable racks, asbestos sheeting of 3mm thickness shall be provided below the bottom cable tray to protect the cables from fire.

5.05.18 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.

5.05.19 Separation

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.

At least 300mm clearance shall be provided between :

- HV power & LV power cables,
- LV power & LV control/instrumentation cables,

5.05.20 Segregation

Segregation means physical isolation to prevent fire jumping.

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

Interplant cables of station auxiliaries and unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire. Power and control cables for AC drives and corresponding emergency AC or DC drives shall be laid in segregated routes. Cable routes for one set of auxiliaries of same unit shall be segregated from the other set.

For Coal Handling Plant all the cables of one stream shall be segregated from the cables of the other stream and shall run on either side of the trestle.

5.06.00 Cable fire sealing

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.

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.

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.

5.07.00 Cable laying in trenches between switchyard and Transformer yard

5.07.01 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.

5.07.02 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.

5.07.03 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.

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

5.07.05 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.

5.07.06 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.

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

5.07.08 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.

5.07.09 Cable ends shall be carefully pulled through the conduit, to prevent damage to these cables. Where required, approved cable lubricant shall be used for this purpose. Where cable enters conduit the cable should be bent in large radius. Radius shall not be less than the recommended bending radius of the cables specified by the manufacturer.

Following guide of the pipe fill shall be used for sizing the pipe size:

a) 1 cable in pipe - 53% full

b) 2 cables in pipe - 51% full

c) 3 or more cables - 43% full

d) Multiple cables - 40% full

After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound/'PUTTI' for sealing purpose. Alternatively, G.I. Lids or PVC bushes shall be employed for sealing purposes. The cost for the same shall be deemed to have been included in the installation of G.I. pipe and no separate payment shall be allowed.

5.07.10 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.

6.00.00 CABLE IDENTIFICATION

6.01.00 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry & exit, and at every 20 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centers, control and relay panels etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2 mm thick aluminum with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. Alternatively, the Contractor may also provide cable tags made of nylon, cable marking ties of 'TY-CAB' or equivalent type with cable number heat stamped on the cable tags.

6.02.00 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.

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

7.00.00 CABLE TERMINATIONS & CONNECTIONS

7.01.00 The termination and connection of cables shall be done strictly in accordance with cable termination kit manufacturer'' instructions, drawings and/or as directed by Site Engineer. Cable jointer shall be qualified to carryout satisfactory cable jointing/termination. Contractor shall furnish for review documentary evidence/experience reports of the jointers to be deployed at site.

7.02.00 Work shall include all clamps, fittings etc. and clamping, fitting, fixing, plumbing, soldering, drilling, cutting, taping, preparation of cable end, crimping of lug, insulated

sleeving over control cable lugs, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job to the satisfaction of the Engineer in charge of TANGEDCO.

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

7.04.00 The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for punching of gland plates, painting and touching up. Holes shall not be made by gas cutting. The holes shall be true in shape. All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively sealed by 2mm thick aluminium sheets.

7.04.00 Contractor shall drill holes for fixing glands wherever necessary at no extra cost. Gland plate shall be of non-magnetic material/aluminium sheet in case of single core cables. If the cable end box or terminal chamber provided on the equipment is found unsuitable and requires major modifications the same shall be carried out by the contractor at the discretion of the Engineer- in-Charge.

7.05.00 Control cable cores entering control panel/switchgear/MCC/miscellaneous panels shall be neatly bunched, clamped and tied with self locking type nylon cable ties with de interlocking facility to keep them in position.

7.06.00 The panels where a larger number of cables are to be terminated and cable identification may be difficult, each core ferrule shall include the complete cable number. The ferrules shall be indelible interlocking type and shall fit tightly on cores. Spare cores shall have similarly ferrules with a suffix letter ‘S’ alongwith cable numbers and coiled up after end sealing.

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

7.08.00 It is the responsibility of the Contractor to terminate the cables at motor terminals in correct phase sequence to ensure the proper direction of rotation.

7.09.00 All cables upto 1.1KV grade shall be terminated at the equipments by means of compression type cable glands. They shall have a screwed nipple with conduit electrical threads and check nut.

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

7.11.00 Power cables, wherever colour coding is not available, shall be identified with red, yellow and blue PVC tapes. Where copper to aluminium connections is made, necessary bimetallic washers shall be used. For trip circuit identification additional red ferrules shall be used only in the particular cores of control cables at the termination points in the Switchgear/Control panels and Control Switches.

7.12.00 In case of control cables all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules. Wire numbers shall be as per schematic/ wiring/ inter-connection diagram. Contractors shall have the samples of PVC markers approved before starting the work. All unused spare cores of control cables shall be neatly bunched and ferruled with cable tag at both ends. Control cables shall be neatly bunched and served with PVC perforated tape to keep it in position at the terminal block.

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

7.14.00 The cable shall be taken through glands inside the panels or any other electrical equipment such as motors. The individual cores shall then be dressed and taken along the cable ways (if provided) or shall be fixed to the panels with polyethylene straps. Only control cables of single strand and lighting cables may be directly terminated on to the terminals.

In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom, close fit hole should be drilled in the bottom plate for all the cables in one line, and then bottom plate should be split in two parts along the centre line of holes. After installation of bottom plate and cables it should be sealed with cold setting compound. Cables shall be clamped over the open armouring to connect it to earth bus.

7.15.00 Cable leads shall be terminated at the equipment terminals by means of crimped type solder less connectors.

Crimping shall be done by hand crimping/hydraulically-operated tool and conducting jelly shall be applied on the conductor.

Insulation of the leads should be removed immediately before the crimping. Conductor surface shall be cleaned and shall not be left open.

7.16.00 Termination and connection shall be carried out in such a manner as to avoid strain on the terminals.

7.17.00 All cable entry points shall be properly sealed and made dust and vermin proof. Unusual opening, if any, shall be effectively closed. Sealing work shall be carried out with approved sealing compound having fire withstand capability for at least three hours.

7.18.00 Cable accessories for H.V. Systems

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

7.20.00 The termination and straight through joint kits for use on high voltage system shall be suitable for the type of cables offered by the contractor or the type of cables issued by owner for installation. The materials required for termination and straight through joints shall be supplied in kit form. The kit shall include all insulating and sealing materials apart from conductor fittings and consumable items. An installation instruction shall be included in each kid.

7.21.00 The termination kits shall be suitable for termination of the cables to an indoor switchgear or to a weatherproof cable box of an outdoor mounted transformer/motor. The termination kits shall preferably be as of the following types.

a. 'PUSH ON' type for LV cables.

b. Heat-shrinkable sleeve type for LV & HV cables.

However, termination kits for HV cables shall be of Heat Shrinkable type of makes with specific approval of owner.

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

7.22.00 The straight through jointing kits shall be suitable for underground buried installation with uncontrolled backfill and possibility of flooding by water. The jointing kit shall be one of the following types.

a. 'TAPEX' of M-seal make or equivalent for LV cables

b. Heat-shrinkable sleeve type for LV & HV cables.

However, termination kits for HV cables shall be of Heat Shrinkable type of makes with specific approval of owner.

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

8.00.00 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.

9.00.00 LIST OF TESTS TO BE CONDUCTED

9.01.00 Type tests on Cable Trays support system

A) Test 1A:

On main support channel type-C2 for cantilever arms fixed on one side only. A 3.5 metre length of main support channel shall be fixed vertically at each end to a rigid structure as per appropriate fixing arrangement. Eight (8) nos. 750 mm cantilever arms shall be fixed to the main channel and each arm shall be loaded over the outboard 600 mm with a uniform working load of 100 kg. Subsequently a point load of 100 kg shall be applied on arm 2. A uniform proof load on all the arms equal to twice the working load shall be then be applied. Deflections shall be measured at the following load intervals and other necessary points:

i) Working load

ii) Working load + point load

iii) Off load

iv) Proof load + point load

v) Off load

The deflection measured at working loads shall not exceed 16 mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied.

B) Test 1B: Test 1A shall be repeated with Eight Cantilever arms uniformly loaded and with the same point load on arm 2

Test 2: On Main support channel type -C2 for cantilever arms fixed on both sides

a)Test 2A: A 3.5 m length of main support channel C2 for cantilever arms fixing on both sides shall be fixed at each end to rigid structure as per appropriate fixing arrangement. Six (6), 750 mm cantilever arms shall be attached to each sides and each arm uniformly loaded to a working load of 100 kg over the out board 600 mm. A point load of 100 kg shall than be applied to arm 2, followed by a uniform proof load of twice the working load on all the arms; deflection shall be measured at the following load intervals and other necessary points.

i) Working load

ii) Working load + Point load

iii) Off load

iv) Proof load + Point load

v) Off load

The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of

proof load and point load applied

b) Test 2B: The test 2 A shall be repeated with the assembly but with an asymmetrical load on the C2 column and point load applied to arm 8. The 100 kg and 200 kg uniformly distributed loads shall be applied to the upper three arms on one side and the lower three arms on the opposite side.

Test 3: 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.

a) **Test 3A :** A length of steel structure shall be rigidly supported. It should be fitted on a metre length of channel section using beam clamps welded/bolted. A point load of 1200 kg shall be applied to the centre point via two brackets. No distortion or pulling of the components shall take place.

b) **Test 3B:** With the components assembled as in Test 3A, two perpendicular point loads of 600 kg shall be simultaneously applied at positions 150 mm either side of the centre line, no distortion or pulling of the components shall take place.

c) **Test 3C:** With the components assembled as in Test 3A, a perpendicular point load shall be applied at a point 150 mm on one side of the centre line.

The load shall be gradually increased to the maximum value that can be applied without causing distortion or pulling of the components. This value shall be recorded.

Test 4 Channel nut slip characteristics (what ever applicable)

Tests 4A1, 4A2, 4A3:

A length of channel C1 section 200 mm long shall have fitted bracket with the two bolts fixing.

With loads applied at the appropriate position nut slip shall be determined with bolt torque of 30 NM, 50 NM and 65 NM No fewer than three measurements shall be made or each torque setting.

A minimum loading of 720 kg shall be obtained before nut slip with bolt torque of 65 NM.

Tests 4B1, 4B2, 4B3:

The length of channel C1 section 200 mm long shall have fitted bracket with the one bolt fixing. With loads applied at the appropriate position, nut slip shall be determined with bolt torques of 30 NM, 50 NM and 65 NM. No fewer than three measurements shall be made for each torque setting.

A minimum loading of 350 kg shall be obtained before nut slip with a bolt torque of 65 NM

Test 5 Weld Integrity Test

After deflection test as per test 1A, 1B, 2, 3 & 4 weld integrity shall be checked by magnetic particle inspection to detect sub-surface cracks developed, if any.

Cable termination kit and straight through joints should have been tested as per IS: 13573 for 3.3kV and 11kV class.

Fire proof Cable Penetration system should have been tested for the following tests:

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

9.02.00 Routine/ Acceptance Tests

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

9.02.01 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.

9.02.02 Welding

The quality of welding shall be visually inspected, particular attention being paid to the following points.

1) The welded joints shall be continuous along its length on both sides and of uniform width and thickness. It should be free from blow holes.

2). The weld metal shall be properly fused with the parent metal without undercutting.

3) The outside surface of the weld shall be clean. All slag shall have been removed. All welding shall be regularly checked for cracking using magnetic particle inspection or their equivalent technique.

1. Physical and dimensional checks for all items.
2. All conduits/pipes, etc. shall be routine/acceptance tested as per relevant standards.
3. All acceptance and routine tests on cable glands as for BS: 6121. Additionally Proof torque test shall be carried out as acceptance on each body group of cable glands.
4. Deflection test cable trays.
5. All acceptance and routine tests on Junction boxes.

6. Following tests shall also be carried out on each type of equipments, devices and materials/items supplied:

    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.

9.02.03 Cable trays / supports and accessories

1) Check for proper galvanizing/painting and identification number of the cable trays/supports and accessories.

2) Check for continuity of cable trays over the entire route.

3) Check that all sharp corners, burrs, and waste materials have been removed from the trays supports.

4) Check for earth continuity and earth connection of cable trays.

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO.: PE-SS-999-506-E101 Rev 00

1.0 INTENT OF SPECIFIATION

The specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer's work, and packing of Low voltage (LV) squirrel cage induction motors along with all accessories for driving auxiliaries in thermal power station.

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors.

2.0 CODES AND STANDARDS

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:

IS:325	Three phase Induction motors
IS : 900	Code of practice for installation and maintenance of induction motors
IS: 996	Single phase small AC and universal motors
IS: 4722	Rotating Electrical machines
IS: 4691	Degree of Protection provided by enclosures for rotating electrical machines
IS: 4728	Terminal marking and direction of rotation rotating electrical machines
IS: 1231	Dimensions of three phase foot mounted induction motors
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 13555	Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment
IS: 2148	Flame proof enclosures for electrical appliance
IS: 5571	Guide for selection of electrical equipment for hazardous areas
IS: 12824	Type of duty and classes of rating assigned
IS: 12802	Temperature rise measurement for rotating electrical machnines
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 12075	Mechanical vibration of rotating electrical machines

In case of imported motors, motors as per IEC-34 shall also be acceptable.

3.0 DESIGN REQUIREMENTS

3.1 Motors and accessories shall be designed to operate satisfactorily under conditions specified in data sheet-A and Project Information, including voltage & frequency variation of supply system as defined in Data sheet-A

3.2 Motors shall be continuously rated at the design ambient temperature specified in Data Sheet-A and other site conditions specified under Project Information
Motor ratings shall have at least a 15% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified above.

3.3 Starting Requirements

3.3.1 Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

3.3.2 Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.

The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.

3.3.3 The following frequency of starts shall apply

i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature.

ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour)

iii) Motors for coal conveyor and coal crusher application shall be suitable for three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be suitable for mimimum 20,000 starts during the life time of the motor

3.4 **Running Requirements**

3.4.1 Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.

3.4.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage upto 70% of the rated voltage for duration of 2 secs.

3.5 **Stress During bus Transfer**

3.5.1 Motors shall withstand the voltage, heavy inrush transient current, mechanical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.

3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.

3.6 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.

3.7 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.

4.0 **CONSTRUCTIONAL FEATURES**

4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy

4.2 Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362.

Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled

4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.

4.4. Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.

4.5 Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.

4.6 In case Class 'F' insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class 'B' insulation.
In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.

4.7 **Terminals and Terminal Boxes**

4.7.1 Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A.

Unless otherwise stated in Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet "A".

4.7.2 unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.

4.7.3 Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or U W & V respectively.

4.7.4 Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.

4.7.5 Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.

4.7.6 Degree of protection for terminal boxes shall be IP 55 as per IS 4691.

4.7.7 Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.

4.7.8. Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.

4.7.9 Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.

4.8 Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.

4.9 **General**

4.9.1 Motors provided for similar drives shall be interchangeable.

4.9.2 Suitable foundation bolts are to be supplied alongwith the motors.

4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above.

4.9.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956.

4.9.5 All motors rated above 30 kW shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz.

4.9.6 Name plate with all particulars as per IS: 325 shall be provided

4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions.

5.0 INSPECTION AND TESTING

5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied.

5.2 LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser.

5.3 All motors shall be subjected to routine tests as per IS: 325 and as per BHEL standard quality plan.

5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A.

6.0 DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT

a) OGA drawing showing the position of terminal boxes, earthing connections etc.
b) Arrangement drawing of terminal boxes.
c) Characteristic curves:
(*To be given for motor above 55 kW unless otherwise specified in Data Sheet*).

i) Current vs. time at rated voltage and minimum starting voltage.
ii) Speed vs. time at rated voltage and minimum starting voltage.
iii) Torque vs. speed at rated voltage and minimum voltage.
For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.
iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.

2X660MW ENNORE TPP

MOTOR DATA SHEET-A

SPECIFIC ELECTRICAL REQUIREMENT FOR VENTILATION SYSTEM

SL.NO.	PARAMETERS	UNIT	Ennore
	MOTOR		
1	DESIGN AMBIENT TEMP	DEG. C	50
2	VOLTAGE SUPPLY AND VARIATION	VOLT	415V, ± 10%
3	FREQUENCY WITH VARIATION	Hz	50, +3% to -5%
4	COMBINED VOLTAGE & FREQUENCY VARIATION		10%
5	MAX ACCEPTABLE RATING OF MOTOR AT 415 V	KW	160 KW & below
6	SYSTEM FAULT LEVEL AND ITS DUARTION	KA	50kA, 1sec
7	SUTABILITY OF TERMINAL BOX FOR FAULT LEVEL AND DURATION		50 KA, 0.25 sec
8	CLASS OF INSULATION & TEMP RISE LIMITED TO		Class-F and temp rise limited to Class-B
9	MIN. STARTING VOLTAGE		85%
10	MOTOR RATING FOR SINGLE PHASE SUPPLY		0.2 kW & Below
11	MAXIMUM LOCKED ROTOR CURRENT	% OF FLC	600% inclusive of IS tolerance.
12	ACCEPTABLE NOISE LEVEL	DB	As per IS 12065
13	TYPE OF STARTER PROVIDED IN MCC		DOL
14	DOP OF ENCLOSURE		IP-55 & IP-54 for outdoor & indoor resp.
15	SPACE HEATER REQUIREMENT	<30kW	30KW & ABOVE
16	PAINT SHADE		Siemens Grey (RAL 7032)
17	SPECIAL REQUIREMENT		-
18	ENERGY EFFICIENT		All LV MOTORS ABOVE 10 KW WITH S1 DUTY SHALL BE COMPULSORILY OF ENERGY EFFICIENT LEVEL IE2 AS PER IS 12615:2011

Anshul S A Khan Praveen Kishore

	TITLE	SPECIFICATION NO.
	MOTOR	VOLUME II B
	DATA SHEET - C	SECTION D
		REV NO. 00 DATE 29/08/2005
		SHEET 1 OF 2

S. No.	Description	Data to be filled by successful bidder
A.	**General**	
1	Manufacturer & country of origin	
2	Motor type	
3	Type of starting	
4	Name of the equipment driven by motor & Quantity	
5	Maximum Power requirement of driven equipment	
6	Rated speed of Driven Equipment	
7	Design ambient temperature	
B.	**Design and Performance Data**	
1	Frame size & type designation	
2	Type of duty	
3	Rated Voltage	
4	Permissible variation for	
5	a Voltage	
6	b Frequency	
7	c) Combined voltage & frequency	
8	Rated output at design ambient temp (by resistance method)	
9	Synchronous speed & Rated slip	
10	Minimum permissible starting voltage	
11	Starting time in sec with mechanism coupled	
12	a) At rated voltage	
13	b) At min starting voltage	
14	Locked rotor current as percentage of FLC (including IS tolerance)	
15	Torque	
	a) Starting	
	b) Maximum	
16	Permissible temp rise at rated output over ambient temp & method	
17	Noise level at 1.0 m (dB	
18	Amplitude of vibration	
19	Efficiency & P.F. at rated voltage & frequency	
	a) At 100% load	
	c) At 75% load	

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

Anshul S A Khan Praveen Kishore

S. No.	Description	Data to be filled by successful bidder
	c) At starting	
C.	**Constructional Features**	
1	Method of connection of motor driven equipment	
2	Applicable Standard	
3	DOP of Enclosure	
4	Method of cooling	
5	Class of insulation	
6	Main terminal box	
	a) Type	
	b) Power Cable details (Conductor, size, armour/unarmour)	
	c) Cable Gland & lugs details (Size, type & material)	
	d) Permissible Fault level (kArms & duration in sec)	
7	Space heater details (Voltage & watts)	
8	Flame proof motor details (if applicable)	
	a) Enclosure	
	b) suitability for hazardous area	
	i Zone	O / I / II
	ii Group	IIA / IIB / IIC
9	No. of Stator winding	
10	Winding connection	
11	Kind of rotor winding	
12	Kind of bearings	
13	Direction of rotation when viewed from NDE	
14	Paint Shade & type	
15	Net weight of motor	
16	Outline mounting drawing No (To be enclosed as annexure)	
D.	**Characteristic curves/ drawings** (To be enclosed for motors of rating ≥ 55KW)	
	a) Torque speed characteristic	
	b) Thermal withstand characteristic	
	c) Current vs time	
	d) Speed vs time	

NAME OF VENDOR				REV.	
			SEAL		
NAME	SIGNATURE	DATE			

Anshul S A Khan Praveen Kishore

	QUALITY PLAN	CUSTOMER :	PROJECT-2X660MW ENNORE TPP TITLE	SPECIFICATION : NUMBER :
		BIDDER/ VENDOR :	QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03	SPECIFICATION : TITLE
	SHEET 1 OF 9	SYSTEM	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)	SECTION VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	RAW MATERIAL & BOUGHT OUT CONTROL											
1.1	SHEET STEEL, PLATES, SECTION, EYEBOLTS	1.SURFACE CONDITION	MA	VISUAL	100%	-	FREE FROM BLINKS, CRACKS, WAVINESS ETC	LOG BOOK	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	-DO-	3	-	-	
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	-DO-	-DO-	-DO-	INSPEC. REPORT	3	-	2	
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, UN-EVENNESS ETC.	-DO-	3	-	-	
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	MANFR'S DRG./SPEC BOOK	RELEVENT IS/SPEC.	SUPPLIERS TC & LOG	3	-	2	PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, BLOW HOLES ETC.	LOG BOOK	3	-	2	
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1/HEAT NO.	MANFR'S DRG./SPEC	RELEVENT IS/	SUPPLIER'S TC	3	-	2	HEAT NO. SHALL BE VERIFIED
		3.DIMENSIONS	MA	MEASUREMENT	100%	MANUFR'S DRG.	MANUFR'S DRG.	LOG BOOK	3	-	2	
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	LOG BOOK	3	-	2	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT-2X660MW ENNORE TPP TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 2 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10	10	10	11
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	MFG. DRG. SPEC.	RELEVANT IS	SUPPLIER'S TC	3	-	2	
		3. DIMENSIONS	MA	MEASUREMENT	100%	-DO-	MANUFR'S DRG.	LOG BOOK	3	-	2	
		4.INTERNAL FLAWS	CR	UT	-DO-	ASTM-A388	MANUFR'S SPEC. BHEL SPEC.	-DO-	3	2	1	FOR DIA OF 55 MM & ABOVE
1.6	SPACE HEATERS, CONNEC-TORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING	MA	VISUAL	-DO-	MANUFR'S DRG. SPEC.	MANUFR'S DRG. SPEC.	-DO-	3	-	2	
		2. PHYSICAL COND.	MA	-DO-	-DO-	-	NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY	-DO-	3	-	2	
		3.DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG./ SPEC.	MANUFR'S DRG. / SPEC.	-DO-	3	-	2	
		4.PERFORMANCE/ CALIBRATION	MA	TEST	100%	-DO-	-DO-	INSP. REPORT	3	-	2	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT-2X660MW ENNORE TPP TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 3 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC.	MA	VISUAL	100%	-	NO VISUAL DEFECTS	INSPT. REPORT	3	-	2	
		2. OTHER CHARACTERISTICS	MA	TEST	SAMPLE	MANUF'S SPEC.	MANUF'S SPEC.	LOG BOOK AND OR SUPPLIER'S TC	3	-	2	
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND.	MA	VISUAL	100%	-	NO VISUAL DEFECTS (FREE FROM BURS)	LOG BOOK	3	-	-	
		2.DIMENSIONS INCLUDING BURS HEIGHT	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG. .	MANUFR'S DRG.	-DO-	3	-	2	FOR MV MOTOR INSULA-TION/VARNISH THICKNESS SHALL BE MORE THAN THE BURS HEIGHT
		3. ACCEPTANCE TESTS	MA	ELECT. & MECH TESTS	-DO-	MANUF'S SPEC./ RELEVANT IS	RELEVANT IS	SUPPLIER'S TC	3	-	2	
1.9	CONDUCTORS	1. SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	LOG BOOK	3*	-	2*	* MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY BHEL/CUSTOMER.
		2.ELECT. PROP, & MECH. PROP	MA	ELECT. & MECH.TEST	SAMPLES	RELEVANT IS/ BS OR OTHER STANDARDS	RELEVANT IS/ BS OR OTHER STANDARDS	SUPPLIERS TC & VENDOR'S INSPN. REPORTS	3	-	2	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
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	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT-2X660MW ENNORE TPP TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 4 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	 W	 V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		3.DIMENSIONS	MA	MEASUREMENT	-DO-	-DO-	-DO-	Log Book	3	-	2	
1.10	BEARINGS	1.MAKE & TYPE	MA	VISUAL	100%	MANFR'S DRG./ APPROVED DATASHEET	MANFR'S DRG./ APPROVED DATASHEET	-DO-	3	-	2	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	BHEL DATA SHEET	BHEL DATA SHEET BEARING MANUF'S CATALOGUES	-DO-	3	-	2	
		3.SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	2	
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-DO-	-DO-	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	-DO-	MANUF'S SPEC./ BHEL SPEC.	MANUF'S SPEC./ BHEL SPEC.	-DO-	3	-	2	
		4.HV/IR	MA	-DO-	100%	-DO-	-DO-	-DO-	3	-	2	
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	MANUF'S DRG/SPECS	MANUF'S DRG./ SPECS.	-DO-	3	-	-	
		2.SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

Anshul

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Praveen Kishore

	QUALITY PLAN	CUSTOMER :			PROJECT-2X660MW ENNORE TPP TITLE			SPECIFICATION : NUMBER :			
		BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 5 OF 9	SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
2.0	IN PROCESS											
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	3/2	2	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	2	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	-DO-	RELEVENT SPEC./ ASTM-E165	MANUFR'S SPEC./ BHEL SPEC./	-DO-	2	-	1	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	MANFR'S SPEC/BHEL SPEC./ RELEVANT STAND	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-DO-	-DO-	-DO-	2	-	-	
		3.SHADE	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	-DO-	-DO-	-DO-	Log Book	2	-	-	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
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	QUALITY PLAN	CUSTOMER :	PROJECT-2X660MW ENNORE TPP TITLE	SPECIFICATION : NUMBER :
		BIDDER/ VENDOR :	QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03	SPECIFICATION : TITLE
	SHEET 6 OF 9	SYSTEM	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)	SECTION VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	MANUFR'S SPEC.	MANUFR'S SPEC.	Log Book	2	-	-	
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-DO-	-DO-	Log Book	2	-	-	
		3.CORE LOSS & HOTSPOT	MA	ELECT.TEST	-DO-	-DO-	-DO-	Log Book	2	1*	1	(FOR MOTORS OF 2MW AND ABOVE) * ON 10% RANDOM SAMPLE
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	MANUFR'S SPEC./BHEL SPEC.	MANUFR'S SPEC./BHEL SPEC.	Log Book	2	-	-	
		2.CLEANLINESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.IR-HV-IR	CR	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.RESISTANCE	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
		5.INTERTURN INSULATION	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		6.SURGE WITH STAND AND TAN. DELTA TEST	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	FOR MV MOTOR
2.6	IMPREGNATION	1.VISCOSCITY	MA	PHY. TEST	AT STARTING	-DO-	-DO-	Log Book	2	-	-	
		2.TEMP. PRESSURE VACCUM	MA	PROCESS CHECK	CONTINUOUS	-DO-	-DO-	Log Book	2	-	-	
		3.NO. OF DIPS	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	THREE DIPS TO BE GIVEN

BHEL	PARTICULARS	BIDDER/VENDOR	
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	DATE		BIDDER'S/VENDORS COMPANY SEAL

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	QUALITY PLAN		CUSTOMER :			PROJECT-2X660MW ENNORE TPP TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 7 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		4.DURATION	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
2.7	COMPLETE STATOR ASSEMBLY	1.COMPACTNESS & CLEANLINESS	MA	VISUAL	100%	-DO-	-DO-	Log Book	2	-	-	
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.SOUNDNESS	CR	MALLET TEST & UT	-DO-	-DO-	-DO-	Log Book	2		1	
		3.HV	MA	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2		1	
2.9	COMPLETE ROTOR ASSEMBLY	1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	-DO-	MFG SPEC./ ISO 1940	MFG. DWG.	Log Book	2		1	VERIFICATION FOR MV MOTOR ONLY
		2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	-DO-	MFG. SPEC.	MFG. SPEC.	Log Book	2		1	
2.10	ASSEMBLY	1.ALIGNMENT	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.WORKMANSHIP	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.AXIAL PLAY	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.DIMENSIONS	MA	-DO-	-DO-	MFG.DRG./ MFG SPEC.	MFG. DRG/ RELEVANT IS	Log Book	2	-	-	
		5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2	-	-	
		6. RTD, BTD & SPACE HEATER MOUNTING.	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2		1	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
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Praveen Kishore

	QUALITY PLAN	CUSTOMER :	PROJECT-2X660MW ENNORE TPP TITLE	SPECIFICATION : NUMBER :
		BIDDER/ VENDOR :	QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03	SPECIFICATION : TITLE
	SHEET 8 OF 9	SYSTEM	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)	SECTION VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10	10	10	11
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS AS PER BHEL SPEC.	MA	ELECT.TEST	1/TYPE/SIZE	IS-325/ BHEL SPEC./ DATA SHEET	IS-325/ BHEL SPEC./ DATA SHEET	TEST REPORT	2	1*	1	* NOTE - 1
		2.ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1	$ NOTE - 2
		3.VIBRATION & NOISE LEVEL	MA	-DO-	100%	IS-12075 & IS-12065	IS-12075 & IS-12065	-DO-	2	1$	1	$ NOTE - 2
		4.OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPC. REPORT	2	1	-	
		5.DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	RELEVANT IS	BHEL SPEC. AND DATA SHEET	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1	$ NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1	$ NOTE - 2
		8. NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPC. REPORT	2	1$	1	$ NOTE - 2
		9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	IS-3682 IS-8239 IS-8240	IS-3682 IS-8239 IS-8240	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	BHEL SPEC. & DATA SHEET	BHEL SPEC. & DATA SHEET	TC	2	1$	1	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY $ NOTE - 2

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT-2X660MW ENNORE TPP TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 9 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11

NOTES:

1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED.

2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON.

3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THESE TEST MAY NOT BE REPEATED.

4 WHEREVER CUSTOMER IS INVOLVED IN INSPECTION, AGENCY (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER.

Legends for Inspection agency

1. BHEL/CUSTOMER
2. VENDOR (MOTOR MANUFACTURER)
3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER)

P. PERFORM
W. WITNESS
V. VERIFY

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

Anshul

S A Khan

Praveen Kishore

	QUALITY PLAN	CUSTOMER :	PROJECT-2X660MW ENNORE TPP TITLE	SPECIFICATION : NUMBER :
		BIDDER/ VENDOR :	QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01	SPECIFICATION TITLE
	SHEET 1 OF 2	SYSTEM	ITEM AC ELECT. MOTORS BELOW 55KW (LV)	SECTION VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10	10	10	11
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	2	-	-	
		2.DIMENSIONS	MA	-DO-	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	2	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE	MA	VISUAL	100%	MFG.SPEC./ RELEVANT IS	MFG.SPEC. RELEVANT IS	-DO-	2	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MANUFR'S SPEC/BHEL SPEC./RELEVANT STANDARD	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	IS-325/ BHEL SPEC./ DATA SHEET	SAME AS COL.7	TEST REPORT	2	1		NOTE -1 & NOTE-3
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPN. REPORT	2	1	-	NOTE -1 & NOTE-3

BHEL	PARTICULARS	BIDDER/VENDOR
	NAME	
	SIGNATURE	

		QUALITY PLAN	CUSTOMER :			PROJECT-2X660MW ENNORE TPP TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION : TITLE :			
		SHEET 2 OF 2	SYSTEM			ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2	1	-	

NOTES:

1 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON

2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER.

3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW , ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY.

Legends for Inspection agency

1. BHEL/CUSTOMER
2. VENDOR (MOTOR MANUFACTURER)
3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER)

P. PERFORM
W. WITNESS
V. VERIFY

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

Anshul

S A Khan

Praveen Kishore

LOAD TITLE	RATING (KW / A)		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME >5 SEC (Y)	LOCATION	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.
	NAME PLATE	MAX. CONT. DEMAND (MCR)		RUNNING	STANDBY								SIZE CODE	NOs				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

NOTES:
1. COLUMN 1 TO 12 & 18 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY PEM (ELECTRICAL)
2. ABBREVIATIONS : * VOLTAGE CODE (7):- (ac) A=11 KV, B=6.6 KV, C=3.3 KV, D=415 V, E=240 V (1 PH), F=110 V (dc): G=220 V, H=110 V, J=48 V, K=+24V, L=-24 V
: ** FEEDER CODE (8):- U=UNIDIRECTIONAL STARTER, B=BI-DIRECTIONAL STARTER, S=SUPPLY FEEDER, D=SUPPLY FEEDER (CONTACTER CONTROLLED)

LOAD DATA (ELECTRICAL)	JOB NO.	412	ORIGINATING AGENCY		PEM (ELECTRICAL)
	PROJECT TITLE	2X660MW ENNORE TPP	NAME		DATA FILLED UP ON
	SYSTEM / S	VENTILATION SYSTEM	SIGN.		DATA ENTERED ON
	DEPTT. / SECTION		SHEET 1 OF 1	REV. 00	DE'S SIGN. & DATE

CABLE SCHEDULE FORMAT

ANNEXURE III

UNITCABLENO	FROM	TO	PURPOSE	CABLE SCOPE (BHEL PEM/ VENDOR)	REMARKS	CABLESIZE	PATHCABLENO	TENTATIVE CABLE LENGTH

SECTION: C-4
TECHNICAL SPECIFICATION (C&I PORTION)

C&I SPECIFICATION
FOR
VENTILATION SYSTEM
FOR
2X660 MW ENNORE SEZ STPP

DESIGN	AC
CHECKED	SK/SCS
APPROVED	SCS
REV- 00	DATE 08.04.15
JOB NO.	412

TABLE OF CONTENTS

A. General & Specific Technical Requirement for Ventilation system
B. List of vendor deliverables for Ventilation System
C. Specification for Motorized Valve Actuator
D. Specification for Field Instruments
E. Specification for Control Panels
F. Drive control philosophy
G. Applicable codes and standards
H. Specification for Quality assurance & Testing
I. Mandatory spares
J. Drawings
K. BHEL-PEM's Approved Vendor List

GENERAL & SPECIFIC

TECHINICAL REQUIREMENT

FOR

VENTLATION SYSTEM

GENERAL REQUIREMENT

1.0 Bidder shall provide complete and independent control & instrumentation system with all accessories, auxiliaries and associated equipments for the safe, efficient and reliable operation of auxiliary systems.

2.0 The quantity of instruments for auxiliary system shall be as per tender P &ID wherever provided of the respective system as a minimum, for bidding purpose. However, Bidder shall also include in his proposal all the instruments and devices that are needed for the completeness of the plant auxiliary system/ equipment supplied by the bidder, even if the same is not specifically appearing in the P & ID. During detail engineering if any additional instruments are required for safe & reliable operation of plant, bidder shall supply the same without any price implication.

3.0 Measuring instruments/equipment and subsystems offered by the bidder shall be from reputed experienced manufacturers of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Further all the instruments shall be of proven reliability, accuracy, and acceptable international standards and shall be subject to employer's approval. All instrumentation equipment and accessories under this specification shall be furnished as per technical specification, ranges, makes/ numbers as approved by the employer' during detail engineering.

4.0 The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifold and all the other accessories required for mounting/ erection of these local instruments shall be furnished, even if not specifically asked for, on as required basis. The contacts of equipment mounted instruments; sensors, switches etc for external connection including spare contacts shall be wired out to suitably located junction boxes.

5.0 The customer specification attached as Specific Technical Requirement will supercede the Data sheets, if there is any mismatch.

Specific Technical Requirements (C&I):

1. The control of Ventilation system shall be through PLC based system provided by AC system vendor.

2. Complete instrumentation for Ventilation system is in bidder's scope of supply. Items not specifically mentioned however required for the completeness of the system shall be supplied by the bidder.

3. Vendor to furnish the list of drives /motors/fans/pumps, etc. Input/Output Lists to be hooked up to PLC panel and other necessary inputs so that necessary provision and hardware requirement can be ensured at PLC panel by the AC system vendor for designing and fabrication of its panel.

4. All the instruments/drives shall be terminated on JBs/Panels in field. JBs/Panels shall be in Bidder's scope. RTD's shall be of duplex type. Temperature transmitters are envisaged for RTD for monitoring services/application only. Each instrument shall have unique KK tag no.

5. Scope of Instrumentation cables (Screened Control Cables), Fibre Optic cable & Control cables shall be as per Electrical Cable scope matrix in Electrical portion of specification.

6. All electrical actuators shall be of conventional type with integral starter.

7. The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial implication in this regard shall be acceptable. In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with.

8. The solenoid valves shall have limit switches for open/close feedback.

9. Interface of MCC, HT SWGR, Actuators etc. with PLC based control system shall be as per Drive Control Philosophy attached in the specification. The attached philosophy is for DCS based control system. However, the same is applicable for PLC as well.

10. Complete Industrial grade furniture swivel chairs, printers, keyboards, computers etc. shall also be furnished by bidder. The exact details shall be finalized & approved by owner/purchaser during detailed engineering.

11. Bidder to comply with codes and standards as mentioned in the specification.

12. Bidder shall provide an unlimited warranty on all equipment for three years after the start of the warranty period, i.e. after satisfactory completion of initial operations. This warranty shall include repair, replacement or correction of identified software or hardware discrepancies at no cost to OWNER.

13. All local gauges, transmitters and switches shall be mounted on suitable enclosures, racks subject to owner's approval. All transmitters shall be HART compatible.

14. Bidder to delegate /depute their persons/experts as per owner/consultants' requirement.

15. Bidder must offer general tools and tackles and special calibration instruments required during start-up, trial run, operation and maintenance of the system.

16. All the instruments/ equipments/ electrical items shall be provided and designed with maximum star rating as available in line with energy conservation policies notified by BEE, GOI, at the time of supply.

17. The above given scope is indicative & minimum. Any item/ equipment not indicated above however required for the completeness of the system is to be supplied by bidder without any technical, commercial and delivery implication to BHEL.

8.00.00 AIR CONDITIONING SYSTEM & VENTILATION SYSTEM

i) Air conditioning facilities shall be provided for areas of central control room, control equipment room, shift- in-charge room, Engineer's room, UPS room, analyzer room etc. in the main plant building; ESP control room; service building; all control rooms and other rooms in the scope of the bidder requiring provision of air conditioning. The system shall consist of:

a) Central chilled water type air conditioning plant for main plant building and service building (Including Instrumentation Lab, Electrical lab and Computer server room , telephone exchange room, etc.,)

b) DX air conditioning plant for ESP control room , AHP , Switchyard Control Building & RO-DM plant (Including Chemical Lab) FOPH and CWPH

c) Split/ window type for other areas as required.(Zero meter control Room, boiler A Elevation, SWAS and Chemical Express Lab, FWPH, Service Water Pump House , Compressor room , etc.,

The PLC shall be preferably from plant DDCMIS family.

The PLC system shall be provided as detailed in chapter 4 of this specification..

Open and Close limit switch feed backs of valves are to be connected to PLC for remote viewing and for interlocks and protection.

Remote and local indications of various parameters to the process requirement shall be provided. (The same can be decided during detailed engineering)

The OLCS and CLCS philosophy shall be as per the section V of this volume

The One no of Operator work station and one no. of Operation cum Engineering work station with 24 " LED Monitor and printers as defined in the Vol. V, Annexure A shall have to be complied. In addition to OWS operation, Backup control desk with coloured Process Mimics, Hard wired Annunciation system, required Push .Button arrangements in Back Panel for complete operation of the systems, Ammeters, Parameter Indicators, LED Based indication Lamps etc., shall also be provided.

This PLC shall have interface module for redundant and bi-directional OPC connectivity with DDCMIS

ii) Evaporative type ventilation system shall be provided for main plant building with air washer units distributed along 'A' row and 'B' row of the building. Filtered and cooled air from the air washer unit shall be distributed to various areas through diffusers. The main plant building shall be provided with adequate number of roof exhausters. Unitary air filtration system using water repellent type nylon filters shall be provided for ESP control buildings as applicable. Mechanical type ventilation system using supply air fans, exhaust air fans and roof exhausters as applicable shall be provided for other miscellaneous areas such as cable vaults, electrical switch gear rooms, battery rooms, toilets, elevator machine rooms, AC plant room, DG set room etc..

iii) The basic function of the system shall be to closely control and monitor inside temperature and humidity conditions inside the air-conditioned spaces, to provide remote centralized monitoring & control for various mechanical facilities including sequential start/stop of the whole HVAC System, automatically calculate record and cooling load for each hour/ day/season, to generate maintenance data & alarms, to maintain records of plant operation & energy consumption for varying loads, duty cycling to operate all the equipment including standby equipment for equal duration, automatic startup of standby equipment in case of failure of operating unit and displaying fault alarm status of the tripped unit, activating/ deactivating water valves to startup/stop water flow

through chiller/condenser circuit.

0 WATER CHILLING PLANT CONTROL

i) Microprocessor based controls shall be provided along with facilities to Interface with central PLC and to meet the requirement of all system operations and controls.

ii) Water chilling unit control system shall be designed to have a constant chilled water outlet from evaporator at all load condition by means of controlling ON-OFF thermostat (one for each compressor) in an automatic manner.

iii) Water chilling unit shall be equipped with superheat control of water chilling unit through thermostatic expansion valve, which gets its impulse from temperature element connected with suction line after chiller outlet.

iv) High discharge pressure cut-out and oil pressure (OP) differential cut-out shall be of manual reset type and low pressure cut-out shall be automatic reset type. The OP cut-out shall trip the compressor in case of low oil pressure.

v) On-off toggle switch to close the liquid refrigerant line solenoid valve shall be provided to shut the compressor by the operation of the operation of low pressure cut-out (after the refrigerant has been pumped to the condenser).

vi) Switching of crank case heaters shall be interlocked with starting and stopping/tripping of compressor motor. Further, the safety thermostat shall switch off the crank-case heater in the event temperature rises above safe limit.

vii) Provision shall also be made for the manual restarting of the compressor.

viii) On-off type anti-freeze thermostats, one for each chiller shall be provided in addition to the controlling on-off thermostat for safety purpose and shall act in the event of failure of on-off thermostat to close the liquid line solenoid valve and also to trip the compressor simultaneously.

ix) Compressor starting/running shall be interlocked with the flow switches to be provided at the outlet of each chiller and each condenser and as well as with pressure in the inlet of the condensers. In addition closure or open status of various valves through limit switches shall be used for interlock, alarm and control of air conditioning system.

x) The standby condenser water pumps (if applicable), standby chilled water pumps, standby fresh air fan & standby AHU shall be started automatically when the working equipments are stopped/tripped. Auto/manual selector switches and working /standby selector switches for the pumps/AHU/fresh air fan shall be provided in the panel.

xi) Closure of fire dampers shall raise an annunciation in the panel.

xii) Condenser water pumps shall be interlocked with the low level switch in each cooling tower sump and operation of cooling tower fans. High level in the cooling tower shall be annunciated in the panel by means of a separate level switch.

1 AIR HANDLING UNIT

i) Control of the inside room temperature and humidity shall be by controlling the chilled water flow by means of motor operated three way modulating valve and the modulating valve shall get its signal from the temperature sensor.

ii) Humidistat located in the return air duct shall actuate the pan humidifier to obtain the desired degree of humidification.

iii) Separate Humidistat and thermostats shall be provided and interlocked in steps with winter heater / re-heater / strip heaters for monsoon and winter re-heating or heating as the case may be.

iv) Heater banks shall be interlocked with the running of AHU, temperature of return air, humidity of return air and safety thermostat (Geyserstat located in front of the each heater in the supply air duct)

v) AHU shall be started either from its local panel or from the main control panel of AC system by means of Remote/Manual selector switches.

vi) The closure of fire dampers, automatic tripping of AHU fans and fresh air fans shall be interlocked with Bidder's fire Detection System.

vii) Each AHU shall be provided with temperature indictors and flow indicator in the chilled water piping inlet and outlet to monitor the air-conditioning load of each area.

viii) The motorised air regulators shall be provided for individual rooms for regulating the room temperature. The temperature control of different partions of central control room shall also be possible for maintaining different temperature.

2 D-X AIR-CONDITIONING SYSTEM

i) The control and interlocks described above for water chilling plant shall be application for this system also.

ii) Further, the compressor starting/ running shall be interlocked with the flow switches in condenser water circuit and as well as with AHU motors.

iii) The standby condenser water pumps, fresh air fan & standby AHU shall be started automatically when the working equipments are stopped/ tripped. Auto / manual selector switches and working/ standby selector switches for the pumps, fresh air fans and AHU shall be provided in the panel.

3 GENERAL REQUIREMENTS

i) Separate emergency local stop push button shall be provided for each pump, compressor, fans etc. of AC system.

ii) Lamps shall be provided for indicating the status of each pump, compressor, fans etc. of AC system in the main and local panel.

iii) All the annunciation related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped/tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, compressor, AHU etc. in the respective panel.

iv) Fully wired, twenty percent (20%) spare annunciation windows shall be provided in all the panels.

v) Air washer units shall be started/stopped by initiation from the local panel and the starting/stopping of fans and pumps shall be automatic upon such initiation.

vi) The operation of the pumps shall be interlocked with the low level of water in the sump. High level of the sump shall be annunciated. The standby pump shall be started automatically when the working pump is tripped.

vii) Auto/manual selector switches and working/standby selector switches for the pump shall be provided in the panel.

iv) A selection switch enabling the running of AWU fan or pump alone shall be provided.
Separate emergency local stop push button shall be provided for each pump, fans etc.

vi) Lamps shall be provided for indicating the status of each pump, fans etc. in the main and local panel.

vii) All the annunciations related to failure of equipments, tripping of equipments, source of failure/ reason due to which the equipment is stopped/ tripped, low and high limits of parameters such as level, temperature, pressure, pressure drop etc. shall be provided for each pump, fan, AWU etc. in the respective panel.

viii) Both supply and exhaust fans shall be operated locally.

ix) Fully wired, twenty percent (20%) spare annunciation windows shall be provided in all the panels.

C&I DELIVERABLES

FOR

VENTILATION SYSTEM

LIST OF DELIVERABLES OF PEM - C&I DEPARTMENT FOR VENTILATION SYSTEM							
2X660MW ENNORE SEZ TPP							
DOCUMENT NUMBER PE-GL-412-145-I100							
Sl.No.	DRAWING NO.	DRAWING/DOCUMENT TITLE	CATEGORY	CUSTOMER	FROM	USER	REMARKS
INSTRUMENTATION							
1	PE-V9-412-554-I901	INSTRUMENT DATA SHEETS	A	-	VENDOR	C&I	
2	PE-V9-412-554-I902	INSTRUMENT SCHEDULE	I	-	VENDOR	C&I	
3	PE-V9-412-554-I903	INSTRUMENT INSTALLATION/ HOOK UP DIAGRAMS	A	-	VENDOR	C&I	
4	PE-V9-412-554-I904	FIELD JB TERMINATIONS /GROUPING DOCUMENT	I	-	VENDOR	C&I	
5	PE-V9-412-554-I905	QUALITY PLANS (CV,FE, Tx and Analyser)	A	-	VENDOR	C&I	
PLC PANEL							
1	PE-V9-412-554-I906	~~PLC CONFIGURATION DRAWING~~	A	A	VENDOR	C&I	
2	PE-V9-412-554-I907	~~PLC PANEL GA (INTERNAL & EXTERNAL) DRAWING~~	A	-	VENDOR	C&I	
3	PE-V9-412-554-I908	CONTROL SCHEMES (BLOCK LOGIC)	A	-	VENDOR	C&I	
4	PE-V9-412-554-I909	~~PLC~~ INPUT / OUTPUT SIGNAL LIST	I	-	VENDOR	C&I	
5	PE-V9-412-554-I910	UPS ~~BATTERY CHARGER/ BATTERY DATASHEET & SL~~D	I	$$	VENDOR	C&I	
6	PE-V9-412-554-I911	~~UPS SIZING CALCULATIONS~~	I	-	VENDOR	C&I	
7	PE-V9-412-554-I912	~~BATTERY SIZING CALCULATIONS~~	I	-	VENDOR	C&I	
8	PE-V9-412-554-I913	~~CONTROL DESK LAYOUT / GA DRAWING~~	A	-	VENDOR	C&I	
9	PE-V9-412-554-I914	~~PLC-OWS/PRINTER FURNITURE BOM~~	A	-	VENDOR	C&I	
10	PE-V9-412-554-I915	~~PLC CONTROL ROOM LAYOUT DRAWING~~	A	-	VENDOR	C&I	
11	PE-V9-412-554-I916	~~PLC CATALOGUE~~	I	-	VENDOR	C&I	
12	PE-V9-412-554-I917	~~PLC QUALITY PLAN & FAT PROCEDURE~~	A	-	VENDOR	C&I	
13	PE-V9-412-554-I918	LIST OF SIGNAL EXCHANGE WITH DDCMIS (BOTH HARDWIRED & SERIAL INTERFACE IN BHEL FORMAT)	A	`	VENDOR	C&I	
14	PE-V9-412-554-I919	~~PROCESS GRAPHIC MANUSCRIPTS PLC~~	I	-	VENDOR	C&I	
15	PE-V9-412-554-I920	~~PROCESS GRAPHIC MANUSCRIPTS FOR DDCMIS~~	I	-	VENDOR	C&I	
16	PE-V9-412-554-I921	CABLE SCHEDULE (IN BHEL EXCEL FORMAT) & CABLE INTERCONNECTION DETAILS	I	-	VENDOR	C&I	
17	PE-V9-412-554-I923	PANEL & ELECTRONIC EARTHING REQUIREMENT	I	-	VENDOR	C&I	
18	PE-V9-412-554-I924	PANEL HEAT DISSIPATION DATA	I	-	VENDOR	C&I	
19	PE-V9-412-554-I925	MANDATORY SPARES BILL OF MATERIAL	A	A	VENDOR	C&I	
20	PE-V9-412-554-I926	~~PLC O & M MANUAL~~	I	-	VENDOR	C&I	
21	PE-V9-412-554-I927	~~PLC EARTHING SCHEME~~	I	-	VENDOR	C&I	
	Notes:	412 - Project No.					
		554 -SI No of MAX Package (VENTILATION SYSTEM)					
		$$ -Approval by BHEL if Vendor BBU Item Approval by Customer if Customer BBU Item					

Documents of C&I System shall be submitted to end user/owner for approval during detail engineering. Changes, if any, shall be accommodated by the bidder without any price/time implication.

SPECIFICATION

FOR

MOTORISED

VALVE ACTUATOR

CHAPTER – 13

ACTUATORS

1.00.00 ELECTRICAL ACTUATORS WITH INTEGRAL STARTERS

The Actuators shall be integral starters along with overload relays with built in SPP (Single Phase Preventer) with provision for operation from Control room, Local and by wireless set.

1.01.00 General

The actuator motors shall be suitable for use on 415 Volt 3 phase 50Hz power supply. The actuator comprising motor, integral reversing starter, local control facilities and terminals for remote control and indication shall be housed within a self contained, sealed enclosure. Actuator working platforms shall be provided for maintenance purpose.

Commissioning tools shall not form an integral part of the actuator and must be removable for secure storage/authorized release. In addition, provision shall be made for the protection of configured actuator settings by a means independent access to the commissioning tool.

For some specific applications, integral starter shall also be separately mountable casting type and plug-in. Such applications shall be decided during detail engineering.

1.02.00 Actuator Sizing

The actuator shall be sized to guarantee valve closure at the specified differential pressure. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10% below nominal. The operating speed shall be such as to give valve closing and opening at approximately 4 to 5 mm per second unless otherwise stated in the job specification.

1.03.00 Environmental

Actuators shall be suitable for indoor and outdoor use. The actuator shall be capable of functioning in an ambient temperature ranging from 10°C to 50°C, upto 95% relative humidity.

Actuators for explosion-hazardous applications shall in addition be certified Flameproof for Zones 1 and 2 (Divisions 1 and 2 Group gases).

1.04.00 Enclosure

Actuators shall be 'O' ring sealed, watertight to IP68 degree of protection. The motor and all other internal electrical elements of the actuator shall be protected from ingress of moisture and dust when the terminal cover is removed at site for cabling.

1.05.00 Motor

The electric motor shall be Class F insulated, with a time rating of at least 15 minutes at 50°C or twice the valve stroking time, whichever is more, at an average load of at least 33% of maximum valve torque.

1.06.00 Motor Protection

Protection shall be provided for the motor as follows:

- The motor shall be de-energized in the event of a stall when attempting to unseat a jammed valve.
- Motor temperature shall be sensed by a thermostat de-energising the motor in case of overheating.
- Lost phase protection
- Overload protection
- Short circuit protection by suitably rated long acting fuse.

1.07.00 Gearing

The actuator gearing shall be totally enclosed in an oil-filled gear casing suitable for operation at any angle. All drive gearing and components must be of metal construction and incorporate a lost-motion hammer blow feature. For rising spindle valves the output shaft shall be hollow to accept a rising stem, and incorporate thrust bearings of the ball or roller type at the base of the actuator. The design should be such as to permit the opening of the gear casing for inspection or disassembling without releasing the stem thrust or taking the valve out of service.

1.08.00 Hand Operation

A hand wheel shall be provided for emergency operation, engaged when the motor is declutched by a lever or similar means, the drive being restored to power automatically by starting the motor. The hand wheel or selection lever shall not move on restoration of motor drive. Provision shall be made for the hand/auto selection

lever to be locked in both hand and auto positions. It should be possible to select hand operation while the actuator is running or start the actuator motor while the hand/auto selection lever is locked in hand without damage to the drive train.

The hand wheel drive must be mechanically independent of the motor drive and any hand wheel gearing should be such as to permit emergency manual operation in a reasonable time. Clockwise operation of the hand wheel shall give closing movement of the valve unless otherwise stated in the job specification.

1.09.00 Drive Bushing

The actuator shall be furnished with a drive bushing easily detachable for machining to suit the valve stem or gearbox input shaft. Normally the drive bush shall be positioned in a detachable base of the actuator. Thrust bearings, when housed in a separate thrust base should be of the sealed for life type.

1.10.00 Torque and Turns Limitation

Torque and turns limitation to be adjustable as follows:

- Position setting range 2.5 to 100,000 turns, with resolution to 15 deg. of actuator output
- Torque setting 40% to 100% rated torque.

"Latching" to be provided for the torque sensing system to inhibit torque off during unseating or during starting in mid travel against high inertia loads.

The electrical circuit diagram of the actuator should not vary with valve type remaining identical regardless of whether the valve is to open or close on torque or position limit. Spare 1 NO + 1 NC Limit switch and Torque switch shall be provided in each Actuator.

1.11.00 Remote Valve Position/Actuator Status Indication

Four contacts shall be provided which can be selected to indicate any position of the valve. Provision shall be made for the selection of a normally closed or open contact form. Contacts shall maintain and update position indication during hand wheel operation when all external power to the actuator is isolated.

The contacts shall be rated at 5A, 250V AC, 30V DC.

As an alternative to providing valve position any of the four above contacts shall be selectable to signal one of the following:

- Valve opening, closing or moving
- Thermostat tripped, lost phase
- Motor tripped on torque in mid travel, motor stalled
- Remote selected
- Actuator being operated by hand wheel
- Position feedback has to be provided for all inching type applications. These shall be interfaced with plant DDCMIS

1.12.00 Local Position Indication

The actuator shall include a digital position indicator with a display from fully open to fully close in 1% increments. Red, green and yellow lights corresponding to open closed and intermediate position shall be included on the indicator. End of travel indication colours shall be reversible. The digital display shall be maintained and updated during handwheel operation when all external power to the actuator is isolated. The display shall incorporate valve, actuator and control status indication. Provision shall be made to orientate the display through increments of 90°.
Provision shall be made in the design for the addition of a contactless transmitter to give a 4-20mA analogue signal corresponding to valve travel for remote indication when required.

1.13.00 Integral Starter and Transformer

The reversing starter, control transformer and local controls shall be integral with the valve actuator suitably housed to prevent breathing and condensation. The starter shall be suitable for 60 starts per hour and of rating appropriate to motor size. The starter logic shall be microprocessor- based. The controls supply transformer shall be fed from two of the incoming three phases and incorporate overload protection. It shall have the necessary tappings and be adequately rated to provide power for the following functions:

- Energization of the contactor coils
- DC output where required for remote controls
- Supply for all the internal electrical circuits

1.14.00 Integral Local Control and Control Mode Selector

The actuator shall incorporate local controls for Open, Close and Stop and a Local/Stop/Remote mode selector switch lockable in any one of the following three

positions: local control only, stop (no electrical operation), remote control plus local stop only. It shall be possible to select maintained or non-maintained local control.

The local controls shall be arranged so that the direction of valve travel can be reversed without the necessity of stopping the actuator.

Provision shall be made to orientate the local controls through increments of 90°.

1.15.00 Control Facilities

The necessary wiring and terminals shall be provided in the actuator for the following control functions:

- Open and close external interlocks to inhibit local and remote valve opening and/or closing control. Provision shall be made to configure the interlocks to be active in remote control only.

- Remote controls fed from an internal 24V DC supply and/or from an external supply rated 110V AC to be suitable for any one or more of the following methods of control:

  Open, close and stop control

  a) Open and close maintained or 'push to run" (inching) control

  b) Overriding Emergency Shut-down to Close (or Open) valve from a normally closed or open contact

  The following individual potential free relay contacts shall be provided in the actuator for remote annunciation to facilitate continuous monitoring of the actuator.

  - Actuator in local mode
  - Actuator in remote mode
  - Actuator (valve) running in OPEN direction.
  - Actuator (valve) running in CLOSE direction.
  - Limit switch OPEN trip
  - Limit switch CLOSE trip
  - Actuator in local mode.
  - Actuator in inching mode.
  - Actuator in self-retaining mode
  - Actuator power switched off /single phasing.
  - Torque switch trip, thermo switch trip and overload relay trip

(or close)

Automatic phase correction facility and potential free contact for annunciation of power failure shall be provided

It shall be possible to reverse valve travel without the necessity of stopping the actuator. The starter contactors shall be protected from excessive current surges during travel reversal by an automatic time delay on energization of the contactor coils.

1.16.00 Monitoring Facilities

Facilities shall be provided for monitoring actuator operation and availability as follows:

Monitor (availability) relay, having one changeover contact, the relay being energised from the control transformer only when the Local/Off/Remote selector is in the Remote position to indicate that the actuator is available for remote (control room) operation.

Where required, it shall be possible to provide indication of Thermostat trip and Remote selected as discreet signals. The actuator shall include a diagnostic module, which will store and enable download of historical actuator operation and torque data to permit analysis of actuator and valve in-service performance. Data download shall be carried out without removing any covers and all shall be available locally to the actuator or remotely via telecom data transfer.

Diagnostic and configuration software shall be made available in a Lap Top PC for user.

1.17.00 Wiring and Terminals

Internal wiring shall be tropical grade PVC insulated stranded cable of appropriate size for the control and 3-phase power. Each wire shall be clearly identified at each end.

The terminals shall be embedded in a terminal block of high tracking resistance compound.

The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight sea land shall be provided with a minimum of 3 threaded cable entries with provision for a minimum of 4.

All wiring supplied as part of the actuator to be contained within the main enclosure for physical and environmental protection. External conduit connections between components are not acceptable.

A durable terminal identification card showing plan of terminals shall be provided attached to the inside of the terminal box cover indicating:

- Serial number
- External voltage values
- Wiring diagram number
- Terminal layout

This must be suitable for the contractor to inscribe cable core identification alongside terminal numbers.

1.18.00 Startup Kit

Each actuator shall be supplied with a start-up kit comprising installation instruction manual, electrical wiring diagram and cover seals to make good any site losses during the commissioning period. In addition, sufficient actuator commissioning tools shall be supplied to enable actuator set up and adjustment during valve/actuator testing and site installation commissioning.

1.19.00 Performance Test Certificate

Each actuator must be performance tested and individual test certificates shall be supplied free of charge. The test equipment should simulate a typical valve load, and the following parameters should be recorded:

- Current at maximum torque setting
- Torque at max. torque setting
- Flash test voltage
- Actuator output speed or operating time.

In addition, the test certificate should record details of specification such as gear ratios for both manual and automatic and second stage gearing if provided, drive closing direction, wiring diagram number.

1.20.00 The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer's recommendation shall also be carried out.

- Measurement of insulation resistance.
- Measurement of full load current.
- Test running of the motors

SPECIFICATION

FOR

MEASURING INSTRUMENTS

CHAPTER-3

FIELD AND MEASURING INSTRUMENTS

3.00.00 FIELD & MEASURING INSTRUMENTS (PRIMARY & SECONDARY INSTRUMENTS)

3.01.00 GENERAL REQUIREMENTS

3.01.01 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.

3.01.02 The instrumentation and control equipment shall conform to all applicable codes and standards including those referred in Cl. no. 1.08.00 in this Volume. All equipment and systems shall also fully comply with the design criteria stated in chapter-2 of this part.

3.01.03 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.

3.01.04 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.

3.01.05 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.

3.01.06 All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved. The enclosures of all electronic instruments shall conform to IP-65 unless otherwise specified (Explosion proof for NEC article 500, class 1, Division 1 area & flame proof) and an anti corrosive 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.

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

i. 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.

ii. Level switches for sump/tank level high/normal/ low/very low interlocks.

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

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

v. Flow elements 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.

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

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

viii. Tapping points/test points shall be provided.

ix. 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.

x. All Thermocouples & RTDs shall be Duplex.

xi. 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).

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

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

xiv Pull cord, belt sway, zero speed switches, emergency stop PB for conveyers, other limit switches, cable gland etc. of CHP which produce spark shall be provided with dust and flame proof enclosure conforming to IS-2148.

xv Lockable Deinterlock switches shall be provided for CHP as per requirement.

xvi 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 weighers.

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

xviii All limit switch shall be conform to IEC-60947-5-1.

xix 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.

xx. 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 transmitter.

xxi. 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/PLC using instrumentation & Extension cables respectively.

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

xxiii. Contacts less, electronic 2-wire position transmitters shall be provided for all inching type motorised valve and dampers.

xxiv. For CW sump level, Raw water reservoir level, Turbine oil tank, coal bunkers, Ash Silo, LDO/HFO tank, DM water tanks, CS tank, Acid and alkali applications, only non contact type level transmitters like Acoustic, Ultrasonic, Radar based shall be provided by bidders as specified in NIT and as approved by owner.

xxv. 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. xxiv. However Wireless technology as adopted by Bidder shall be reliable and field proven in power plants and same shall be approved by Owner.

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

xxvii. 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.

FIELD INSTRUMENTS SHALL BE SUPPLIED & OFFERED AS PER DATA SHEETS SPECIFIED BELOW:

3.03.00 TRANSMITTERS, SWITCHES, GAUGES AND PANEL MOUNTED INSTRUMENTS

3.03.01 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.

Type/Construction	:	Sealed capacitance/ Inductance/ Silicon resonance type
Material		
- Body	:	Die cast Aluminum with epoxy coating for air & flue gas SS316 for other services
- Diaphragm	:	316 SS
- Measurement element	:	Teflon seal
- Valves	:	Carbon steel for non-corrosive Applications SS316 for corrosive applications.
Output signal	:	4 to 20 m Amp. DC (Two wires) HART Compatible
Local Indicator	:	LCD indicator (5 digit) with scale of Engg. unit
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.
Turn down ratio	:	100:1 in general
Stability	:	± 0.15% of URL for 5 years.
Response time	:	150 msec.
Power supply	:	24V DC nominal
Drive capability	:	600 Ohms nominal
Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
Span and Zero	:	Locally adjustable, non-interacting

Zero suppression / elevation	:	At least 100% of Span
Connection		
- Process	:	1. 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.
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

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.

3.03.01.01 Transmitters & other HART based instruments shall be supplied along with 3 Nos. of universal type hand held/portable pressure calibrators. Temperature transmitters shall be supplied along with 3 Nos. of hand held/portable mV source generators.

3.03.02 PRESSURE SWITCHES (PS) & DIFFERENTIAL PRESSURE SWITCHES (DPS)

Applicable Standards	:	IS3624 - 1966/ISA-RP-8.1 except as modified in spec.
Type/Construction	:	Bourdon/Sealed Diaphragm Piston Actuated preferable. Indicators with contacts are not acceptable.
Materials		
- Bellows	:	316 SS
- Bourdon tube	:	316 SS
- Movement	:	316 SS
- Enclouser	:	Die-cast aluminum with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere.
- Protective Diaphragm	:	Teflon

Accuracy	:	± One (1) percent or better
Repeatability	:	± 0.5(half) percent or better
Setting & Differential	:	Adjustable

Contact

- Number	:	DPDT /2 SPDT
- Type	:	Auto reset with internal Adjustable snap action micro switch
- Rating	:	5 Amp, 240V AC / 0.2 Amp, 220V DC
Connection - instrument	:	Half (1/2) inch NPT Male Process
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.
- Over range protection	:	One Fifty (150) percent of full scale
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)

Accessories

- 3 / 5 valve manifold	:	As applicable for all switches
- Self cleaning type pulsation dampners/Snubber (Material SS316)	:	Pump and compressor discharge lines
- Syphon	:	For all steam lines
- Protective separating diaphragm	:	For fuel oil & corrosive liquid lines.
Mounting	:	Local (in LIE/LIR for BTG package).

3.03.03 PRESSURE & DIFFERENTIAL PRESSURE GAUGES (PG & DPG)

Applicable standard	:	IS:3602-1966, IS/3624, ASME B 40.1
Type/Construction		
-760 mm to 1.0Kg/cm2	:	Bellows/Diaphragm
-Above1.0Kg/cm2	:	Bourdon Tube
- Suction side of pumps	:	Compound gauge

Materials

- Bourdon tube	:	316 SS
- Bellows	:	316 SS
- Movement	:	316 SS
- Case	:	SS 316/ Die-cast aluminum with stoved enamel black finish. Epoxy coating

		shall be provided for corrosive atmosphere.
- Protective Diaphragm	:	Teflon
Dial size	:	150mm with shatter proof glass
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.
Accuracy	:	± One (1) percent or better
Connection - Instrument Process	:	1/2 inch NPT Male Bottom
Mounting	:	Local
	:	1/2 inch NPT Male (Back entry) mounted on local gauge board.
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)

Accessories

- 3 way needle valve/manifolds	:	For all gauges
- Self cleaning type Pulsation dampener/snubber (S316)	:	Pump and compressor discharge lines
- Syphon	:	For all steam lines
- Protective separating	:	For fuel oil and corrosive liquid lines

Other particulars

- External Zero adjustment	:	For all gauges
- Safety device		
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.
- Over range protection	:	One Fifty (150) percent of full scale
Other Requirments	:	Movement mechanism shall be glycerin filled for oil services & vibration prone area.
	:	For Fuel oil & corrosive liquid lines diaphragm type sensors required. Armored 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 mm wc or suitable range having **dial size of 300mm or bigger size** shall be provided.

3.03.04 **TEMERATURE TRANSMITTERS**

Type	:	SMART type configurable from control room through HART protocol (HMS System).
Display type	:	Indicating type (5 digit LCD Display),
Accuracy	:	±0.10%,
Ambient temperature error	:	0.1% per 10°C change
Output	:	4-20 mA DC (2 wire system) HART compatible signals for analogue monitoring inputs to the distributed control system (DDCMIS), DCS & PLC.
Protection class	:	NEMA 4/IP66 or equivalent degree of protection for enclosure)/ (Explosion/Flame proof for NEC Class-1, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
Material of accessories	:	SS316.
Stability	:	± 0.1 % or ± 0.1 deg C of reading (whichever is great) for 2 years in case of RTD inputs and for 1 year in case of Thermocouples inputs.
Operating Voltage	:	16 – 48 V DC
Calibration	:	as per NIST monograph 125 for T/C & European Curve Alpha = 0.00385 for RTD .
Ref. Junction compensation	:	Provided
Span/zero adjustment	:	Locally adjustable, Non interacting
Auto calibration	:	Provided
Burn out protection upscale	:	Provided
Input - output isolation	:	Provided
Circuit ungrounded	:	Provided

Any RTD & Thermocouples shall be directly wired to DDCMIS/DCS/PLC for metal temperature application, bearing & winding temp application only.

The Temperature transmitter shall accept Universal dual inputs of all types of thermocouples & RTD, 0-5V input signals etc.

Temp. Transmitter shall be extremely stable against Ambient temp variation, The accuracy figure shall be inclusive of effect due to ambient temperature variation.

Considering the application & distance involved for monitoring parameters **wireless technology** shall be adopted by interfacing with DDCMIS through OPC connectivity. However Wireless technology as adopted by Bidder shall be reliable and field proven in power plants and same shall be approved by Owner.

3.03.05 RESISTANCE TEMPERATURE SENSORS WITH THERMOWELLS

Applicable Standard	:	ASME PTC 19.3 - Latest Revision DIN EN 60751:1996, BS EN/IEC60751: 2008
Element	:	Platinum, R0=100 ohm 4-wire Duplex for Process Temp. Measurement Platinum, R0=100 ohm 3-wire Duplex for Bearing & Winding Temp. Measurement
Sheath Material/ Insulation	:	316SS/Compacted Magnesium Oxide
Sheath O D	:	8 MM
- Gauge	:	18 AWG
Terminals	:	Spring loaded high temperature ceramic base with silver plated brass for high vibrating locations.
Calibration	:	As per DIN Standard – 43760, Class A
Head	:	Hex Head, Die Cast Aluminum (Screwed) with galvanized SS chain
Response Time	:	6-10 Sec bare & 30 Sec. With protective sheath/thermowell
Accuracy	:	± 0.35 degree C or Class-A whichever is better.
Electrical connection	:	Gold plated Plug in type. Double entry – one unused entry with blind plug
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)

THERMOWELL

Applicable Standard	:	ASME PTC 19.3 TW - 2010
- Construction	:	Tapered drilled from Bar stock (Straight for Air & Gas systems)
- Material	:	- 316 SS/F11/F22/F91 - water and steam Services depending upon process parameters. - Inconel for air & flue gas services For furnace zone, impervious ceramic protecting tube of suitable material along

with Incoloy supporting tubes and adjustable flanges.

For Mill classifier outlet long life solid sintered tungsten carbide material or better of high abrasion resistance.

Bidder shall provide calculation for thermowell as per ASME – PTC-19.3 2010. "All Thermowells in high velocity steam service shall be checked for Strouhal's frequency limit to arrive at a safer size and design of Thermowells".

- Process Connection	:	(i) M 33 x 2 (ii) SS316 Flanged, for Air & Gas systems, with mating flanges, fasteners, gaskets etc.
- Extension	:	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
Immersion length	:	Within ± 10 mm of center line of pipe and as per ASME – PTC-19.3 - 2010
Extension neck length	:	Minimum 100 mm above insulation of pipe and Minimum 160 mm when there is no insulation on pipe.
IBR Certification	:	For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations
Note	**:**	**Extension /**Compensating/paired cable exposed to atmosphere in the conventional method melts away due to high temperature at the top of mill or due to coal burning. Hence The terminals of temperature sensors shall not be at the top of mills itself. The temperature sensors wires are to be laid up to JB though SS tube of required diameter and the head shall be placed nearer to the JB.

3.03.08 TEMPERATURE SWITCHES (TS)

Type/Construction

- Switch	:	Industrial type inert gas filled with capillary and separable thermowell and contacts directly connected to Bourdon element/vapor pressure sensing, gas filled bellows type preferred.
- Thermowell	:	Bar stock

Material

- Bulb	:	316 SS
- Capillary	:	Armored Stainless Steel
- Bourdon	:	316 SS
- Bourdon Movement	:	SS 316
- Casing	:	Die-cast aluminum with stoved enamel black finish Epoxy coating shall be provided for corrosive atmosphere.
Setting and Differential	:	Adjustable
Accuracy	:	± One (1) percent of setting and differential
Repeatability	:	One half(1/2) percent of setting.

Contacts

- Number	:	DPDT/2 SPDT
- Type	:	Auto reset with internal Adjustable snap action micro switch
- Rating	:	5 Amp, 240V AC / 0.2 Amp, 220V DC

Connection

Pipe	:	M33 x 2
- Extension	:	Threaded union (SS316) 1/2" NPT (F)

with two nipples of SS 316 having 1/2"NPT(M) threads at both ends

Thermowell	:	To suit Temp. switch with same design criteria as specified for RTDs.
Electrical	:	Suitable for Plug in type.
		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.
Other Particulars		
- Capillary length	:	As per requirement (min 10 meters)
- Immersion Length	:	Within + ten (10) mm of center line of pipe with adjustable nuts.
- Extension neck length	:	Minimum 50 mm above insulation of pipe /As per approved hookup drawings.
- Packing glands	:	Yes
IBR Certification	:	For high pressure service, Steam Temp, Fuel oil temp. measurement as per IBR rules and regulations
N.B	:	Switches designed for cross ambient operation shall be used in applications where the ambient temperature will approximate or exceed the switch set point.

3.03.09 TEMPERATURE GAUGES (TG)

Applicable standard	:	IS : 3602,BS:5235 ISA:RP:8.1 except as modified in this specification
Type/Construction		
- Thermometer	:	Industrial type, Gas in Filled type with separable thermowell
- Thermowell	:	Bar stock
Material		
- Bulb	:	316 SS
- Capillary	:	Armoured SS (Applicable for capillary Type)
- Casing	:	SS 316/ Die-cast aluminum with stoved enamel black finish. Epoxy coating

		shall be provided for corrosive atmosphere
Dial Size	:	150mm with shatter proof glass
Scale Details	:	270 degree dial rotation/deflection. Graduations in black lines on white dial provided with glass cover. Smallest scale division shall be one (1) percent of full scale value or smaller .Pointer stop for all gauges
Accuracy	:	± One (1) percent or better
Response time	:	Maximum 15 seconds without thermowell and 30 seconds with thermowell
Connection		
- Pipe	:	M33 x 2
- Thermowell	:	To suit instrument with same design criteria specified for RTDs.
- Process Connection	:	(i) M 33 x 2 (ii) SS316 Flanged, for Air & Gas systems, with mating flanges, fasteners, gaskets etc.
- Extension	:	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
Other Particulars		
- Capillary length	:	5Meters/10 Meters as required
- Immersion Length	:	Within + ten (10) mm of center line of pipe with adjustable nuts.
- Extension neck length	:	Minimum 50 mm above insulation of pipe /As per approved hookup drawings.
- Stop at Maximum value	:	For all gauges of scale
- Pointer	:	Externally adjustable
	:	In general, Contact type Temp. gauges are not acceptable for interlock & protection. Contact type Temp. gauges are acceptable for interlock & protection in case of bearing temp. only.
- Over range protection	:	150 percent (%) of full scale
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)
IBR Certification	:	For high pressure service, Steam

Temp., Fuel oil temp. measurement as per IBR rules and regulations

3.03.10 TEST THERMOWELLS (TW)

Applicable Standard	:	ASME PTC 19.3 TW - 2010
Type/Construction	:	Machined from Bar Stock
Material	:	316 SS/F11/F22/F91
Connection		
- Pipe	:	M33 x 2
- Test Instrument	:	To suit test instruments
Accessories	:	Plug with chain
IBR Certification	:	For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations Bidder shall provide calculation for thermowell as per ASME – PTC-19.3 TW - 2010.

Test wells shall be provided on main steam, reheat steam, extraction steam, feed water, condensate, spray water lines and other piping as required to meet ASME test requirements.

3.03.11 DIRECT MOUNTED LEVEL TRANSMITTERS (LT)

Displacer type level transmitter shall not be used in the process anywhere in the plant.

3.03.12 Ultrasonic Level Transmitter (for Water sump/Tank level, Raw water reservoir level, Cooling water fore bay level measurements)

Principle of Operation	:	Detection of reflected ultrasonic pulse
Measuring Ranges	:	Up to 30 meters (typical)
Signal Processing	:	Microprocessor Controlled Signal Processing
Operating Freq.	:	10 KHz to 50 KHz (typical)
Display	:	Head mounted alpha-numeric back lit LCD/LED
Calibration & Configuration	:	Accessible from front of panel & HART calibrator.
Diagnosis	:	On-line
Status	:	For power, Hi / Lo / V. Hi / V. Lo-level indication, fault etc.
Construction	:	Plug-on board
Power supply	:	240 V AC 50 Hz / 24V DC
Signal Output	:	4-20 mA DC with HART (isolated) - 600 Ohm load.
Hysteresis	:	Fully adjustable preferred
Output contacts	:	2SPDT Potential free changeover contacts @ 8A 230V AC.
Accuracy & Repeatability	:	± 0.25% of span or better
Resolution	:	± 0.1% of span

Temperature Compensation: To be provided with Transducer.

Operating temp.	:	Transmitter-50 deg C and Sensor – 80 deg C
MOC Sensor	:	Body- PVDF and Face – Polyurethene
Humidity	:	1% to 95% non condensing.
Enclosure	:	IP-67 Epoxy painted die cast Aluminum or SS316L housing.
Cable Connection	:	3/4" ET
Mounting	:	2" – 4" NPT or flanged
Accessories	:	Cable gland, prefab cable, mounting accessories like EPDM seal, SS316 flanged etc. Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications which will be decided during detailed engineering.

3.03.13 CAPACITANCE TYPE LEVEL TRANSMITTER

The total system shall consist of capacitance probe, pre-amplifier and transmitter

Type	:	Capacitance type
Probe	:	a) Rod or suspended electrode. b) Rope type probes may be used only where required probe length is greater than 3 meters
Probe Mounting	:	Stainless steel 1-1/2 ANSI RF Flange / ¾" NPT (M)
Material of construction	:	316 SS
Insulation	:	PTFE Part/Full as per service.
Transmitter	:	The transmitter shall receive output of the preamplifier and convert it into 4-20 mA DC output signal.
Accuracy	:	± 1% of Full scale
Repeatability	:	± 0.5 % of Full scale
Load	:	Min 600 Ohms
Enclosure	:	Powder/Epoxy coated Die cast aluminum. with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
Ambient temperature	:	0-60 ºC.
Mounting	:	Wall / Surface
Supply voltage	:	240V AC, 50Hz / 24V DC
Response time	:	100 m sec or better
Cable connection	:	¾" ET
Accessories	:	Counter flange, Cable gland, prefab cable if any
Preferable features	:	Alarm output contacts with adjustable set point facility

3.03.14 GUIDED WAVE RADAR/RADAR LEVEL TRANSMITTER

Type	:	Guided wave Radar (Contact type)/Radar (Non contact type) as finalized by owner.
Application	:	For Turbine Lube oil tank, HFO & LDO tank level,

Condenser Hotwell, LP heaters, CBD tank level, Stator water expansion level, and other Low pressure, Vacuum vessels.

Environment Class	:	Highly abrasive with Gases and Fumes
Orientation	:	Vertical
Probe Type	:	Flexible Single lead with chuck
Probe Material	:	SS 316L
Connection Size & Type	:	2” Flanged ANSI 300 lb SS316L material
Connection material	:	SS 316L
Accuracy	:	+/- 5 mm
Resolution	:	± 1 mm
Type (Transmitter)	:	SMART, 2 Wire
Operating Principle	:	Time Domain Reflectrometry
Output	:	4-20 mA, DC with **HART protocol** and 600 Ω output load.
Electrical Connection	:	½” NPT
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)
Electrical Power	:	11-42 V DC
Housing material	:	Die Cast Aluminum
Vent & Drain Plug material	:	SS
Side Flange Material	:	SS
Local Display	:	Provided (LCD Digital)
Units of Measurement	:	Length M
Electromagnetic compatibility:		EN-61326

3.03.15 3 D TYPE ACOUSTIC WAVE LEVEL TRANSMITTER

Type	:	Acoustic Wave Level Transmitter (3 D type)
Application	:	Coal and Ash Bunker Level, Volume & Mass.
Temperature compensation	:	Required for high temp applications
Operating Principle	:	Non - Intrusive acoustic wave transmission & Reflection
Frequency Range	:	3 – 10 KHz
Accuracy	:	+/- 0.25 % for even surface & ± 0.5% for uneven surface.
Resolution	:	1 mm
Output	:	4-20mA DC with HART
Display Unit:		
Type	:	Head mounted LCD Display with Engg. Units
Location	:	Suitable location at bunker / Silo operating floor area
Protection Class	:	IP 65 or better// flame proof (IEC-79.1, Part I) As applicable).
Material Of construction:		

Housing	:	Polypropylene
Flange	:	Polypropylene
Sizes:		
Flange Size	:	2” ANSI 300 # RF SS
Electrical connection size	:	½” NPT (F)
Accessories	:	i. Double compression type Nickel Plated Cable glands
		ii. Suitable Mating Flange, necessary gaskets,
		iii. Local display unit and Suitable mounting brackets, necessary mounting hardware for Local display unit.
		iv. Complete software as required to have 3 D view on monitors.

3.03.17 LEVEL SWITCHES (LS)

Type/Construction	:	a) External float cage type with magnetic switch actuator for tanks and vessels. b) Electrode/Capacitance (for oil tanks) c) Displacer -Top mounted for all clean water sumps. d) Conductivity type for high Pressure and high temperature enclosed vessel like drain pot, HP heaters etc.
Materials		
- Body	:	Cast Carbon Steel/Die cast Aluminum suitable for specified pressure and temperature ratings
	:	For corrosive liquids suitable anti-corrosive coat/lining shall be provided.
- Float/Displacer	:	316 SS
- Wire rope	:	316 SS
Differential	:	± 12 mm minimum (Adjustable)
Contacts		
- Number	:	DPDT/2 SPDT
- Type	:	Snap action micro switch Auto reset with internal Adjustable
- Rating	:	5 Amp 240V AC 0.2 Amp 220V DC
Connection - Process	:	One (1) inch SCRD NPT Female Or One (1) inch ANSI Flanged Four(4) inch ANSI Flange for sump services.
Electrical	:	Suitable for Plug in type connection

Temperature/pressure rating	:	As per service conditions
Accessories	:	Counter flanges, still pipe of requisite length with anticorrosive coating for sump services.

Nuclear, capacitance, or ultrasonic type level switch for bulk material applications shall be provided.

3.03.17.01 Conductivity Type Level Switch

Type	:	Conductivity discrimination.
Mounting	:	Flanged – on standpipe.
Probe MOC	:	Stainless steel with high purity ceramic.
Probe rating	:	> Maximum design pressure of vessel.
Input	:	Four independent channel with selectable switching threshold for water conductivity.
Relay Output	:	Four isolated output relays for Hi, Lo, Hi-Hi, Lo-Lo.
Contact type & rating	:	2SPDT or 1 DPDT @ 5A 30V DC.
Faults Detection	:	Power Fail/Electrode Connection Open circuit/short circuit to ground, Ground failure. In built Fail Safe Logic.
Indicator	:	One Red LED for steam/ one Green LED for water/ Two no. LED one each for Process & system fault.
Power supply	:	Dual 240V AC, 50 Hz, 1Ph. From UPS
Enclosure	:	IP–65, corrosion resistant & wall mounting type.
Accessories	:	i. PTFE cable from probe to electronics unit. **Electronic unit shall be separate.** Head mounted electronic unit is not preferred. ii. Mounting accessories iii. standpipe iv. Washer & gasket
Test pressure	:	Two times rated pressure

3.03.17.02 Capacitance Type Level Switch

Type	:	Capacitance type
Probe	:	a) Rod or suspended electrode b) Rope type probes may be used only where required probe length is greater than 3 meters.
Probe Mounting	:	Stainless steel 1-1/2 ANSI RF Flange / ¾“ NPT (M)
Material of construction	:	316 SS
Insulation	:	PTFE Part/Full as per service.

Enclosure	:	Powder/Epoxy coated Die cast Aluminium. with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
Ambient temperature	:	0-60 ºC.
Mounting	:	On Top
Supply voltage	:	240V AC, 50Hz from UPS/ 24V DC
Relay output	:	2SPDT
Contact rating	:	5A min. at 240V AC on resistive load
Response time	:	100 m sec or better
Cable connection	:	¾" ET
Accessories	:	Counter flange, Cable gland, prefab cable and stainless steel name plate engraved with alpha-numeric.

3.03.17.03 RF TYPE LEVEL SWITCH

A. Electronic Controller

1.	Input Supply	:	240 V AC from UPS
2.	Construction	:	Cast Aluminum Housing
3.	Relay Output	:	2 Nos. Relay Changeover Potential Free Contacts(2SPDT)
4.	Contact Rating:	:	5A at 240 V AC & 0.25 at 220 V DC
5.	Class of Protection	:	IP-66
6.	Ambient Temperature	:	55 Deg. C(Max)
7.	Local Indication	:	Local LED Indications
	Green	:	Normal Level
	Red	:	Alarm Level
	Yellow	:	Probe Healthy
8.	Cable Connection	:	3/4" ET(2 Nos.) for Supply and Output 5/8" ET(1 No.) for Probe Connection
9.	Repeatability	:	100%

B. Sensing Probe

1.	Type of Probe	:	Rigid
2.	Material	:	Stainless steel SS 316
3.	Probe Head Housing	:	Cast Aluminum
4.	Insulation (B/W Active & Shield And Shield & Ground)	:	PTFE
5.	Probe Head Protection	:	IP-66
6.	Mounting	:	Side Mounted
7.	Cable Connection	:	5/8" ET(1No.)
8.	Process Connection	:	40 NB BSP THREADED
C.	Signal Cable	:	Coaxial cable for Connection Between Sensing probe and electronic Controller(@ 10 Mtrs. Per Level Probe)

D. Application : Ash Silos

3.03.18 **LEVEL INDICATORS (Gauge Glass) (LI)**

Type/Construction	:	**a)**	**Reflex**
		b)	Tubular (For tanks open to atmosphere only)
Material:			
a) Glass	:	Tempered borosilicate resistant to thermal shock	
b) Case	:	Carbon steel	
c) Integral cocks and	:	i)	Forged carbon steel with drain valves stainless steel internals
		ii)	Rubber lined corrosion resistant 316 stainless steel (for Demineralised and Osmosis water service)
d) Fittings	:	i)	Forged carbon steel
		ii)	Rubber lined 316 steel/PVC for corrosive liquids Demineralised and Osmosis water service)
		iii)	304 Stainless Steel for non-corrosive liquids
e) Packing	:	Teflon	
Dial size/scale	:	150 mm /1.5 Meters maximum length with	
Scale details	:	Aluminum/SS316 scale Graduated in mmwc	
Connection	:	25 Nb/40 Nb ANSI Flanged	
Accessories	:	a)	Integral cocks
		b)	Drain valves
		c)	Bolts, nuts and gaskets
		d)	Illuminating lamps as required
		e)	Periscope as required
Tests	:	Tested at two hundred (200) percent of the maximum process pressure	
Other details	:	For larger lengths, additional gauge glasses shall be provided with minimum of 50 mm overlap.	

3.03.19 FLOAT & BOARD TYPE LEVEL GAUGE

Type of Instrument	:	Mechanical Type (Float Operated)
Service/ Application	:	As per service requirement
Measuring Range	:	as per requirement
Material Specification		
a) Float Material	:	SS316 having 2 nos. Guide wires
b) Float Wire Pulley	:	Shall comprise of 2 nos. Cast Aluminum Pulley hosing Assembly with SS 304 pulley and pulley shaft. Steel ball bearings shall be provided in pulley housing for easier float movement. Float wire material shall be

SS316L. Between 2 pulleys, 1" NB G.I. short pipe with tentative length as per P&ID

c) Guide wire Assembly	:	CS chamber with spring and adjuster having 1" Class 150 ANSI RF MS flange. Guide wire rope shall be SS316L.
d) Counter Weight	:	MS counter – weight with Aluminum Pointer and Brass assembly Pull Chain.
e) Scale	:	SS 316/Aluminum material in mm with 1 % accuracy.
Nozzle Details	:	For float wire pulley assembly, one tapping and for guide wire assembly two tapping at the top of the tank; Size 1" NB (Top Mounting Type)
Process Connection	:	Flanged as per ANSI B 16.5 to suit 1" NB nozzle (Nozzle length - 150 mm for float wire, 100 mm for guide wire)

Accessories (to be supplied with the instrument)

a) Counter flange	:	All mating Flanges, Nozzle
b) Mounting Accessories	:	All mounting accessories
c) Tag Plate	:	To be provided (material SS316)

3.03.20 MASS FLOW METER

Sensor

Measuring Principle	:	Coriolis Mass flow.
Primary Element	:	Flow Tube of 316SS or better
Heating Arrangement	:	Integral with Flow meter.
Temperature Control For Heating	:	To be provided.
Process Connection	:	ANSI RF Flanged and rating as per process requirement.
Drain	:	Self-draining facility
Accessories	:	Counter flanges, Mounting nuts, bolts, gaskets etc.

Transmitter

Measured quantities	:	Mass Flow rate, Total Mass Flow, Density, Temperature as minimum.
Input Signal Processing	:	Digital Processing.
Display	:	Digital Display (LCD).
Output	:	2 Nos. isolated output of 4-20mA DC selectable from four measured quantities.
Load	:	< 750 ohms.
Power supply	:	240V AC, 50 Hz. From UPS
Accuracy	:	0.15% of measured value for Liquid 0.5% of measured value for Gas
Repeatability	:	0.05%
Housing	:	IP 65 (Explosion proof for NEC Class-1, Division 1 area)
Hazardous duty Version	:	FM Standards.

	Nameplate	:	Tag number, service engraved in stainless steel tag plate
	Accessories	:	a) As required for field mounting, Handheld configurator & complete Software, External zero adjustment facility b) Mounting U-bolts, nuts, bolts, prefab cable etc.
	Application	:	HFO main line, LDO lines, HFO recirculation lines etc.

3.03.21 Turbine Flow meter

Sensor

Type	:	Turbine (in line full-bore, based on magnetic pick of pulses)
Output Signal	:	Pulse
Material of Construction	:	a) Body : AISI 316 b) Rotor: AISI 431 or 410 c) Bearings: Tungsten Carbide / Stellited Sleeve
Flow rate range	:	As required.
Linearity	:	0.25% or better.
Repeatability	:	0.02% or better.
Ambient temperature	:	50 deg C
Mounting	:	On-Line mounting with ANSI RF flanges of stainless steel.
Enclosure	:	IP 65

Transmitter

Electronics	:	Solid State
Power Supply	:	240V AC, 50Hz. UPS
Input	:	Input from Sensor
Display	:	4 1/2 digit LCD
Output	:	Isolated 4-20mA DC HART
Measuring Accuracy	:	0.5% of full scale range
Totalized Value	:	Required
Housing	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
Nameplate	:	Tag number, service engraved in stainless steel tag plate
Accessories	:	a) clamping strip, bracket, prefab cable etc. and Calibration or configurator kit.

3.03.22 VORTEX FLOW METER

Sensor

Type	:	Vortex

Output Signal	:	Pulse
Material of Construction	:	AISI 316
Sensor Seal	:	PTFE / higher based on temperature
Flow range	:	As required.
Linearity	:	0.25% or better.
Repeatability	:	0.02% or better.
Ambient temperature	:	50 deg C
Mounting	:	On-Line mounting with flanges of stainless steel.
Enclosure	:	IP 65
Accessories	:	Nuts, bolts, gaskets etc.

Transmitter

Electronics	:	Solid State
Power Supply	:	240V AC, 50Hz. UPS
Input	:	Input from Sensor
Display	:	4 1/2 digit LCD
Output	:	Isolated 4-20mA DC HART
Measuring Accuracy	:	0.5% of full scale range
Totalized Value	:	Required
Housing	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
Nameplate	:	Tag number, service engraved in stainless steel tag plate
Accessories	:	Clamping strip, bracket, prefab cable etc. Special tool kit for calibration/ configuration .

3.03.23 Flow Transmitter (Ultrasonic)

Type	:	ULTRA SONIC, 2-wired
Sensing element	:	Non-contact
Output	:	4-20mA with HART Protocol
Accuracy	:	± 0.1% FS
Supply	:	24 V DC
Enclosure class	:	IP-65

Transmitter

Mounting	:	On Nozzle
Mounting position	:	Top mounted
Housing	:	Plastic
Display	:	Head mounted LCD Display and remote LCD display
Process connection	:	NPT/Flanged
Electrical connection	:	NPT
Turn Down ratio	:	1:100
Measuring range	:	Adjustable (as per process requirement)
Totaliser	:	Required
Accessories	:	As per process requirement Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications which will be decided during

detailed engineering.

3.03.24 Positive Displacement Flow Transmitter

Positive displacement flow transmitters shall be offered. An electronic totalizer shall be provided for each flowmeter and the location of the totalizers shall be acceptable to the Owner. Air eliminators shall also be provided to ensure maximum accuracy.

Type	:	Hall Effect Sensor
Body Material	:	AISI 316L/Die Cast Aluminium.
Wetted part Material (Like Piston, Bearing, gear etc)	:	AISI 316L/Die Cast Aluminium.
O ring material	:	PTFE / higher based on temperature
Flow range	:	As required.
Accuracy	:	± 0.5% or better of reading
Repeatability	:	± 0.03% or better.
Ambient temperature	:	50 deg C
Mounting	:	On-Line mounting with flanges of stainless steel.
Electronics	:	Solid State
Power Supply	:	230V AC, 50Hz. UPS
Display	:	4 1/2 digit LCD for Flow rate & totalized value.
Output	:	Isolated 4-20mA DC
Turn Down ratio	:	1:30
Totalized Value	:	Required
Housing	:	IP-65/ (Explosion proof for NEC Class-1, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
Nameplate	:	Tag number, service engraved in stainless steel tag plate
Accessories	:	a) Clamping strip, bracket, prefab cable, battery etc.

Nuts, bolts, gaskets, mesh etc.

b) Special tool kit for calibration/configuration.

3.03.25 Electromagnetic Flow meter

Electromagnetic flow meters shall have separate transmitter having accuracy ±0.2% with zero stability feature, suitable for process medium with <= 5 micron Siemens conductivity, flanges material SS-316, electrode & measuring tube material SS-316, liner material Teflon and enclosure IP-66, local digital display configurable as totaliser, 4-20 mA output signal HART compatible with zero and span field adjustable. Application – DM Water and for other application as decided by owner.

3.03.26 FLOW GAUGES (FG)

Type/Construction	:	a) On-line type Rotameter for 50 Nb and below lines b) Bypass type Rotameter for above 50 Nb lines.

Material

- For On-line type

Metering Tube	:	Borosilicate glass
Float	:	316 SS
Packing	:	Teflon
End fittings	:	304 SS

-For Bypass type

Metering Tube	:	Borosilicate glass
Float	:	316 SS
Packing	:	Teflon
End Fittings	:	304 SS
Orifice Plate	:	316 SS
Carrier ring	:	304 SS
Flanges & Mating flanges	:	Same as pipe material, 200 lbs ANSI - RF
Impulse pipe	:	Same as pipe material
Fittings	:	2000 ANSI, SW ends to match with pipe material.
Dial Size/Scale length	:	250 mm
Scale Details	:	Direct reading type engraved on detachable Aluminum scale
Accuracy	:	± Two (2) percent
Reproducibility	:	Half (1/2) percent
Rangeability	:	1:10
Connection	:	SCRD NPT

Accessories	:	a)	Isolating valves (for Bypass type only)
		b)	Bolts, Nuts and Gaskets as required
Tests	:	Shall be tested at two hundred (200) percent of the maximum process pressure	

3.03.27 SIGHT FLOW GLASS INDICATORS

Type/Construction	:	Flapper type.
Materials	:	
Body	:	Carbon steel/SS316 as per process requirement
Glass	:	Toughened Borosilicate
Gaskets	:	Neoprene
Bolts & nuts	:	SS
Flappers / Rotating Wheel	:	316 SS
Flappers / Rotating Wheel holder	:	304 SS
Process Connection	:	SW (Socket Welded)
Accessories	:	Scale, Bolts, Nuts, Cover plates and Gaskets as required
Tests	:	Tested at two hundred (200) percent of the maximum process pressure.

3.03.28 **SOLID FLOWMETER**

Type	:	Online Impact type Microprocessor Based
Measuring Principle	:	The system measurement is basically pertains to the measurement of horizontal deflection using LVDT, created by the impact of solid flow upon online sensing plate. The horizontal deflection being proportional to the impact forces, LVDT convert this horizontal movement into electrical signal. The inbuilt integrator convert this signal into time based flow rate indication & provide totalized flow also.
Sensing plate	:	316 SS
Sensing head	:	Sensing mechanism shall be mounted outside the process flow line.
Enclosure	:	316 SS
Enclosure protection	:	IP 67 class
Accuracy	:	+/-1%
Repeatability	:	+/- 0.2%
Drift	:	Both zero & span $\pm$ 2% / month
Output	:	4-20mA DC isolated, load 600 ohm (min)
Digital communication	:	yes, (HART) facility
Power supply	:	240 V AC, 50Hz. UPS
Ambient condition	:	Temperature -60^0 C, RH-95% Environment – Highly Dusty

Accessories	:	Shall be complete with all the accessories including digital display for flow rate, integral vents, baffles for air separation, etc. which ever required for satisfactory operation.

Note:-

1. The above on line flow meter shall not create any obstruction on flow.

2. User's list shall be submitted to support on proven satisfactory performance for similar process application.

3.03.29 **Instrument Air System**

The instrument Air Supply System for various pneumatic Control & Instrumentation devices like pneumatic actuators, power cylinders, I/P converters, pneumatically operated valves etc. shall be complete in all respect with necessary Air Filter Regulators, valves, piping/tubing etc.. Each pneumatic instrument shall have an individual air shut off valve. The pressure-regulating valve shall be equipped with an internal filter, a 50 mm pressure gauge and a built in filter-housing blow down valve.

Filter shall be of minimum 5-micron size & sintered bronze material.

On collection of water in the drains of instrument air lines, mechanical automatic drains and periodically solenoid operated drains (with electronic timer - 15m, 30m, 60m and 2 Hours & Timing adjustable) are to be provided.

For mechanical type & Electrical type, the locations to be provided in the instrument air lines of boiler area, Chimney area, turbine area etc., shall be decided during detailed Engineering.

Bulk header nearby the crowded applications shall be provided and from this bulk header individual air lines with necessary isolation values are laid to the application.

These bulk header are to be provided with **mechanical / electronic based automatic Drains.**

Individual moisture separator for O_2 analyzer or vital application shall be provided nearby the instrument so as to enhance the cell life or the performance of vital final control elements.

3.03.30 **Air Filter Regulator (AFR)**

Constant bleed type AFR with an accuracy of $\pm$ 1.0 % inlet pressure range of 5-8 kg/ cm2 and suitable spring ranges (AFR) for use with positioners in control valves, control damper, E/P convertors and shut off valves for phosphor bronze filter element; Filtering particles above five microns. Weather and water proof enclosure. Material of accessories will be SS316.

Air filter regulators shall be provided in the :

(a) Air supply line to valve positioners / power cylinders
(b) Air supply line to electric to pneumatic converters.

(c) Air supply line to pneumatic interlocked block valves.
(d) For each instrument rack, field instruments enclosure for purging.

3.03.31 Electro-Pneumatic Convertors (E/P)

Two wire type E/P convertors with an accuracy of ±0.25% accepting 4-20 mA dc signals from control system and converting to 0.2 to 1 kg/cm2 air pressure to operate valve positioner of all final control elements; Housed in cast aluminum casing (with polyurethane paint); NEMA 4 or equivalent degree of protection for enclosure. Material of accessories will be SS. E/P convertors shall have fail freeze (stay put) feature also. Process connection shall be 1/4" NPT (F) and Electrical connection shall be ½" NPT (F). Zero/span adjustment facility shall be provided. The E to P converters shall **retain the pneumatic signal (last value) even in failure of control signal** and shall have **self volume boosters.** Necessary air lock devices and pressure switches for air pressure low alarming shall be provided.

3.03.32 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 Die Cast Aluminum or SS316.

.
(f) All solenoid shall be with varister, LED indication, surge suppress diode and circuits.

3.03.33 Power Cylinders (Pneumatic)

Mounting Type	:	a) Fixed position mounting (End mounting).
	:	b) Trunnion mounting
Control Signal	:	0.2 to 1 Kg/Sq. cm. from I/P converter for modulating purposes. 24V/48VDC operated solenoid valve operating on pneumatic line.

		The Pilot solenoid will have separate coils for open closing purpose.
Supply Air	:	0-7 Kg / Cm2.
Selection	:	Based upon thrust / torque, stroke length, angular movement, full-scale travel time, repeatability, space factor etc. Provision for air-to-open and air-to-close operation.
Casing	:	IP-65.
Accessories (as required)	:	a) Air lock relay b) Hand wheel. c) Air filter regulator with gauge. d) Volume Booster. e) Limit Switches. f) Positioner with Input, Output and supply pressure gauges. g) Pilot Solenoid Valve (Double Coil type) h) Position Transmitter (4-20 mA DC linear output, LVDT or non contact type).
Fail-safe operation	:	Stay put, open or close position on pneumatic / electrical power supply failure as per process safety criteria.
Repeatability	:	Better than 0.5% of full travel.
Hysterisis	:	Less than 1% of full travel.

3.03.34 Nucleonic Type Density Meter (For Ash Handling Plant):-

Type	:	Nuclear type radiation
Application	:	Abrasive Slurries & Corrosive Chemicals
Accuracy	:	< 1% of Span
Orientation	:	As per requirement.
System Type	:	Radiation Source & Scintillation Detector
Meter Material	:	SS 316L/ Aluminium with PVC coating
Connection material	:	SS 316L
Compensation	:	Temp. Compensation required
Type (Transmitter)	:	SMART, 2 Wire HART based
Operating Principle	:	As the density increase, the lower the radiation field at detector and vice versa.
Output	:	With photomultiplier, 4-20 mA, DC
Electrical Connection	:	½" NPT
Enclosure Class	:	IP 66
Local Display	:	Provided
Accessories	:	Radiation Survey Meter and all erection/installation hardware

3.03.35 Non - Nucleonic (Vibration) Type Density Meter (For DM & AHP Plant):-

Application	:	Liquid Density measurement
Detector		

- Failure Diagnostics
- Long Term Stability
- Fast Response
- IP 66 / NEMA4X Protection
- Supplied with Calibration Certificate Traceable to National & International Humidity Standards
- Sensor protection with sintered filter
- Local LCD Display for Dew Point

3.03.42 **Junction Boxes**

v.	Type	:	Flame proof/weather proof
vi.	Enclosure	:	IP-65/Explosion/Flame Proof as per area classification.
vii.	Material	:	FRP with protective Coating
viii.	Cable entry	:	Bottom or Side
ix.	Cable glands	:	Double compression type – Nickel plated brass with PVC hoods.
x.	Mounting	:	Indoor/Outdoor
xi.	No. of terminals	:	As required with standardization with 20% spare of each size & type.
xii.	Terminals	:	Phoenix/Wago (screw less cage clamp type spring loaded)
xiii.	Grounding	:	Two terminals for body and shield ground
xiv.	Door	:	Hinged, lockable type.

xi. Suitable mounting clamps and other accessories shall be in scope of bidder.

xii 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.

Xiii M6 Ni plated Brass earthing stud shall be provided (external 2 nos. internal 1 no.)

xiv Gasket (Normal)- Neoprene thickness 6.0 mm

3.03.43 **Interposing Relays (IPR)**

Electro magnetic 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. Free wheeling 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 –20 deg. C to 60 deg. C. 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.

3.03.44 RECORDERS (CHARTLESS)

Type	:	Micro-processor based, Digital TFT display type
- No. of Channels	:	Forty Eight (48) point).

6 Nos. of recorders shall be supplied with BTG packages and the parameters shall be decided during detailed Engineering. Quantities of recorders for BOP packages shall be decided during detailed Engineering.
(Simultaneous parameter display preferred)

Input Signal	:	Fully configurable multi range (Programmable) universal (input)
Recording method	:	Continuous with different colour, for each channel
Display colour	:	Selectable from 30 Colours
Bar graph facility	:	To be provided
Digital indication	:	To be provided
Accuracy	:	+/- 0.1 % for reading for DC V Input And 0.1 Deg for TC/RTD input
Programmability	:	Front key board
Data Storage	:	hard disk/ Flash Memory
Data Retrieval	:	Compact 4 GB flash Memory card and USB port with 8 GB USB drive.
Scan rate	:	≤ 20 m **second** for individual channel. **Selection of scan time for individual channel is required.**
Power Supply	:	240 VAC 1 Phase UPS
Ambient Temperature	:	0-50 Degrees
Mounting	:	Front panel mounted weather & Dust proof IP 65
Application software	:	Yes, To be provided
Internal Memory	:	400 MB or more
Screen	:	≥ 10.5" colour LCD TFT
Resolution	:	≥ 640 X 480 Pixels
Type of Display	:	i) Trends ii) Bar Graph iii)Digital display/ values
Event Sampling	:	1/2/5/10/30/60/120 sec.
Zoom & Scroll Facility	:	Required
OWS and printer connectivity port	:	Required
	:	Necessary software shall be supplied for uploading the data.
Communication	:	Additional MODBUS/PROFIBUS ports connectivity between recorder and third party systems.

3.03.45 DIGITAL INDICATOR

Type	:	**Programmable electronic digital indicator** with floating point decimal.
Input	:	4-20 mA DC/1-5V DC/RTD/T/C.
Number of inputs	:	One
Range	:	As per requirement/adjustable by end user

through key pad available on the indicator.

Number of digits	:	Four plus sign
Digit height	:	20 mm or larger
Display	:	Fluorescent red
Input over range/open sensor (T/C)	:	All digits to flash
Input hold time	:	0.7 seconds max.
Accuracy	:	±0.25% of span
Power supply	:	240V AC, 50Hz
Mounting	:	Flush panel, compatible for mounting on mosaic grid panel
Size	:	96x48 mm
Other Particular	:	Indicator receiving thermocouple signal shall have automatic cold junction compensation.
	:	Retransmission Output 4-20 mA isolated required.
	:	24 V DC inbuilt power supply
	:	Alarm contact with 2 NO/NC contact (rating 5A/230 V AC)

3.03.46 RECEIVER INDICATORS (SINGLE/DUAL CHANNEL)

Type	:	Analogue indicator
Input Signal	:	Universal input (T/C, RTD, 4-20 mA, Voltage)
Scale	:	Range fully configurable and programmable
Measurement Accuracy	:	± 0.2% of span ± 1 count
Resolution	:	0.5% Span
Dead band	:	± 0.2% of span
Repeatability	:	0.2% of span
Full scale response time	:	Less than two(2)seconds
Power Supply	:	240V AC, 50 Hz
Connection	:	Plug in type
Accessories	:	Mounting Bracket for Bins
Other Particulars	:	Indicator receiving thermocouple Signal shall have automatic cold junction compensation.
	:	Retransmission Output 4-20 mA isolated required.

3.03.47 Temperature Scanner

Type	:	Microprocessor based Electronic Digital Scanner.
No. of channels	:	16/24 (as per the application)
Input	:	RTD /Thermocouple/4-20mA
Accuracy	:	± 0.1 of FS ± 1 count
Number of digits	:	4 digit (7 segment display with Engg. Units)
Digit height	:	12 mm or larger
Display color	:	Fluorescent red/green
Display mode for		

Input over range/open sensor	:	All digits to flash
Mounting	:	Panel mounting
Zero and Span	:	Adjustable by digital calibration
Serial communication communication	:	Isolated RS232/485 for modbus-RTU
Memory Capacity	:	5MB Flash
Alarm output	:	Required
Contact rating	:	2A at 220 V AC
Power supply	:	240 V AC/24 V DC
Properties	:	i. Any channel shall be configured for Data Logging ii. Channel to Channel online Isolation shall be provided iii. Real Time RTC Interface for Printer shall be provided
Operation Modes	:	Auto/manual mode, Run mode, Verify mode, Calibration Mode, Program mode.

3.03.48 AMMETERS (AMM)

Input	:	4-20 mA DC
Mounting	:	Flush panel, compatible for mounting on mosaic grid panel
Face Dimensions	:	96 x 96 mm
Scale/Type	:	Moving coil, circular, FSD 240 deg. With six times suppression scale
Zero adjustment	:	Screw on meter face
Accuracy	:	± 1 percent (class 1)
Indication	:	Pointer with scale
Magnetic Shield	:	Shielded Case
Quantities	:	For all HT Motors & LT motor with rating ≥ 30 KW and other critical application motors/drives.

3.03.49 VOLTMETER:

Input	:	4 - 20 mA DC
Mounting	:	Flush Panel, compatible for mounting on mosaic grid panel
Face Dimension	:	96x96 mm
Range	:	As per requirement
Accuracy	:	± < 0.5 %
Indication	:	Digital type 4 1/2 digit
Magnetic Shield	:	Shielded Case
Connection	:	Plug in type
Quantities	:	For 230 V AC input power supply, UPS power supply, 24 V DC interrogation voltage & 220 V DC.

3.03.50 FREQUENCY METER/MW METER (DIGITAL)

Type	:	Electronic digital 7- segment with fluorescent display
Input	:	4 - 20 mA DC
Mounting	:	Flush Panel compatible for mounting On mosaic grid panel
Number of digits	:	41/2 digit
Face Dimension	:	192X192 mm
Digit size	:	Approximately 40 mm
Range	:	As per requirements
Accuracy	:	± 0.2 Hz
Display	:	Red LED display.
Connection	:	Plug in type
Magnetic Shield	:	Shielded Case

3.03.51 AC CURRENT TRANSDUCERS

Input	:	0 - 1 A CT current
Output	:	Dual 4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	± 0.25%

3.03.52 DC CURRENT TRANSDUCERS

Input	:	0 - 75 mV
Output	:	Dual 4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	± 0.25%

3.03.53 AC VOLTAGE TRANSDUCERS

Input	:	0 - 110 V PT, Volts
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	+ 0.25%

3.03.54 DC VOLT TRANSDUCERS

Input	:	System Voltage
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	± 0.25%

3.03.55 TRANSDUCERS FOR POWER

Input	:	CT and PT (1A) (110V)
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	± 0.25%

3.03.56 TRANSDUCERS FOR FREQUENCY

Input	:	110 V PT Volts
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	± 0.25%

3.03.57 TRANSDUCERS FOR POWER FACTOR

Input	:	PT (110V)
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	± 0.25%

3.03.58 TRANSDUCERS FOR MVAR

Input	:	CT & PT (110V/1A)
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	± 0.25%

3.03.59 DIFFERENTIAL FREQUENCY TRANSDUCERS (FOR SYNCHRONIZATION)

Input	:	110 V PT
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	± 0.25%

3.03.60 DIFFERENTIAL VOLT TRANSDUCERS (FOR SYNCHRONIZATION)

Input	:	System voltage
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	± 0.25%

3.03.61 PUSH BUTTONS (PB)/ ILPBs FOR ON/OFF, OPEN/CLOSE, START/STOP

Type	:	Momentary/Miniaturised Suitable for mosaic grid 24x48 Mm with 2 PB and 3 coloured LED.
Contact Configuration	:	2 NO + 2 NC
Contact Material	:	Hard Silver Alloy
Contact Rating	:	500V / 10 A
Insulation Voltage terminals and earth	:	2 KV for 1 minute between
Lamp Rating :-		
a) Voltage	:	240 V AC
b) Watt	:	2 Watt (approx.)
Colour		

CHECK LIST FOR PRESSURE SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	1.1 MODEL NO/TAG NO						
	1.2 RANGE						
	1.3 END CONN						
	1.4 NO. OF CONTACT						
2	CALIBRATION			P	V	V	
	2.1 REPEATABILITY						
	2.2 SET POINT ADJUSTMENT						
	2.3 DIFFERENTIAL						
3	OVER PR & LEAK TEST			P	V	V	
4	ELECT. INSULATION/HV TEST	ONE		P	V	V	
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT		V	V	V	
	5.1 SENSOR						
	5.2 MOVEMENT						
	5.3 PROCESS CONNECTION						
	5.4 HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	REVIEW OF TC OF MICROSWITCH	FOR LOT		V	V	V	

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to carry out ROUTINE TEST on 100 %.
3. Contractor to provide compliance certificate for tests/checks verifid by contractor and the same alongwith test certificates to be verified by BHEL

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STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TRANSMITTER

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECKS FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	VISUAL.						
	MODEL/TAG No						
2	PROCESS CONNECTION			P	W	V	
3	ACCURACY			P	W	V	
4	REPEATABILITY			P	W	V	
5	HYSTERESIS			P	W	V	
6	EFFECT OF TEMP VARIATION ON ACCURACY			P	W	V	
7	SPAN / ZERO ADJUSTMENT	ONE / TYPE		P	W	V	
8	EFFECT OF SUPPLY VOLTAGE VARIATION			P	W	V	
9	EFFECT OF LOADING (500 OHM METERS)			P	W	V	
10	HIGH PRESSURE TEST	SEE NOTE-1 BELOW		P	W	V	
11	BURN-IN TEST	ONE / TYPE		P	W	V	
12	DEGREE OF PROTECTION			P	W	V	
13	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

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.

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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.

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STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR LEVEL 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 / DRWGS	P	W	V	
	TYPE						
	MODEL/ TAG NO.						
	DAIL SIZE						
	RANGE/SCALE						
	END CONNECTION						
2	DIMENSIONS, PROCESS CONNECTION			P	W	V	
3	ACCURACY			P	W	V	
4	MATERIAL TC FOR	ONE / LOT		P	V	V	
	BODY ISO.						
	VALVE						
	GAUGE GLASS						
5	HYD. TEST	SEE NOTE-1 BELOW		P	W	V	
6	ACCESSORIES AS APPLICABLE			P	W	V	

Legend :

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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. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

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STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR ANNUNCIATORS

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE/ MODEL						
	DIMENSIONS OF HARDWARE						
	MODULARITY						
	SEQUENCE						
	FACIA DETAILS						
2	FUNCTIONAL TEST	100%		P	W	V	
3	IMMUNE TO STEP VARIATIONS IN THE POWER SUPPLY	SEE NOTE-1 BELOW		P	W	V	
4	DEGREE OF PROTECTION FOR ENCLOSURE	TYPE TEST		P	W	V	
5	I/R CHECK	SEE NOTE-1 BELOW		P	W	V	
6	RESPONSE			P	W	V	

Legend :

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

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SPECIFICATION

FOR

CONTROL PANELS

1.0 SCOPE

This specification covers the Design, Manufacture, Inspection and Testing at the manufacturer's works, proper packing for transportation and delivery to site, supervision, erection, and commissioning at site of Local Panels required for control and monitoring of the Auxiliary Plant & Equipment.

2.0 CODES AND STANDARDS

2.1 All the equipments specified herein shall comply with the requirements of the latest issue of the relevant National and International standards.

2.2 As a minimum requirement, the following standards shall be complied with:

a) IS-6005 : 1998 : Code of practice for phosphating of iron and steel.
b) IS-5 : 2007 : Colors for ready mixed paints and enamels.
c) IS-1248:2 003 : Direct Acting Indicating Analog Elec Measuring Instruments.
d) IS/IEC 60947:Part 1:2004 : Low Voltage switchgear & control gear: Part-I (General Rules)
e) IS-8828:1996 : Circuit breaker for household and similar installations.
f) IS-13947 (Part-I):1993 : Low Voltage switchgear & control gear : Part-I (General Rules)
g) ISA-18.1:1979 : Annunciator Sequences and Specification
h) NFPA-496:2003 : Purged & Pressurised Enclosure fo r Elect rical Equipment in Hazardous Locations.

3.0 TECHNICAL REQUIREMENTS

3.1 Panel Construction

3.1.1 The local panels shall house the secondary instruments, annunciation system, Single lo op controller, Control switches / push buttons, indicating lamps/LED cluster, relays, timers and other devices required for operation and monitoring of the equipment locally.

3.1.2 The panels shall be of free standing type either welded construction on angle iron (minimum section of 50 x 50 x 4 mm) structure o r folde d con struction by she et m etal formatio n dep ending upon th e equipments to be mounted on it. The panels shall be robustly built and stiffeners as necessary shall be provided.

3.1.3 The panel shall be suitably reinforced to ensure adequate support for all instruments mounted thereon. All welds on exposed panel surfaces shall be ground smooth.

3.1.4 The salient features of construction shall be:

Sheet material: Cold rolled sheet steel
Frame thickness: Not less than 3.0mm
Enclosure thickness: Not less than 2.5 mm for load bearing sections (Mounted with instruments)
1.6 mm for doors and Not less than 2.0 mm for others
Gland plate thickness: 3.0mm
Base channel: ISMC 100 with anti-vibration mounting & foundation bolts.

3.1.5 The panel shall be provide d with doo rs with integral lockable handle. The door when lo cked shall b e held at minimum three p laces. The d oor wi dth sh all not be more than 55 0mm.The doo rs shall be provided with suitable stiffeners to prevent buckling. The handle shall be on the right side of the door. The door shall be remov able type with conceal ed hinges to facilit ate maintenance work. Suitable pocket inside the door shall be provided for keeping the drawings / documents.

3.1.6 Suitable neo prene ga sket shall be p rovided on a ll doors an d re movable covers. Suitable ventilatio n system along with louvers shall be provided at bottom and top of the doors covered with removable wire mesh.

3.1.7 The class of protection shall be in accordance with IP-55 unless otherwise specified in the data sheet – A (No. PES-145-54A-DS1-0).

3.1.8 All steel surf aces shall be cle aned b y sand / pellet blastin g, treated fo r pi ckling, de greasing an d phosphating etc. by seven tank method. The p anel shall have a high quality finish and appearance. The panel shall be painted with two coats of primer followed by two coats of epoxy / synthetic enamel based final paint of color shade and finish as given in data sheet-A (No. PES-145A-DS1-0). Minimum thickness of the paint shall be 85 microns for external paint and 70 microns for internal paint.

3.1.9 The cable glands of the required size and type as given in data sheet-A (No. PES-145A-DS1-0) shall be supplied alongwith the Panel.

3.1.10 All operable and indicating devices shall be mounted on the front of the panel while aux. Relays / timers MCBs etc. re quired for re alization of control l ogics shall be mo unted on a mounting plate inside the panel. Auxiliary relays and timers etc. shall be grouped according to the control function.
The devices shall be located in such a way so as to ensure easy access for operation / maintenance.

3.1.11 Single / dual control power supply feeders of voltage class as specified in data sheet-A (No. PES-145A-DS1-0) shall be provided by the purchaser. In case redundant power supply feeders are provided then auto ch angeover unit sh all be mounte d on the pan el are in the panel su pplier's scope. Whe re DC control po wer sup ply is specified an a dditional 24 0V, 50 Hz AC supply feed er for po wering of spa ce heater and lighting shall b e provided by the purcha ser. Suitable arrangement shall be provided in side the panel to receive an d termin ate the powe r supply feeder(s). For thi s pu rpose M CBs of suitabl e current rating shall b e provided by the vendor. A su pervisory relay along with a pilot lamp t o indicate control supply 'ON' shall b e provide d on the pan el. Any other po wer supply required for the operation of the devices mounted in the panel shall be arranged by the vendor.

3.1.12 The internal wiring shall b e carried out with 1100 volt grade PV C insulated copper multi strand wire / flexible of 1.5mm2 si ze. AC & DC wires shall be k ept separate from eac h other. Separate colou red wires to b e used for AC and DC circuits. All wire s shall b e p roperly nu mbered an d identi fied with ferrules as per the Control sche me / wiring dia gram. Wires shall be routed and run th rough PVC troughs.

3.1.13 Terminal blocks shall be clip on type, 1100 volts grade. Separate termin al blocks shall be used for AC & DC circuits. The terminals shall be suitable for terminating 0.5 mm2 to 2.5mm2 external cables. The TB points in terminal block shall be cage clamp type / screw type. The terminal for ammeters shall be provided with removable links for shorting CTs. Each terminal strip shall be provided with identification strip. The panel shall have ten (20) percent spare terminal.

3.1.14 The interior of each panel shall be suitably illuminated through fluorescent lamps / tube lights with shrouded cover of minimum 15W operable on 240V 50 Hz AC power supply through panel door switch. A 15 Amp. 3-pin Power receptacle shall be provided.

3.1.15 Suitable space heaters operable on 240 Volts 50 Hz AC power system sh all be provided at the pa nel bottom. These shall be designed to maintain the panel temperature five (5) deg. C above the ambient temperature during maintenance shutdown. Suitable isolating and control devices comprising of MCB, thermostat etc. shall be provided for the space heater.

3.1.16 The panel shall be provided with a copper earth bus of 50 x 6 mm size running throughout the width of the panel. It shall be terminated i nternally with 10 mm bolts at extreme ends for connection to; mai n station earth. The panel m ounted equipments / devices shall be connected to earth bus through green coloured PVC insulated stranded copper conductor of 2.5 mm2 size.

3.1.17 Local Panel shall be provided with main name plate of 150 mm x 40 mm size having inscription of 2 0 mm height. The individ ual devices on the pa nels sh all be a s provided with separate name plate with inscription of 3 mm height. The instrum ent / devices shall be provided with stick on label plates insi de the panel. T he mate rial of the main and individu al labels shall be three (3) pl y 3 mm thi ck Traffolyte Sheet / 2 mm Anodised Aluminium Plate. The inscriptio n shall be with white letters on bl ack background on traffolyte sheet. The labels shall be fixed by self tapping non-rusting screws.

3.1.18 Vendor shall furnish electric load and heat load list (in case panel is to be placed in ac environment) of each panel.

3.2 Hazardous Area Panel Requirement

3.2.1 The Local Panel located in hazardous area shall be pressurized as per NFPA-496 requirements to render it non-hazardous. Alarms shall be provided for local and remote annunciation when pressurisation falls below 2.5 mm of water column. Protection shall be of type Z of NFPA-496. It shall not be possible to switch ON the power of purged section unless it is purged as per the recommendation of NFPA-496. Vendor must provide a protective device on the panel to protect the panel from over pressurisation.

3.2.2 Vendor shall supply pressurisation kit consisting of valves, restriction orifices, dual filter regulation, pressure gauges, pressure switches, rotameter etc. Pressurisation kit shall be surface mounting on a metal board and located outside the local panel. Pressurisation kit shall further consist of solenoid valve flow switch, timer blow off safety device etc., so as to make purging fully automatic. However final start shall be manual. Panel protection against over pressure to be provided as per NFPA-496.

3.2.3 Pressurised local control panel pressurization kit assembly design shall provide minimum leakage flow through the Local Control Panel. Panel venting shall be as per NFPA-496.

3.2.4 All components in the local panel like indicating instruments, push buttons switches, lamps etc., which are required to be energized without panel pressurization or before completion of purge cycle shall be explosion proof as per NEMA-7 & suitable for area classification.

3.2.5 All push butt ons etc. requiring frequent operation during machine running shall have good positive sealing. Weatherproof housing or cover to be provided wherever necessary. Vendor shall provide pressurisation bypass switch outside explosion proof enclosure of pressurized panel with lamp indication. This shall be used only during maintenance. All hinges, screws, other non-painted metallic parts shall be of stainless steel material.

3.2.6 Provision to switch off manually all types of power shall be provided in the panel. In addition, it shall also be possible to switch off power circuits / components which are powered from motor control centre or control room manually in case of pressurization failure. All such cables from MCC and main control room shall be terminated in explosion proof boxes (NEMA-7).

3.3 Control & Monitoring devices

3.3.1 Instruments like Indicators, recorders, single loop controllers etc. as applicable and specified elsewhere for the plant / equipment shall be supplied and mounted on the panel.

3.3.2 Alarm Annunciator System

It shall be solid state discrete facia type having a sequence of ISA-S18.1A or as specified, opaque facia windows of 70 mm x 50 mm size, having two (2) lamps per window, and hooter of 10W, and provision for repeat group alarm at remote. The annunciator shall be provided with ten (10) percent spare windows or minimum two (2) windows along with electronics.

3.3.3 Relays

The relays shall be electromagnetic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable. There shall be ten (10) percent spare contacts.

3.3.4 Timers

The timers shall be electronic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However, minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable.

3.3.5 Control / Selector Switches

Switches shall be Rotary Cam type with minimum of 5 Amps AC & 2 Amp DC continuous current rating. Selector switches shall be stay put type while control switches shall be spring-return-to-neutral type.

Contact configuration and rating shall be as per the control function requirement. The switches shall be lockable type wherever specified. Each switch shall be provided with engraved plates indicating the switch position / functions.

3.3.6 Push Buttons / Indicating Lights

The push buttons shall be momentary action self-resetting type, however stop P.B. for unidirectional drives shall be provided with manual reset facility. Its contact configuration & rating shall be as required for the control function but minimum 2 NO + 2 NC of 5 Amp. AC rating. It shall have round coloured projecting tab and engraved escutcheon plate / inscription plate. Colour coding of push buttons shall be as under:

RED	Motor OFF / Valve CLOSE	YELLOW	Alarm acknowledge	Left Hand Side
GREEN	Motor ON / Valve OPEN	BLACK	Lamp test	Right Hand Side

Indicating lights shall be suitable for direct connections across specified power supplies. It shall be fitted with built in resistance to prevent circuit tripping on shorting of lamp filament. It shall be fitted with LED cluster type lamp replaceable from front.

GREEN	Motor OFF / Valve CLOSED condition	AMBER	Motor tripped	Left Hand Side
RED	Motor ON / Valve OPEN condition	WHITE	Normal / healthy	Right Hand Side

3.3.7 Ammeters

Ammeter shall be 96 x 96 mm size, 90 deg. deflection, 1.5% accuracy, 1 Amp. CT operated or with 4-20mA input and Flush mounting type as called for in the data sheet-A (No. PES-145-54A-DS1-0). Ammeters for motors shall have six (6) times folded scale at upper end to enable motor starting current indication

3.3.8 Miniature Circuit Breaker (MCB)

These shall be instantaneous magnetic trip type for short circuit in addition to current time inverse delayed thermal trip feature for over current protection. The housing of MCB shall be made of non-ignitable, high impact material. It shall have minimum short circuit rating of 9 KA for AC Voltages and 4 KA for DC Voltages.

3.3.9 Makes of various instruments / devices shall be as given below

1.	Alarm Annunciators	:	Procon / IIC
2.	Ammeters	:	AEP / IMP
3.	Control / Selector Switches	:	Alsthom / Kaycee / Siemens / L&T
4.	Push Buttons / Indicating Lamps	:	Siemens / L&T / Teknic / Alsthom
5.	Auxiliary Relays	:	Jyoti / Siemens / L&T / OEN
6.	Timers	:	L&T / Alsthom / Bhartiya Cutler Hammer
7.	MCBs	:	S&S Power Engg. / Indo Asian / MDS
8.	Terminal Blocks	:	Jyoti / Elmex

4.0 TESTING AND INSPECTION

4.1 The bidder shall adopt suitable quality assurance program to ensure that the equipments offered will meet the specification requirements in full.

4.2 BHEL's standard Quality Plan for LCP is enclosed with the specification. The bidder shall furnish his acceptance to BHEL's QP and submit the signed and stamped copy of QP along with the offer.

4.3 The vendor shall conduct the following tests as a minimum requirement:

4.3.1 Routine Tests

1. High Voltage (H.V.)
2. Insulation Resistance (I.R.)
3. Functional

4.3.2 Type Tests

1. Enclosure Class Test

5.0 SPARES AND CONSUMABLES

5.1 Commissioning Spares and consumables

The bidder shall supply all commissioning spares and consumables 'as required' during Start-up, as part of the main equipment supply.

5.2. Mandatory Spares

The bidder shall offer alongwith main offer, the Mandatory Spares as specified elsewhere in the specification. The Mandatory Spares offered shall be of the same make and type as the main equipment.

5.3. Recommended Spares

The bidder shall furnish a list of Recommended Spares indicating the normal service expectancy period and frequency of replacement; quantities recommended for 3 years operation alongwith unit rate against each item to enable BHEL/BHEL's Customer to place a separate order later, if required.

6.0 DRAWINGS AND DOCUMENTS

6.1 The bidder shall furnish the following documents in required number of copies along with the bid :

1. Data Sheet no. PES-145A-DS1-0
2. General Arrangement Drawing.
3. Catalogue and technical information for instruments and devices.
4. Quality Plan.

6.2 The vendor shall furnish the following documents in required number as agreed after the award of contract:

1. Data Shee No. PES-145A-DS2-0
2. GA Drawing indicating layout of instruments, construction details, foundation details, cable gland plate alongwith cable glands and all details mentioned in this specification.
3. Control Schematic Diagram along with grouping of different terminals for various functions.
4. Catalogue and technical information for instruments and devices with selected options clearly marked.
5. O&M Manuals.
6. "As Built" Drawing.
7. CDs.

7.0 MARKING AND PACKING

7.1 Panel with all instruments / devices mounted on it shall be suitably packed & protected for the entire period of despatch, storage and erection against impact, abrasion, corrossion, incidental damage due to vermin, sunlight, high temperature, rain moisture, humidity, dust, sea-water spray (where applicable) as well as rough handling and delays in Transit and storage in open.

8.0 APPLICABLE DATA SHEET FORMS

This document shall be read with one or more of the following data sheet forms :

- Data sheet A&B for Local Panels : Data sheet no. PES-145A-DS1-0
- Data sheet C for Local Panels : Data sheet no. PES-145A-DS2-0

BHEL	**DATA SHEET FOR LOCAL PANELS**	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. 00 / DATE:
		SHEET 1 OF 2

TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet A & B

	DATA SHEET-A FOR LOCAL PANEL (TO BE FILLED BY PURCHASER)		DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
GENERAL	MANUFACTURER		
	CONSTRUCTION	☐ FOLDED ☐ WELDED (As per requirement EDN)	
	ENCLOSURE SHEET THICKNESS – FRONT	■2.5 mm	
	ENCLOSURE SHEET THICKNESS – OTHER	■ 2.5 mm	
	ENCLOSURE SHEET THICKNESS – DOOR	■ 2.5 mm	
	ENCLOSURE SHEET THICKNESS – OTHER	■ Load bearing sheet front shall have 2.5mm thickness	
TECHNICAL	INPUT POWER SUPPLY * (ANY OTHER POWER REQUIREMENT TO BE DERIVED FROM THIS SUPPLY ONLY)	☐ 240V 50 Hz AC ☐ 220V DC ☐ 415V 3 PHASE 3W ☐ 415V 3 PHASE 4W	
	NO. OF FEEDERS	☐ ONE ■ TWO	
	STARTER WITH MCC (CHECK WITH MAUX/ELEC)	■ REQUIRED ☐ NOT REQUIRED	
	IPR POSITION	☐ MCC ■ RELAY PANEL	
	CONTACT RATING OF RELAY	☐ 5 Amp, 230 V AC ☐ 0.25 Amp, 220V DC	
	CONTROL SUPPLY	☐ 110V AC ☐ 220V AC ☐ 220V DC ☐ Other. (As per requirement)	
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)	_____NOS. (AS REQUIRED)	
	TEMP SCANNER (IF REQUIRED –NO. OF CHANNELS TO BE SPECIFIED UNDER SEC-C)	☐ REQUIRED ■ NOT REQUIRED	
	PAINT TYPE	■ EPOXY	
	MIMIC (TYPE OF MIMIC- MATERAIL, THICKNESS TO BE SPECIFIED DURING DETAILED ENGG.)	☐ REQUIRED ☐ NOT REQUIRED	
	PANEL COLOUR (EXTERNAL)	☐ LIGHT GREY (Shade 631 IS-5) ☐ OPALINE GREEN (Shade 275) ■ RAL 7032/RAL7035 (This shall be decided by BHEL during detailed engg.)	
	FINISH (EXTERNAL)	☐ MATT ☐ GLOSSY ☐ SEMI GLOSSY	
	PANEL COLOUR (INTERNAL)	☐ WHITE ☐ CREAM ☐ OFF WHITE ■ GLOSSY WHITE TWO COATS/ RAL 7035 WITH FIRE RESISTANT PAINT (This shall be decided by BHEL during detailed engg.)	
	FINISH (INTERNAL)	☐ MATT ■ GLOSSY ☐ SEMI GLOSSY	

BHEL	**DATA SHEET FOR LOCAL PANELS**	SPECIFICATION NO.:	
		VOLUME	
		SECTION	
		REV. NO. 00	DATE:
		SHEET 2 OF 2	

TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet A & B

	DATA SHEET-A FOR LOCAL PANEL (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
CLASS OF PROTECTION	☐ IP-42 (FOR INDOOR SERVICE) ■ IP-55 (FOR OUTDOOR SERVICE) ☐ ANY OTHER	
CONTROL HARDWARE	■ RELAY BASED	
FOUNDATION ARRANGEMENT	☐ FOUNDATION BOLTS ☐ ANCHOR FASTENERS	
WEIGHT OF PANEL (Kg.)	……..(Vendor to specify)	
PANEL TYPE	☐ PRESSURISED ☐ UNPRESSURISED As per Requirement	
CABLE GLAND	☐ DOUBLE COMPRESSION	
AMMETER (TYPE OF INPUT, IF REQUIRED)	☐ 1 Amp CT ☐ 4-20 mA	
SCOPE OF SUPERVISION FOR ERECTION & COMMISSIONING	☐ APPLICABLE ☐ NA	

	PREPARED BY	CHECKED BY	APPROVED BY	COMPANY SEAL
NAME				NAME:
DESIGNATION				
SIGNATURE				SIGNATURE:
DATE				DATE:

FORM NO. PEM-6666-0

BHEL	**DATA SHEET FOR LOCAL PANELS**	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. 00 / DATE:
		SHEET 1 OF 2

TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet C

DATA SHEET-C FOR LOCAL PANEL
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)

GENERAL	MANUFACTURER			
	CONSTRUCTION		☐ FOLDED ☐ WELDED (As per requirement EDN)	
	ENCLOSURE SHEET THICKNESS	FRONT		
		OTHER		
		DOOR		
		HEIGHT		
		OTHER		
TECHNICAL	INPUT POWER SUPPLY			
	NO. OF FEEDERS			
	CONTACT RATING OF RELAY			
	TEMP SCANNER			
	CONTROL SUPPLY			
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)			
	PAINT TYPE			
	PANEL COLOUR (EXTERNAL)			
	FINISH (EXTERNAL)			
	TYPE OF MIMIC MATERIAL OF MIMC THICKNESS OF MIMIC			
	PANEL COLOUR (INTERNAL)			
	FINISH (INTERNAL)			
	CLASS OF PROTECTION			
	CONTROL HARDWARE			
	FOUNDATION ARRANGEMENT			
	WEIGHT OF PANEL (Kg.)			

FORM NO. PEM-6666-0

BHEL	**DATA SHEET FOR LOCAL PANELS**	SPECIFICATION NO.:	
		VOLUME	
		SECTION	
		REV. NO. 00	DATE:
		SHEET 2 OF 2	

TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet C

DATA SHEET-C FOR LOCAL PANEL
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)

PANEL TYPE			
CABLE GLAND			
AMMETER (TYPE OF INPUT)			
SCOPE OF SUPERVISION			

	PREPARED BY	CHECKED BY	APPROVED BY	COMPANY SEAL
NAME				NAME:
SIGNATURE				SIGNATURE:
DATE				DATE:

CHAPTER-6

SUPERVISORY CONTROL PANELS, SUPERVISORY CONTROL DESKS, EQUIPMENT PANELS

6.00.00 PANEL AND DESKS

6.01.00 GENERAL REQUIREMENTS

All DDCMIS/PLC/any other control system's electronic modules, power supply components, other control devices (except field mounted sensors/transmitters) and required for completeness of the system shall be housed in cabinets furnished by the Bidder. All equipment and dedicated cabinets required for termination, marshalling and proper interface within Bidder's system and also with other systems shall also be provided by the Bidder.

The cabinet mounted equipments shall be fully assembled, installed in mounting racks, wired and fully tested as per specification requirements and Owner approved drawings in the manufacturing works of a qualified manufacturer prior to shipment to the project site. The Bidder shall ensure that the cabinets are complete and ready for installation before dispatch from manufacturing works. The installation work at project site for these cabinets should only involve connections through multi pair cables from marshalling cabinets (wherever provided) to system cabinets and inter-cabinet/cabinet to UCD/UCP/BUP.
The Control cabinets shall house all types of modules / hardware to achieve all functions of Control System including signal conditioning modules, controller modules, I/O modules, communication controller modules, and all other requisite hardware for a complete system.

6.02.00 SUPERVISORY CONTROL PANELS AND DESKS

6.02.01 Control Desks & Other Furnitures

Supervisory control desks for DDCMIS and other systems shall be supplied for mounting the required operating station as specified else where in the specification. Also control desk will be provided for balance work stations – located in computer room, supervisor room etc. All furniture including chairs and tables for printers etc. shall also be provided by the bidder.
Also control desk & complete furniture will be provided for work stations & printers – located in respective control room for BOP packages.

Industry standard Cushioned revolving, wheel, independently, adjustable seat and back chairs with provision for adjustment of height shall be provided for the operator & unit in charge & other personnel in central control room area & BOP's control rooms, simulator rooms, Conference room, meeting room, documentation room, staff room, CAAQMS shelters, CAAQMS room etc. These shall be designed for sitting for long duration such that these are comfortable for the back. The exact details shall be finalised & approved by Owner during detailed engg.

The actual nos., placement and profile of the main plant control room desk shall be decided during the detailed Engineering.

The tentative layout of central control desk, LVS & consoles are shown in the Drg. No. 114-05-0108, 0105 & 0111.

Control Desk for programmer's, Maintenance Engineer's, EWS, Serves, PC & diagnostic OWSs: -

Required numbers of control desks for accommodating programmer's/main-tenance engineer's/diagnostic etc shall be supplied. These shall preferably have the same dimension as that of supervisory control desks. Also required nos. of control desk will be provided for work stations & printers – located in respective control room for BOP packages.

Desks for accommodating printer:

Adequate number of table/desks/stands for accommodating printers in bidder's scope shall be supplied. Each printer shall be on a separate table / stand.

Care shall be taken to ensure ergonomically aspects so as to create ergonomically ideal work place considering physical aspects such as an average Indian person's size and reach, physiological aspects such as line of sight and field of vision and cognitive factors such as concentration and perceptivity. Extreme care shall be taken to design the desks with correct angles and dimensions.

Glass top teak wood offie table with lockable drawers shall be provided for Chief Enginner room and all other executive rooms.

6.02.02 Supervisory Panel Unit Control Panel

In addition to the LVS and OWS, a limited operation from backup unit control panel is envisaged for emergency operation and to provide safe shut down of plant. The Unit control panel shall housed Conventional Push-button (ILPB) stations, Console inserts (for SG, TG & Generator like FSSS, HPBP, SADC, APRDS, ATRS, ATT, DEHC, LPBP etc), Trip Push Buttons, EWLI, Ammeters, chartless recorders, & min. 15 nos. programmable digital display units for Boiler, Turbine & Generator's parameters. The mosaic grid shall be heat resistant, flame retardant, self extinguishing, and shrinkage free, non reflecting type. Finish of mosaic grid shall be mat type with out flaring. Hard wired emergency trip pushbuttons shall be arranged on operator station desk & in parallel on UCP.

Unit control Panel (UCP), shall be located suitably in the CCR.

In addition to above, 21 nos. Programmable digital display units common for both units showing total MW shall be provided by bidder at different locations of plant. The data to this DDU will be fed from DDCMIS through MOD BUS/PROFI BUS /RS 485 protocol and not hard wired. The **digit size** of the display unit will be **300 mm for 6 Nos**. and **200 mm for 15 Nos.** The placements/locations shall be decided during detailed Engineering.

Control panel cum desk with HW annunciation windows, ILPBs, Ammeters, Annunciation & desk PBs, mimic, lamps, Indicators, recorders, etc. shall be provided as per Annexure A – Control System Philosophy for BOP packages.

(Exact service & quantities will be worked out & approved during detailed engineering by owner).

6.02.03 Two (2) nos. vertical Steel Almirahs shall be provided for keeping documents in each BOP package's control room. Glass doors for each rack shall be provided such that the documents are visible from outside. Size of the rack shall be sufficient to easily fit technical manuals. The exact details shall be approved by Owner during detailed engg.

Suitable lockers (min. 24 nos. per unit) shall be provided in the room adjacent to the each central unit control room for storing of personal articles of control room personnel. Similarly suitable lockers (min. 8 nos in each control room) shall be provided in BOP package control rooms for storing of personal articles of control room personnel. Also, vertical steel almirahs (min. 4 nos. per unit) shall be provided in Documentation Room for storing of documents.

Vertical Steel Almirahs shall also be provided for the following rooms, wherein final quantity may be decided by owner during detailed engineering

a. Maintenance room – 6 nos. min. (per Unit)
b. ERP room – 2 nos. min (Common for both unit).
c. PADO Room – One (1) no. min.(per unit)
d. Station In charge room – One (1) no. min (common for both unit).
e. Simulator room – 4 nos. min. (per Unit)

Thickness of steel almirah sheet shall be 18 gauges.

In addition to above, All industry grade furniture including chairs, control tables, tables for printers etc. & Almirahs for storage of consumables/catalogues/manuals shall also be provided by the bidder as on required basis and finalized by owner any where in power plant. Details shall be finalised and approved by Owner during detailed engineering.

6.02.04 Control panels for service system like C.W. Pumps etc. will be located in the respective control room. In addition ,some local panels will be provided near respective system/equipment such as Boiler Feed Pump, Hydrogen seal oil system, Electrostatic precipitator etc.

6.03.00 TERMINATION/Marshalling CABINETS & Interposing Relay Panel

Marshalling/Termination cabinets for the control system shall be supplied for terminating all cables originating from the field, MCC/SWGR or any other source of signal and for distributing the signals to different functional panels, MCC/SWGR and control cubicles.

Incoming cables from the field, MCC/SWGR or any other source of signal shall be terminated in suitable terminal blocks in logical sequence.

Prefabricated cables with plug in connectors at both ends shall be used for extending the signals to the functional panels. Matching plug sockets shall be provided in the termination cabinets for terminating the plugs.

Interposing relay panels for the system shall be supplied for mounting interposing relays & terminating all cables originating from the DO cards in case of solenoid valves, and other required services etc. IPR panels shall be placed in CER and LCR.

Interposing relay shall be mounted in respective SWGR/MCC/integral starter required for commands signals of HT/LT unidirectional drives and bidirectional drives, breakers, isolators & bus couplers etc from DDCMIS/DCS/PLC or any control system.

Terminal blocks shall be located inside the cabinets on support wings fabricated of metal plates.

The plug socket shall be mounted on hinged plates to provide an access to the rear pins of the plugs.

General features of termination cabinets and accessories shall conform to the general design and construction specification of panels. Terminal blocks shall be Rail mounted Terminal blocks (Screw less cage clamp type) with markers.

6.04.00 CONSTRUCTIONAL FEATURES OF PANELS, CONSOLES, CONTROL DESK, CUBICLES & ENCLOSURES

All panels, cubicles, consoles, SOV panels and enclosures furnished as per this specification shall be of free standing type and shall be constructed of specified gauge of steel plates. The panel sheet thickness shall be not less than 2 mm unless otherwise specified herein.

The panels, consoles/desks shall be reinforced as required to ensure true surfaces and adequate support for instruments mounted thereon. All instrument cutouts, mounting studs, and support brackets shall be accurately located. All welds on the exposed panel surfaces shall be ground smooth. Finished panel surfaces shall be free from waves, bellies, or other imperfections. Unless specified, otherwise, panel doors shall be 4 points hinged and shall have turned back edges and additional bracing where required to ensure rigidity. Door hinges shall be of the concealed type. Door latches shall be of the three-point type to ensure tight closing. Door locks shall be furnished which will allow actuation of all locks by a single master key. All panels shall have removable lifting eyebolts for safe lifting from top during storage and installation handling.

Cabinet doors shall be hinged and shall have turned back edges and additional braking where required ensuring rigidity. Hinges shall be of concealed type. Door latches shall be of three/four-point type to assure tight closing. Detachable lifting eyes or angles shall be furnished at the top of each separately shipped section and all necessary provisions shall be made to facilitate handling without damage. Front and rear doors shall be provided with locking arrangements with a master key for all cabinets. If width of a cabinet is equal or more than 800 mm, double doors shall be provided.

All panels shall be mounted on vibration dampers, which are secured to channels mounted on the floor. The channels shall be field welded to steel plates set into the concrete flooring. The steel plates shall be located such as to approximate the outline of panel bases. The exact mounting details shall be as approved by the owner during detailed engineering stage. All panels shall be provided with adequate ventilation and packaging density of components shall be restricted so as to limit the temperature rise

above ambient to 10°C under the worst conditions. All panels shall have auto on/off switch for internal lighting. All the power supply circuit for control panels shall be provided with auto changeover circuitry.

In each panel /cabinet, a 24 VDC Voltmeter digital type shall be provided to check the Field Interrogation voltage.

Exhaust Fans with louvers & filters shall be provided on door's (front & Rear) upper side to remove hot air in all consoles, control desk and panels.

Fire/Smoke detectors shall be provided inside the Control room mounted system/control cabinets.

UPS, 24 V DC & non UPS's Feeder failure/ healthy indication shall be provided in each cabinet & remote indication shall be hooked up to DDCMIS/ PLC/annunciation & suitably grouped.

All the panels shall be equipped with Anti vibration pad of min. 15 mm size. Cable gland plate thickness shall be 3 mm.

Doors shall be provided with neoprene/polyurethene gasket only.

All the cable entries shall be at the bottom of electronic cubicles/control panels.

Protection class of panels shall be as specified at Vol. V, chapter 2.

6.04.01 Operator Control Desk

6.04.01.1 In CCR, Operator work station consoles/desk shall be of granite top of curved nature with powder coated frame. OWS consoles shall be provided with the facility for locating the CPU, document etc with all required utilities.

Unit In charge desk/consoles shall be of granite top of curved nature with powder coated frame. OWS consoles shall be provided with the facility for locating the CPU, document etc with all required utilities.

Station In charge desk/consoles shall be of granite top of curved nature with powder coated frame. OWS consoles shall be provided with the facility for locating the CPU, document etc with all required utilities.

6.04.01.2 Engineer work station and all other consoles/desk shall be ergonomically designed industrial grade type with swivel chairs for use at the various Programming stations and all other plant locations. All the equipment like Programmers stations, PC's, various peripherals & similar devices shall be complete with desks and they shall be of industrial grade stands and other mounting accessories and the same shall be completely erected & commissioned by the bidder. Details for other operating and enginering stations shall be as below:

i. Operator Control desk shall be free standing table top type with doors at the back and shall be constructed of 3 mm thick CRCA steel plates. It shall have concealed cable & wire way management system. The top surface of control

desk shall be 30mm thick with the top 12mm of acrylic solid surface and the remaining 18mm of laminated medium density fibre board. Control desk shall consist of vertical, horizontal and base supports with their coverings for work surface, keyboard trays, Mouse pads, Monitor shelf and concealed cable and wire way management, perforated trays with covers in both horizontal & vertical directions.

ii. To achieve durable & water resistant finish, a sheet of “plastic PVC membrane" on the surface of control desks shall be provided. Final paint finish with proper smoothening is to be ensured. Final finish of CD should be in line with relevant International standards. For more durability, the membrane sheet of the Control desk should extend 200 mm more into the underside of the desk. The cabling / wiring between OWS & CPU’s, power supply cables etc. shall be aesthetically routed and concealed from view.

iii. All the control desk shall be equipped with Anti vibration pad of min. 15 mm size. Cable gland plate thickness shall be 3 mm.

iv. Doors shall be provided with neoprene/polyurethene gasket only.

6.05.00 SURFACE PREPARATION AND PAINTING

All panel exterior steel surfaces shall be ground smooth, and painted as specified below:

Suitable filler shall be applied to all pits, blemishes and voids in the surfaces. The filler shall be sand blasted so that surfaces are level and flat, corners are smooth and even. Exposed raw metal edges shall be ground burr free. The entire panel surface shall be sand blasted to remove rust and scale and all other residue due to the fabrication operation. Oil grease and salts etc. shall be removed from the panels by one or more solvent cleaning methods. Alternatively 7 tank process shall be followed.

Two spray coats of inhibitive epoxy primer – surface shall be applied to all exterior and interior surfaces, each coat of primer surfacer shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish colour (Catalysed epoxy finish) shall be applied to all surfaces of dry film thickness 2.0 mil. The finish colours for exterior and interior surfaces shall conform to the following shades:

a) Exterior - RAL 7032/RAL 7035.

b) Interior - Glossy white two coats/RAL 7035 with fire resistant paint

One uniform colour shade as finalized shall be applicable for complete plant.

Paint films, which show sags, checks, blisters teardrops, fat edges or other painting imperfections, shall not be acceptable and if any such defects appear, they shall be repaired by and at the expenses of the Bidder.

6.06.00 PANEL WIRING

Interconnecting wiring shall be provided between all electrical devices mounted in the panels, and between the devices and terminal blocks if the devices are to be connected

to equipment outside the panels by cabling and through pre-fabricated plug in cables. All alarm contacts located within a panel shall be wired to terminal blocks. Thermocouple and other special circuits shall be field wires direct to instrument terminal blocks without the use of panel wiring.

All control and instrument wiring used within the panels shall confirm to NEC and NEMA standards and shall be factory installed and tested at the works of a qualified manufacturer. All interior wiring shall be installed neatly and carefully, and shall be terminated at suitable terminal blocks. Sufficient clearance shall be provided for all control and instrumentation leads, and all incoming and outgoing leads shall be connected to terminal blocks suitably located for connecting external circuits.

All panel wiring shall have appropriate ferruling for clear identification. Interior wiring shall be so arranged that the external connections can be made with only one wire per terminal point. Any common connections shall be made internal side of the terminal blocks. Common connections shall be limited to two wires per terminal. Instrumentation cable shield wires shall be connected to separate terminal at the terminal block. Signal circuit shields shall be grounded separately.

All internal wiring (except low level instrument wiring) shall be National Electric Code Type SIS, Polymetric/Elastomeric insulated, tinned copper stranded conductor, switchboard wire, or owner approved equal.

Panel wiring shall have a flame resistant insulation with adequately sized 650/1100 V grade tinned copper stranded conductor based on current carrying capacities as etc forth by the National Electric Code.

Wire sizes shall be as specified herein and suitable for intended applications.

Wiring to door mounted devices shall be provided with (49 strand minimum) adequate loop lengths of hinge wire so that multiple door openings will not cause fatigue braking of the conductor.

Wiring shall be arranged to enable instruments or devices to be removed and/or serviced without unduly disturbing the wiring. No wire shall be routed cross the face or rear of any device in a manner, which will impede the opening of covers or obstruct access to leads, terminals or devices.

Panel wires shall be identified with wire number and each termination by means of Action craft products split sleeve or Borden Chemical Co. indelible tubing markers or owner approved equal. Corrections and modifications of all panel wiring shall be Bidder's sole responsibility. Any corrections/modifications required at site for successful commissioning shall be done by the Bidder without any additional costs. Terminal lugs furnished must be of the compression, insulated sleeve, half ring tongue type. Open-ended terminal lugs will not be accepted. Wires shall not be looped around the terminal screws or studs.

Wires shall not be tapped or spliced between terminal points.

Panels, cabinets, consoles/desks will be provided with removable, gasketed cable gland plates and cable glands, for all floor slots used for cable entrance. Split type grommets shall be used for prefab cables.

Internal wiring in factory prewired electronic systems cabinets may be installed according to the Bidder's standard as to wire size, insulation, and method of termination on internal equipment except that insulation for all wiring power supply wiring, and interconnecting cables between devices shall pass the following tests.

a) Flammability test IEEE 383/1974
b) When tested under UITPP test method or ASTM 2893/77 light transmittance of 80%
c) When tested under IEC 754-1 maximum acid gas generation shall be 2% by weight
d) Oxygen index not less than 30 as per ASTM D 2863.

All terminations for intra panel wiring inter panel cabling and connecting the Bidders panels, PB stations, control stations etc. shall be with cage clamp Screwed less connections. Soldered connections are not acceptable. All field side or external input connections shall also preferably of Cage clamp/Spring Clamp/ Screwed less connection.

Conductor Clamping shall also confirm to Standard IEC – 60947-1 & IEC-60947-7-1.

Identification of conductors may be done by insulation colour coding identified on drawings or by printed wiring lists. Terminal blocks for connection of external circuits in to factory prewired electronic system cabinets shall meet all the requirements as described elsewhere in the specification. For all multicore cables, the outer sheath shall satisfy the properties identified above. However, for panel wiring, the wiring insulation shall also satisfy the properties identified above. The internal wiring shall be done in coloured wiring.

6.06.01 Following Wire size shall be utilized for internal wiring:

a.	Current (4-20 mA) Low voltage signals (AI/AO & DI signals)	: :	0.75 sq.mm
b.	DO signals, Ammeter/ voltmeter circuit,control switches, indicator,recorder	:	1.5 sq.mm
c.	Internal Illumination	:	2.5 sq.mm

d. Size of Power supply cables shall be as below:-

i. 1 to 16 Amp. - 2.5 sq. mm
ii. 17 to 20 Amp. – 4 sq. mm
iii. 21 to 32 Amp. - 6 sq. mm
iv. 33 to 40 Amp. - 10 sq. mm.
v. 41 to 60 Amp. - 16 sq. mm
vi. Power earth - 4 sq. mm

6.07.00 INSTRUMENTS MOUNTING

6.07.01 Instruments and relays mounted on the panels shall be easily accessible for repair and replacement without disturbing other equipment their connected wiring. No special tools shall be needed for the purpose.

6.08.00 PANEL ILLUMINATION

Panels shall be provided with LED based illuminating lamps with door switch and six (6) point 6/16A, 240V AC universal type power sockets with switch for maintenance purposes. These switches shall be with quick make and break mechanism. 100 % spare LED lamps shall be provided with each panel, these are in additional to mandatory spares.

6.09.00 FUSE BLOCKS

Where fuse blocks rated 30 amp. 250 Volts are required by the specifications or the manufacturer's design, they shall be modular type with bakelite frame and reinforced retaining clips. Blocks shall be class H.2 pole, screw terminal fuse blocks. Blocks for other current and voltage ratings shall be similar in construction.

6.10.00 FUSES & MCB

All fuses shall be fast acting semiconductor types for AC supply and compatible to the UPS fuses. For all DC Powered devices, similarly the fuses shall be fast acting compatible to DCDB fuse provisions. All the AC power supplies shall be provided with the protection of Fast acting semi conductor fuses & 2 P thermomegnetic type MCB. Make of Fuses shall be GE or Siemens. For all the DC power supply circuits, electronic type DC MCB shall be used only. Make of DC MCB shall be Siemens, Phoenix contacts, Murr, Weidmuller, or Lutze.
50 % spare fuses shall be provided with each panel, these are in additional to mandatory spares.

6.11.00 MOULDED CASE CIRCUIT BREAKERS

Moulded case circuit breakers used in equipment covered under these specifications shall have not less than 5000 amp. Interrupting capacity at 220 Volts DC 10,000 Amp. Symmetrical interrupting capacity at 240 Volts AC. MCCB shall be provided at each main feeder line like ACDB & DCDB main feeders, PLC main feeder, control panels, UPS circuits etc.

6.12.00 GROUNDING

All panels and cabinets shall be provided with a continuous bare copper ground bus of minimum 6 mm x 25/50 mm cross section. The ground bus shall be bolted to the panel structure and effectively ground the entire structure. Each Ground bus shall have provision at each end for connection of ground leaks (6 mm x 50 mm GI Flats) by suitable bolting. All system cabinets shall be brought to a common system ground by the bidder. Electronic earthing resistance shall be < 0.5 ohms.

Each circuit requiring grounding shall be individually and directly connected to the panel ground bus by ring tongue type compression lugs. For electronic system cabinets the system ground bus shall be insulated from the cabinet enclosure and shall be separately

connected to the system ground. All system cabinets shall be brought to a common system ground by the bidder.

The Bidder shall furnish his recommendations regarding grounding requirements for all equipment/systems and shall specifically indicate the deviations if any from the above requirements as a part of his proposal.

6.13.00 TERMINAL BLOCKS

For all inputs to the system emanating from the field or other systems, the bidder shall furnish terminals suitable for correct size of field cables.

6.13.01 All outputs going to MCC/SWGR terminal blocks, shall be rated 600 volts minimum and shall have strap screw less terminals suitable for connection of wires with ring tongue type lugs. Standard terminal blocks shall be screw less cage clamps type. Terminal blocks shall be approximately sized for larger wire size of higher voltage insulated incoming conductors as necessary. All the TBs used shall be 6.6 polymide to withstand corrosion and the metallic portion shall be coated against rust /corrosion. All metal parts should be non –ferrous in nature.

6.13.02 Terminal blocks shall be provided with white marking strips and re permitted by the safety codes and standards shall be without covers.

6.13.03 Fuses shall not be mounted on terminal blocks. Neither step type terminal blocks nor angle mounting of terminal blocks will be acceptable.

6.13.04 At least 20 per cent spare unused fully wired terminals shall be provided on each terminal block for circuit modifications and for termination of all conductors in a multi-conductor control cable with each panel, enclosure, cubicle, SOV Boxes etc.

6.14.00 NAME PLATES AND LABELS

Name plates of adequate size shall be provided for each panel on front and rear of the panel. Instruments/other accessories mounted inside the panels shall have identification marking clearly visible from inside.

Devices to be mounted on the panels shall also be labeled on the panels shall also be labeled on the outside of the panel. Name plates shall be of polyamide sheets with black letters on white background. Name plates shall be attached to the boards by means of stainless steel panhead screws. Fuses provided for protection of various boxes shall be accessible for replacement. Fuse boxes shall be provided with circuit label and fuse rated current and voltage.

Markings/Labels

All markers/labels shall be made of halogen & silicon free polyamide material with inflammability class V2 as per UL 94, ensuring scratch proof printing with the use of environment friendly solvent free ink & latest BLUEMARK UV technology so as to comply the WIPE RESISITANCE according to DIN EN 61010-1/VDE 0411-1.

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STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	1 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
	INCOMING											
1.0	Sheet Steel (CRCA & HR)	1. Chemical Composition	MA	Chemical analysis	Sample	IS:1079 IS:513	IS:1079 IS:513	Test Certificate	3	---	2	
		2. Bend Test	CR	Mech. test	Sample	IS:1079 IS:513	IS:1079 IS:513	Log Book	2	---	---	
		3. Surface finish	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---	
		4. Waviness	MA	Visual	100%	Factory Standard	No Waviness	Log Book	2	---	---	
		5. Thickness	MA	Measurement	100%	BHEL Spec.	BHEL Spec.	Log Book	2	---	---	
		6. Mill marking	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	1	
2.0	Flats / Angles / Channels	1. Dimensions	MA	Measurement	Sample	IS:2062	IS:2062	Log Book	2	---	---	
		2. Surface Defects	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---	
		3. Straightness	MA	Measurement	100%	Factory Std.	Factory Std.	Log Book	2	---	---	
		4. Mill marking	MA	Visual	100%	IS:2062	IS:2062	Log Book	2	---	1	
3.0	Cables / Wires	1. Visual / Surface defects	MA	Visual	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---	
		2. IR and HV	MA	Electrical	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---	

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics

$ P - Agency Performing the Test.; W - Agency Witnessing the Test.; V - Agency Verifying the Test.

1 - BHEL; 2 - Vendor; 3 - Sub-vendor

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STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	2 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
		3. Conductor a) Resistance b) Size c) Sheet colour	 MA MA MA	 Electrical Measurement Visual	 100% 100% 100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---	
		4. Type / Routine Test Certificates	MA	Verification	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	3	---	2	
4.0	Electrical Components like Annunciator Transformers Lamps Switches PBs Contactors Relays Timers Space Heaters Thermostat Indicating meters etc.	1. Verification at make and Type	CR	Visual	Sample	BHEL Spec. and BOM	BHEL Spec. and BOM	Log Book	2	---	---	
		2. Verification of Test Certificates	CR	Scrutiny of Type / Routine T.Cs.	100%	Relevant IS	Relevant IS	Log Book	2	---	---	
		3. Operation / Functional check	CR	Electrical	Sample+ 100%@	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---	+ for relay & contactors only
		4. I.R.	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---	@ for all components except relays & contactors.
		5. H.V.	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---	
		6. Calibration	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	1	
		7. Pick up / Drop off Voltage	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---	

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STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	3 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
5.0	Misc. Components like Gaskets, Terminal Blocks etc.	1. Verification of Type / Make	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
		2. Surface defects	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
		3. IR / HV on Terminal Blocks	MA	Electrical	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
	IN PROCESS											
6.0	Blanking / Bending / Forming	1. Dimensions	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
		2. Surface defects after bending	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	---	
7.0	Nibbling / Punching	1. Cutout Sizes	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
		2. Deburring	MA	Visual	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
	ASSEMBLY											
8.0	Frame Assembly & Sheet fixing	1. Dimensions	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		2. Alignment	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		3. Welding Quality	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		4. Surface defects	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	

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STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	4 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
9.0	Pre-treatment and Painting	1. Pretreatment Process	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		2. Process parameters like bath temp. concentration etc.	MA	Measurement	Periodic	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		3. Dipping / Removal Time	MA	Measurement	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		4. Surface quality after every dip	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		5. Primer after phosphating	MA	Visual, Thickness	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		6. Putty Application & Rubbing after primer	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		7. Paint first coat	MA	Visual, Thickness	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		8. Putty Application and Rubbing after first coat of paint	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		9. Paint second coat	MA	Visual, Thickness, Scratch test Colour adhesion	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	

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STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	5 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
10.	Panel Wiring	1. Wiring Layout	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		2. Wiring Termination (Crimped Lugs)	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		3. Ferrule numbers	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		4. Colour of wiring	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1	
		5. Size of Conductor	MA	Measurement	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1	
11.	Component Mounting	1. Correct components	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	
		2. Fixing	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	
	FINAL											
12.	Final Inspection	1. Workmanship	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.
		2. Component layout (neatness, accessibility & safety) Mounting / Proper fixing of all components	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		3. Components identification Marking / Name plates	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	

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STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	6 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
		5. Dimensions	MA	Measurement	100%	BHEL approved drg. / Spec., BOM	BHEL approved drg. / Spec., BOM	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.
		6. Door functioning	MA	Functional	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		7. Paint Shade	CR	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		8. Paint Thickness	CR	Measurement	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		9. Workmanship of Gaskets	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	
		10. Wiring Layout	MA	Visual	100%	BHEL approved drg.	BHEL approved drg.	Inspection Report	2	1	1	
		11. Wire Termination	MA	Pulling manually	Sample	-----	Firm termination	Inspection Report	2	1	1	
		12. Continuity	MA	Electrical	100%	-----	Continuity OK	Inspection Report	2	1	1	

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STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	7 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
13.	TYPE TEST	Degree of Protection	CR	Mech. Protection	Sample	BHEL approved spec., drg relevant IS-13947 Part-1, IS-2148.	BHEL approved spec., drg relevant IS-13947 Part-1, IS-2148.	Type Test Certificate	3	---	1	
14	ROUTINE TEST	IR before & after HV Test	CR	Electrical	100%	BHEL approved spec., drg., BOM & relevant IS.	BHEL approved spec., drg., BOM & relevant IS.	Test Report	2	1	1	
15	FUCTIONAL TEST	1. Control Logic Operation	CR	Electrical	100%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1	
		2. Instrument Calibratio	CR	Electrical	10%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1	
		3. Temperature rise	CR	Electrical	100%	BHEL approved spec/drg. & relevant IS.	BHEL approved spec/drg & relevant IS.	Inspection Report	2	1	1	

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DRIVE

CONTROL

PHILOSOPHY

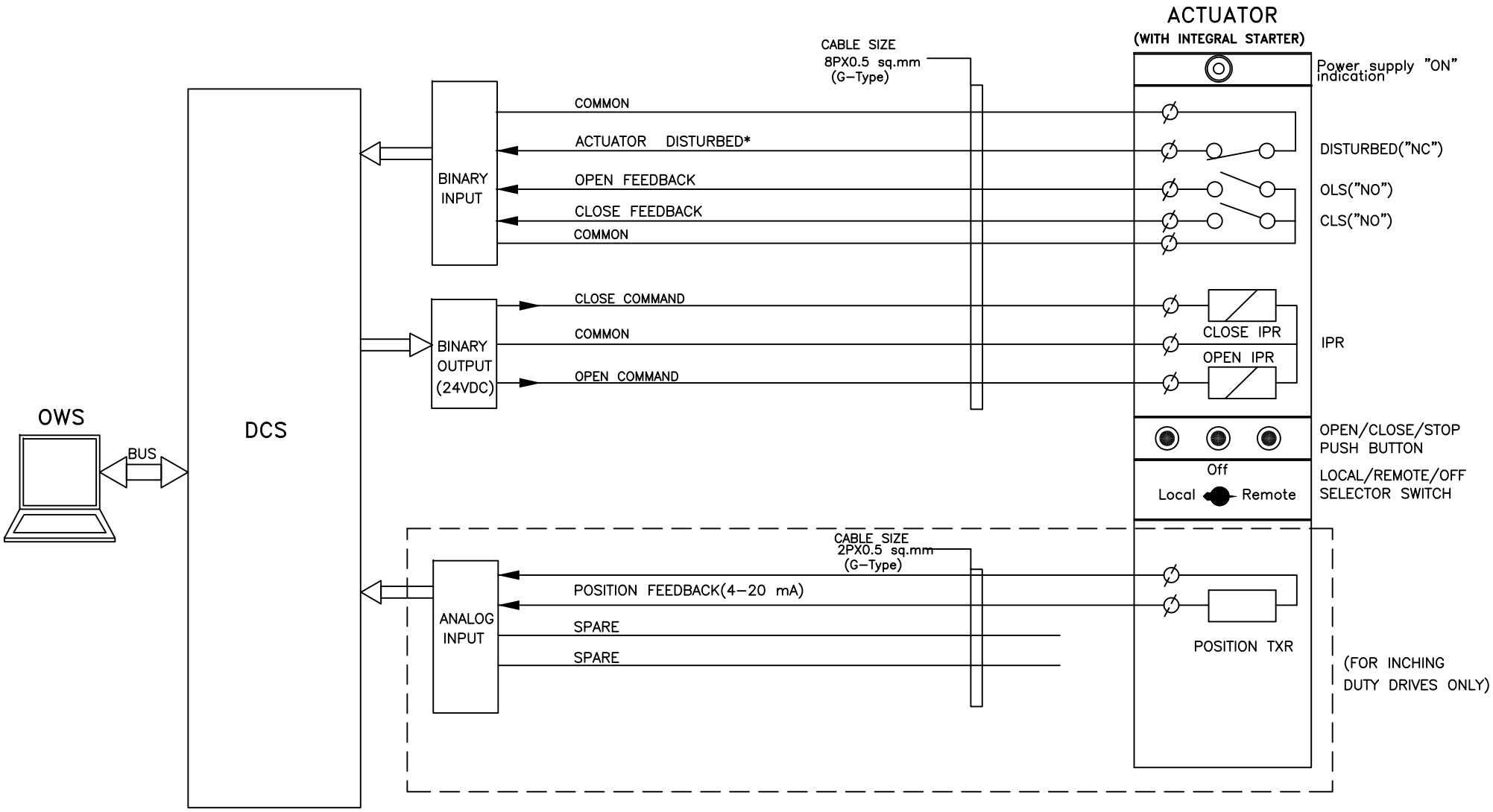
FOR

ANALOG
&

BINARY

DRIVES

DCS INTERFACE FOR BIDIRECTIONAL DRIVE(WITH INTEGRAL STARTER)

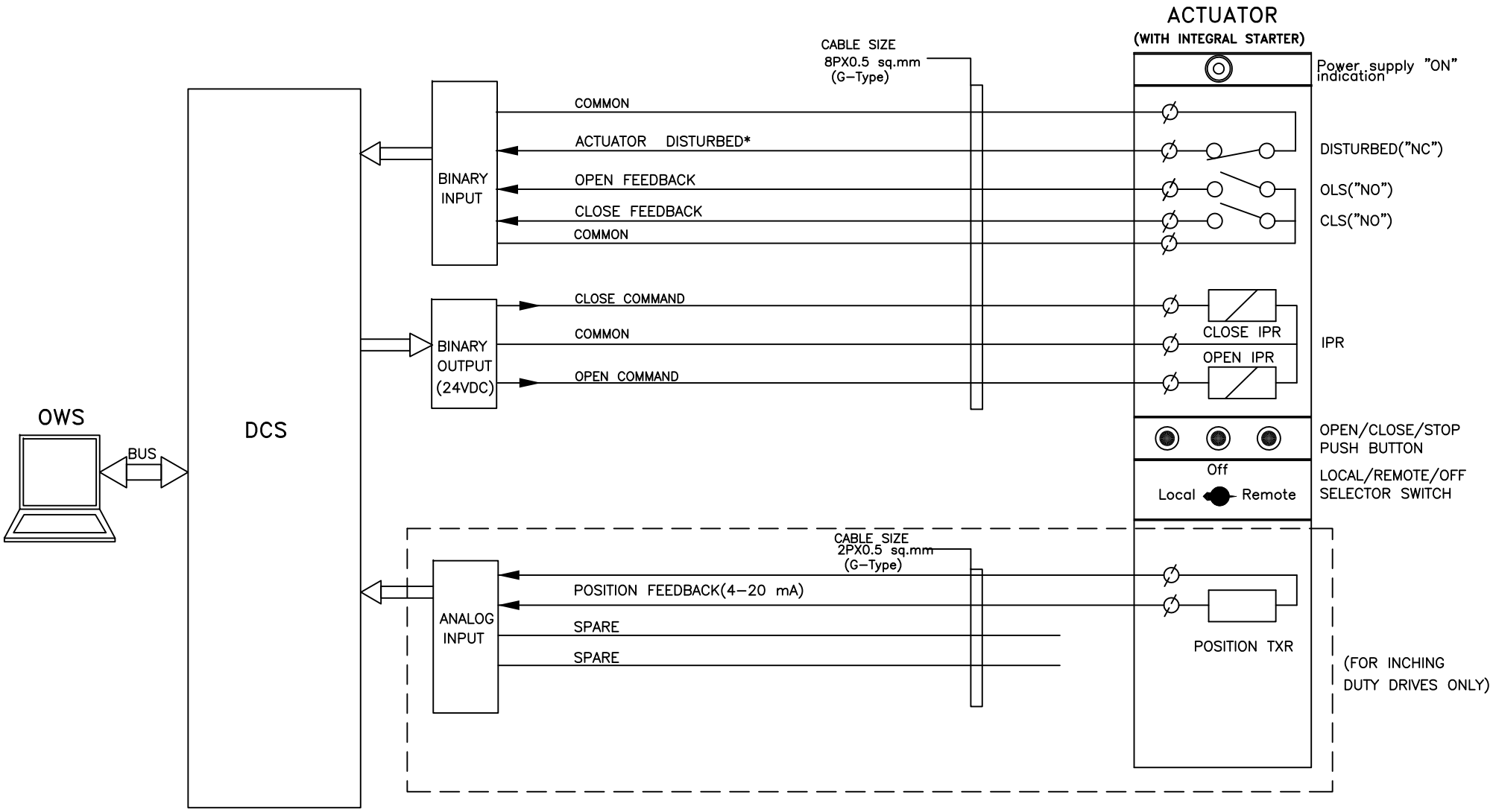


NOTE:

* DISTURBED= Loss of Power supply (1 Phase/3 Phase)/ Loss of control supply/ Motor thermostat trip/ Thermal over load/Torque open/close cutoff Local/Off/Remote Sel. switch in local or off mode/ Stop PB optd.

BHEL	PROJECT: 2X660 MW ENNORE SEZ STPP	DRG.NO.	PE–DM–412–145–I002
		DATE	12.02.2015
	TITLE DDCMIS INTERFACE FOR BIDIRECTIONAL DRIVE	REV.NO.	01
		SHT	7 OF 11

DCS INTERFACE FOR BIDIRECTIONAL DRIVE(WITH INTEGRAL STARTER)

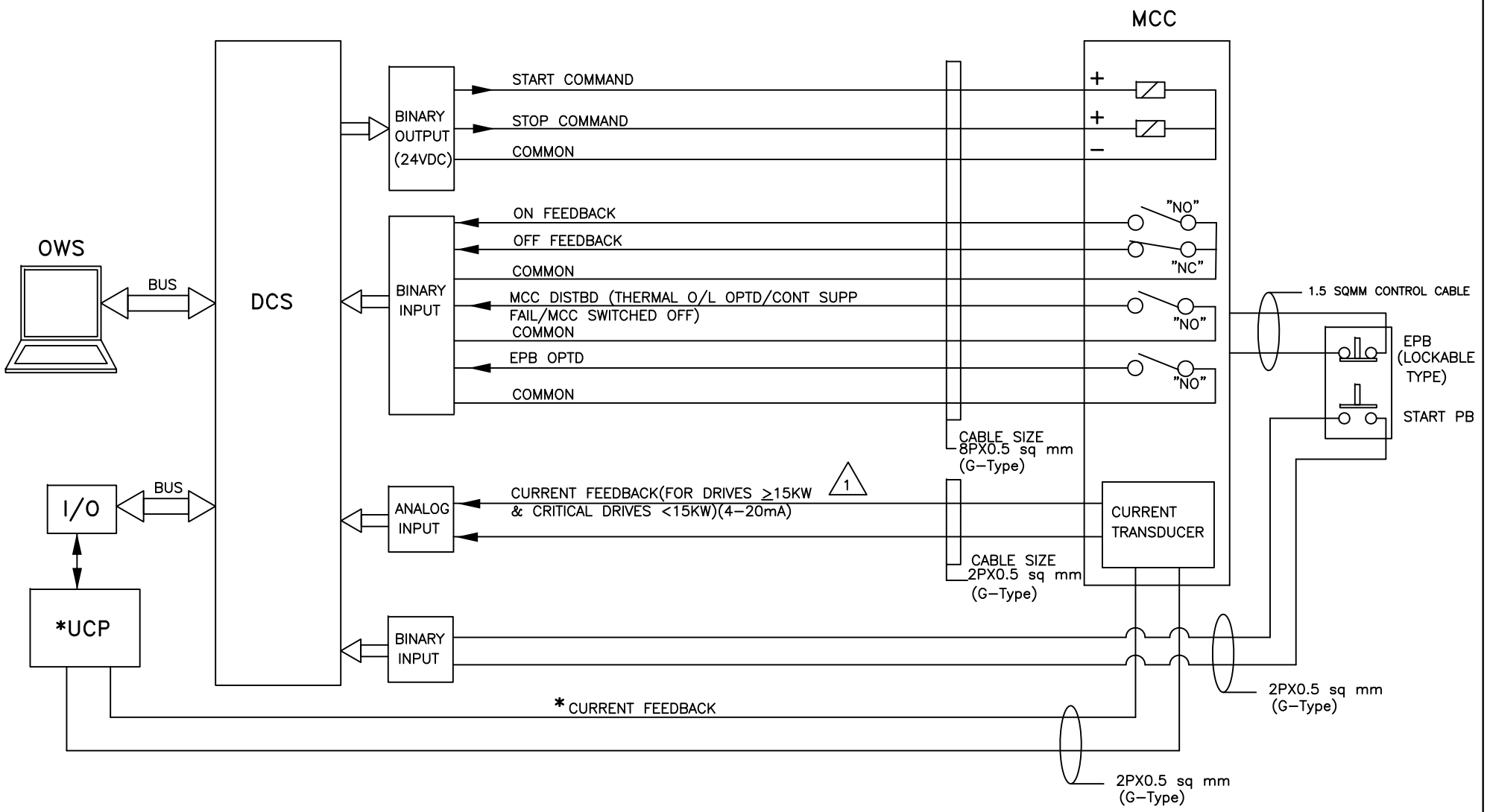


NOTE:

* DISTURBED= Loss of Power supply (1 Phase/3 Phase)/ Loss of control supply/ Motor thermostat trip/ Thermal over load/Torque open/close cutoff Local/Off/Remote Sel. switch in local or off mode/ Stop PB optd.

BHEL	PROJECT: 2X660 MW ENNORE SEZ STPP	DRG.NO.	PE–DM–412–145–I002
		DATE	12.02.2015
	TITLE DDCMIS INTERFACE FOR BIDIRECTIONAL DRIVE	REV.NO.	01
		SHT	7 OF 11

DCS INTERFACE FOR UNIDIRECTIONAL LT DRIVE

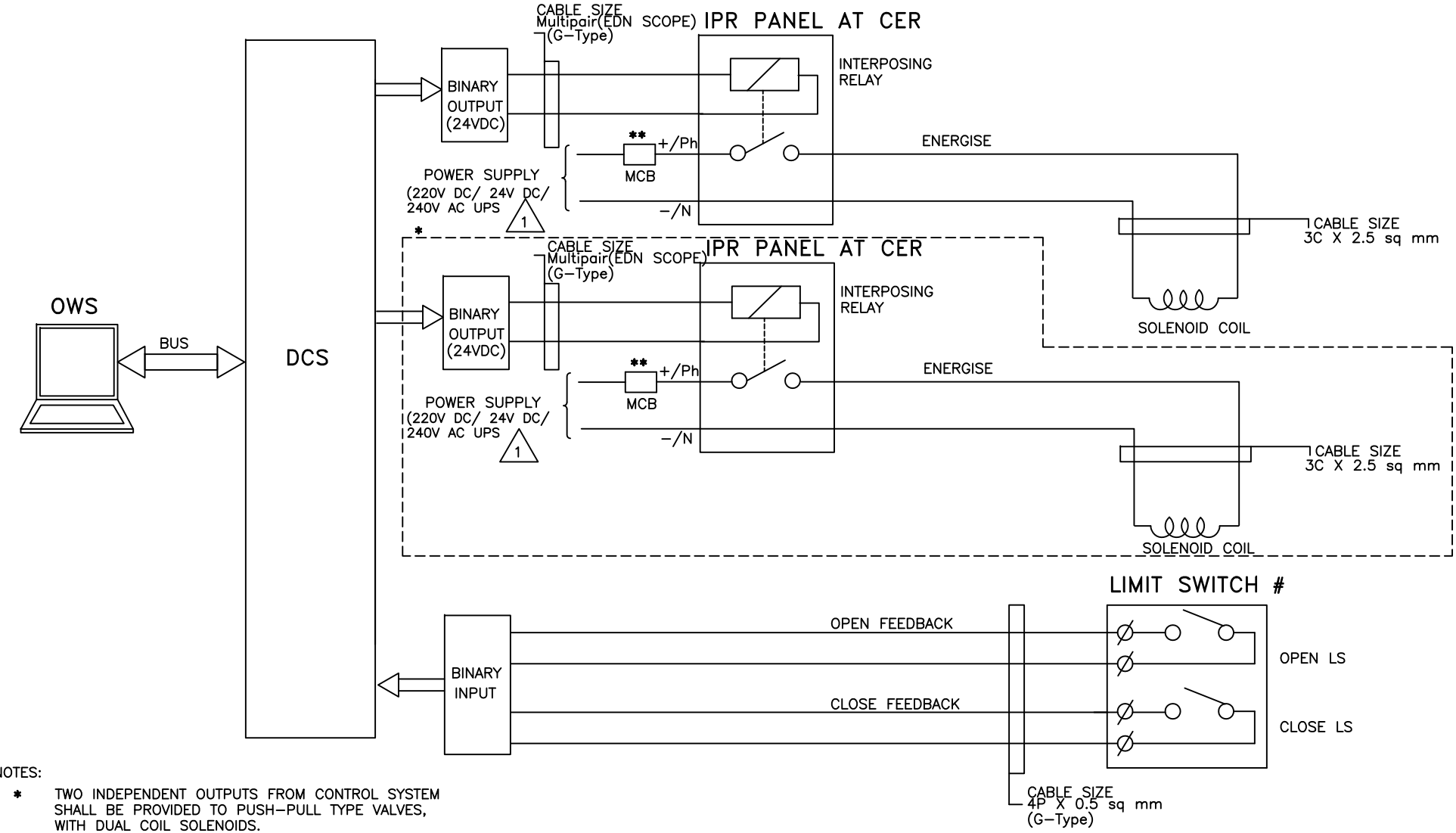


NOTE:

*WHEREVER APPLICABLE

PROJECT: 2X660 MW ENNORE SEZ STPP	DRG.NO.	PE–DM–412–145–I002
	DATE	12.02.2015
TITLE: DDCMIS INTERFACE FOR UNIDIRECTIONAL LT DRIVE	REV.NO.	01
	SHT	8 OF 11

DCS INTERFACE FOR SOLENOID DRIVE
△1 (220V DC/ 24V DC / 240V AC UPS)



NOTES:

* TWO INDEPENDENT OUTPUTS FROM CONTROL SYSTEM SHALL BE PROVIDED TO PUSH–PULL TYPE VALVES, WITH DUAL COIL SOLENOIDS.

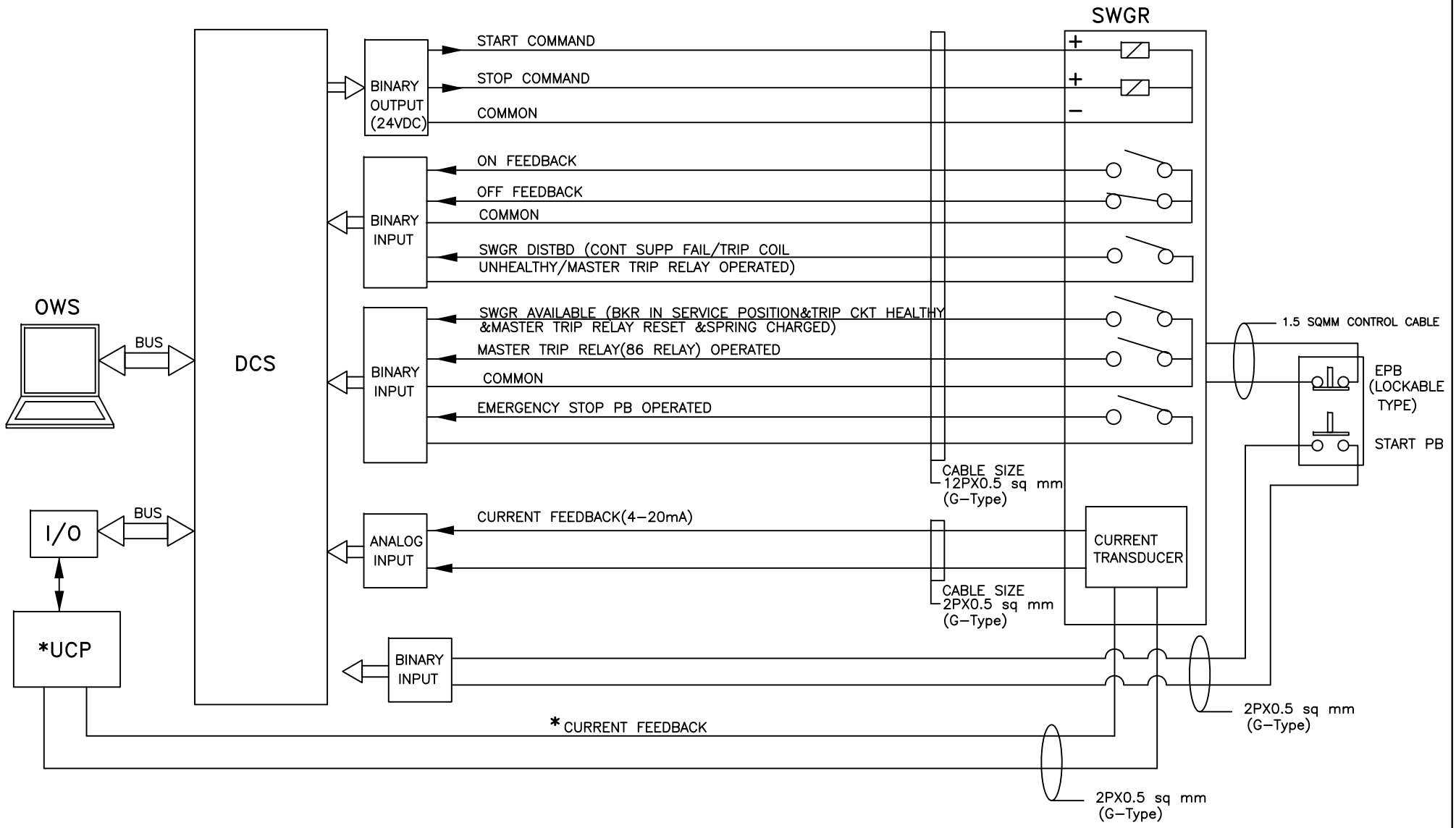
** MCB SHALL BE PROVIDED FOR EACH SOLENOID

△1 # FOR ON/OFF TYPE, SOLENOID ACTUATED VALVE. RELAY CONTACTS SHALL BE WIRED AS FEEDBACK WHEREVER LIMIT SWITCH FEEDBACKS ARE NOT AVAILABLE.

△1 *** BHEL WILL TAKE CARE OF DE–ENERGISE TO TRIP PHILOSOPHY FOR FAIL SAFE CONTROL SYSTEM (WHEREVER REQUIRED)

PROJECT: 2X660 MW ENNORE SEZ STPP	DRG.NO.	PE–DM–412–145–I002
	DATE	12.02.2015
TITLE DDCMIS INTERFACE FOR SOLENOID DRIVE	REV.NO.	01
	SHT	9 OF 11

DCS INTERFACE FOR HT/LT UNIDIRECTIONAL DRIVES(BREAKER OPERATED)



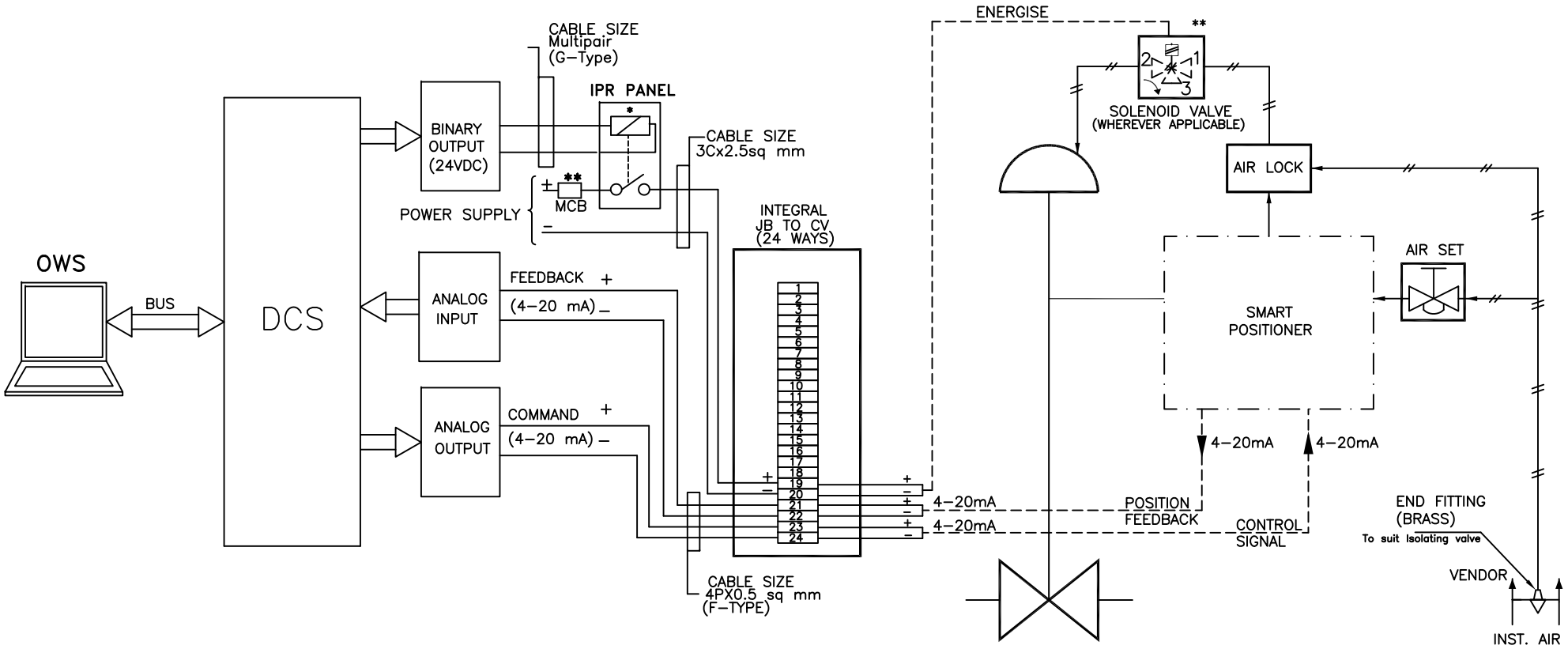
NOTE:

* WHEREVER APPLICABLE

1 # VIBRATION, WINDING & BEARING SIGNALS SHALL BE INTERFACED WITH DDCMIS AND INCLUDED IN EDN'S DOCUMENT.

BHEL	PROJECT: 2X660 MW ENNORE SEZ STPP	DRG.NO.	PE-DM-412-145-I002
		DATE	12.02.2015
	TITLE DDCMIS INTERFACE FOR UNIDIRECTIONAL HT DRIVE	REV.NO.	01
		SHT	10 OF 11

DCS INTERFACE FOR ANALOG DRIVE (WITH SMART POSITIONER)



NOTES:

** APPLICABLE TO VALVES WHERE PROTECTION OPEN/CLOSE ACTION FOR CONTROL DEMAND OVERRIDING IS REQUIRED.

BHEL	PROJECT: 2X660 MW ENNORE SEZ STPP	DRG.NO.	PE–DM–412–145–I002
		DATE	12.02.2015
	TITLE: TYPICAL HOOK–UP DIAGRAM ANALOG DRIVE (WITH SMART POSITIONER)	REV.NO.	01
		SHT	11 OF 11

APPLICABLE

CODES

&

STANDRARDS

1.08.00 CODES AND STANDARDS

1.08.01 All equipments, system and service covered under this specification shall comply with the requirements of the latest statutes regulations and safety codes as applicable in the locality where the equipments/systems will be installed. The Bidder shall fully acquaint himself with these requirements and shall ensure compliance with them.

The equipments, systems and services furnished as per this specification shall conform to the codes and standards mentioned in Cl. no. 1.08.02 of this Section. However in the event of any conflict between the requirements of two standards or between the requirements of any standard and this specification, the more stringent requirements shall apply unless confirmed otherwise by the Owner in writing. The decision of the Owner shall be final and binding in all such cases.

The Bidder's scope of supply shall include some items such as thermowells, and other in-line devices for main steam, hot reheat, cold reheat, feed water system falling under the purview of Indian Boiler Regulation (IBR) Act. It shall be the responsibility of the Bidder to obtain the necessary approval of the concerned Inspecting Authority/Chief Inspector of Boilers for the design and design calculations and manufacturing and erection procedures as called for under the IBR act for all items requiring such certifications.

The requirements of statutory authorities (e.g. MOEF, Inspectors of factories, IBR, TAC, BEE, CPCB/TNPCB etc) with regards to various plants areas like Main plant, Fuel oil plant/system, Chlorination Plant, Fire Fighting system, Emission Measurement, Ambient Air Monitoring system etc. shall be complied, even if not actually spelt out.

1.08.02 Reference Codes and Standards

The design, manufacture, inspection, testing, site calibration and installation of all equipment and systems covered under this specification shall conform to the latest editions of codes and standards mentioned below and all other applicable ANSI,

ASME, IEEE, NEC, NEMA, ISA, DIN, VDE, NFPA, IEC, EIA, TIA and Indian Standards and their equivalents. Bidder to note that in no case, OEM/manufacturers own standards shall be accepted.

1.08.02.01 Temperature Measurement

1. Performance Test Code for temperature measurement ASME PTC 19.3 (1974 – R 1998)
2. Temperature measurement - Thermocouples ANSI-MC 96.1 – 1982, IEC 584
3. Temperature measurement by electrical resistance thermometers - IS-2806.
4. Thermometer-element-platinum resistance-IS-2848, IEC 751/DIN 43760
5. RTD Design Code – DIN EN 60751:1996, BS EN 60751 : 2008
6. Thermowell Design Code – ASME PTC 19.3 TW – 2010

1.08.02.02 Pressure Measurement

1. Performance Test Code for pressure measurement - ASME PTC 19.2 (2010)
2. Bourdon tube pressure and vacuum gauges - IS 3624, IS 3602, ASME B 40.1

1.08.02.03 Electronic measuring Instruments & Control hardware

1. Automatic null balancing electrical measuring instruments - ANSI C 39.4 (Rev. 1973), IS 9319
2. Safety requirements for electrical and electronic measuring and controlling instrumentation - ANSI C 39.5 - 1974.
3. Compatibility of analog signals for electronic industrial process instruments - ISA-S 50.1:ANSI MC 12.1 - 1975.
4. Dynamic response testing of process control instrumentation - ANSI MC 4.1 (1975): ISA-S26 (1968).
5. Surge withstand capability (SWC) tests - ANSI C 37.90A (1974) IEEE Std. 472 (1974). IEC – 255.4.
6. Printed circuit boards - IPC TM-650, IEC 326 C
7. General requirements and tests for printed wiring boards - IS 7405 (Part-I) - 1973
8. Edge socket connectors - IEC 130-11.
9. Requirements and methods of testing of wire wrap terminations DIN 41611 Part-2.
10. Dimensions of attachment plugs & receptacles ANSI C73-1973.
11. Direct acting Electrical Indicating Instruments: IS-1248-1968.

1.08.02.04 Instrument Switches and Contacts

1. Contact rating - AC services NEMA ICS Part-2 125, A600
2. Contact rating - DC services NEMA ICS Part-2-125, N600.

1.08.02.05 DDCMIS & other Control System

1. Application of Safety Instrumented System – ANSI/ISA 84.01 1996
2. Functional Safety - Safety Instrumented System for Process Sector – IEC – 61151

3. IEEE Application Guide for Distributed Digital Control Monitoring for Power Plant – IEEE 1046
4. Fossil Fuel Power Plant Steam Turbine Bypass System – ANSI/ISA – 77.13.01
5. Human System Interface Design Review Guide lines – NUREG – 700
6. Annunciation Sequence and Specification – ANSI/ISA 18.1
7. "IEEE 1050, IEEE guide for Instrumentation & control system grounding in generating station",
8. ANSI/ISA-77.44.01-2007 - Fossil Fuel Power Plant - Steam Temperature Controls
9. ANSI/ISA-RP77.60.05-2001 (R2007) - Fossil Fuel Power Plant Human-Machine Interface: Task Analysis
10. ANSI/ISA-77.42.01-1999 (R2006) - Fossil Fuel Power Plant Feedwater Control System – Drum-Type
11. ANSI/ISA-77.20-1993 (R2005) - Fossil Fuel Power Plant Simulators - Functional Requirements
12. ANSI/ISA-77.41.01-2005 - Fossil Fuel Power Plant Boiler Combustion Controls
13. ANSI/ISA-RP77.60.02-2000 (R2005) - Fossil Fuel Power Plant Human-Machine Interface: Alarms
14. ANSI/ISA-77.70-1994 (R2005) - Fossil Fuel Power Plant Instrument Piping Installation
15. ANSI/ISA-TR77.60.04-1996 (R2004) - Fossil Fuel Power Plant Human-Machine Interface-Electronic Screen Displays
16. ANSI/ISA-77.43.01-1994 (R2002) - Fossil Fuel Power Plant Unit/Plant Demand Development-Drum Type
17 ANSI/ISA-77.13.01-1999 - Fossil Fuel Power Plant Steam Turbine Bypass System

1.08.02.06 Electronic Cards, Subassemblies and Componets

a) Unpackaged

i)	Vibration	:	IEC-68.2.6
ii)	Shock	:	IEC-68.2.27
iii)	Drop & Topple	:	IEC-68.2.31

b) Packaged

Vibration, Drop & Static Compression - NSTA

C) Electromgnetic Compatibility

i)	Electrical Fast Transient	:	IEC-801.4
ii)	Surge Withstand	:	IEC-255.4
iii)	Radiated Electromagnetic Field	:	IEC-801.3
iv)	Electrostatic Discharge	:	IEC-801.2
v)	Electromagnetic Emission	:	VDE 0871, Class B

1.08.02.07 UPS System/DC control power supply system:

1. Practices and requirements for semi-conductor power rectifiers - ANSI C34.2-1973.

2. Relays and relay systems associated with electrical power apparatus - IEEE Std. 3.13, ANSI C 3790-1983.
3. Surge withstand capability tests - ANSI C37.90a-1974. IEEE Std. 472 - 1974
4. Recommended practice for sizing large lead storage batteries for generating stations & substations - IEEE-485.
5. Performance testing of UPS - IEC 146.
6. IEC 62040 – General & Safety requirement of UPS.
7. IEC 62040-2 - UPS – EMC Requirement.
8. IEC 62040-3 - UPS – Method of specifying the performance and test requirement.
9. IEC 60269-2 – Main Supply Fuse.
10. IEC 60947 – MCCB.
11. IEC/EN 60623 – BATTERIES. IEEE485/IEEE1115 IS : 10918, IS : 1069
12. IEC 60146 - For DC system.

1.08.02.08 Control Valves

1. Control Valve sizing - Incompressible fluids - ISA S39.2 - 1972.
2. Control valve sizing - Compressible fluids - ISA S39.3 - 1973, ISA S39.4 - 1974.
3. Face to face dimensions of control valves - ANSI B16.10
1) ISA Hand book of control valves - ISBN B1047-087664-234-2.
2) Valves - flanged, threaded and welding end : ANSI B 16.34(2009)
3) Casting : ASTM A 216 / A 351 (2008)
4) Welded end connection : As per ASME boiler and pressure vessel code / ANSI.B 16.34(2009), B16.25 (2009), B 16.11(2009).
5) Defect removal: ANSI B 16.34 2009.
6) Cleaning : ASTM A 380 2006.
7) CV test : As per ISA procedure S 75.02 (2008).
8) Control Valve seat leakage : ANSI/FCI 70.2

1.08.02.09 Enclosures

1. Types of enclosures - NEMA Std. ICS-6-110.15 through 110.22 (Type 4 to 13).
2. Racks, panels, and associated equipment - EIA: RS-310-B (ANSI C83.9 - 1972)
3. Protection Class for Enclosure, Cabinets, Control Panels and Desks - IS-13947-1962.

1.08.02.10 Apparatus, enclosures and installation practices in hazardous areas

1. Classification of hazardous area - NFPA Art. 500, Vol.70-1984.
2. Electrical Instruments in hazardous dust locations - ISA-RP 12.11
3. Intrinsically safe apparatus - NFPA Art.493 Vol.4.1978
4. Purged and pressurized enclosure for electrical equipment in hazardous location - NFPA Art. 496 1982.

1.08.02.11 Sampling System

1. Stainless steel material of tubing and valves for sampling system - ASTM A269-82 Gr TP316.
2. Submerged helical coil heat exchangers for sample coolers ASTM D 11-98.
3. Water and Steam in power cycle - ASME PTC 19.11(2008).
4. Standard methods of sampling system - ASTM D 1066-69.

1.08.02.12 Annunciators

1. Specifications and guides for the use of general purpose annunciators - ISA RP 18.1-1979.
2. Surge withstand capability tests - ANSI C.37.90a - 1974 and IEEE std. 472-1974

1.08.02.13 Interlocks, Protections

1. Relays and relay system associated with electric power apparatus - IEEE std.3.13.
2. Surge withstand capability tests - ANSI C.37.90a - 1974 and IEEE Std. 472 - 1974.
3. General requirements & tests for switching devices for control and auxiliary circuits including contactor relays - IS-6875 (Part-I) 1973.
4. Turbine water damage prevention - ASME - TDP-1980.
5. Boiler safety interlocks - NFPA Section 85B, 85D, 85E, 85F,85G.

1.08.02.14 Process Connection and Piping:

1. Codes for pressure piping power piping ANSI B31.1
2. Seamless carbon steel pipe ASTM A-106.
3. Forged and Rolled Alloy steel pipe flanges, forged fittings, valves and parts - ASTM A-182.
4. Material for socket welded fittings - ASTM A-105.
5. Seamless ferrite alloy steel pipe - ASTM A-335.
6. Pipe fittings of wrought carbon steel and alloy steel - ASTM A-234.
7. Composition bronze or metal castings - ASTM B-62.
8. Seamless copper tube, bright annealed ASTM B-168.
9. Seamless copper tube - ASTM B-75.
10. Dimensions of fittings - ANSI B-16.11
11. Valves flanged and butt welding ends - ANSI B16.34.
12. Nomenclature for Instrument tube fittings ISA-RP-42.1 - 1982.

1.08.02.15 Instrument Tubing

1. Seamless carbon steel pipe - ASTM - A106.
2. Material for socket weld fittings - ASTM - A105.
3. Dimensions of fittings - ANSI B16.11
4. Code for pressure piping, welding, hydrostatic testing - ANSI B31.1.

1.08.02.16 Cables

1. Thermocouple extension wires/cables - ANSI C 96.1 - 1982.
2. Colour coding of single or multi-pair cables – VDE 0815

3. Guide for design and installation of cable systems in power generating stations (insulation, jacket materials) - IEEE Std. 422 - 1977.
4. Requirements of vertical tray flame test - IEEE 383 - 1974.
5. Standard specification for tinned soft or annealed copper wire for electrical purpose - ASTM B-33 - 81.
6. Oxygen index and temperature index test - ASTM D-2863.
7. Smoke generation test - ASTMD-2843 and ASTME-662.
8. Acid gas generation test - IEC-754-1.
9. Swedish chimney test - SEN - 4241475 (F3)
10. Instrumentation cables and internal wiring IS-1554 (Part-I, 1976) and IS-5831(1984).
11. Standard for Control, Thermocouple Extension and Instrumentation cable - NEMA WC57-2004 ICEA S-73-532, Rev. 2, 2004)□
12. PVC insulated (heavy duty) Electric cables for working voltages upto and including 1100V - IS:1554 (Part-I)
13 Conductors for insulated electric cables and flexible cords. - IS:8130
14 PVC insulation and sheath of electric cables - IS:5831
15. Mild steel wires, strips and tapes top armoring cables - IS:3975
16. Water Immersion Test - VDE 0815
17 Drums for electric cables - IS : 1048

1.08.02.17 Cable Trays, Conduits

1. Guide for the design and installation of cable systems in power generating station (cable trays, support systems, conduits) - IEEE Std. 422, NEMA VE-1, NFPA-70-1984.
2. Guide for the design and installation of cable systems in power generating station (Cable trays, support systems, conduits) Test Standards, NEMA VE-1 - 1979.
3. Galvanising of Carbon steel cable trays - ASTM A-386-78.

1.08.02.18 Flow measurement

1. ASME Performance Test Code PTC-19.5 (2004), ISA RP3.2
2. BS 1042
3. ISO 5167

1.08.02.19 Surge Protection System

1. Surge withstand capability tests - ANSI C37.90a-1974. IEEE Std. 472 – 1974
2. IEC 61643-1:1998-02 and E DIN VDE 0675 part 6:1996-03/A2: 1996-10
3. IEC 61643-21:2000-09 and E VDE 0845 part 3-1:1999-07

1.08.02.20 Digital Video Recording & Management System (DVRMS)

1. ISO 9001 (2000)
2. ISO/IEC15504 Level3 or higher (SPICE 2.0 Software Process Improvement and Capability Determination)

3. SEICMM Level3 or higher (American Software Engineering Institute - Capability Maturity Model)

Where:

i) IEEE - Institute of Electrical and Electronics Engineers.
ii) ISA - Instrument, Systems and Automation Society
iii) NEMA - National Electrical Manufacturers Association
iv) ANSI - American National Standards Institute
v) NFPA - National Fire Protection Association
vi) ASME - American Society of Mechanical Engineers
vii) IS - Indian Standards
viii) IEC - International Electro-technical Commission
ix) ASTM - American Society for Testing Materials
x) EIA - Electronic Industries Association
xi) DIN - Deutsche Institute Normale
xii) TIA – Telecommunication Industries Association

SPECIFICATION

FOR

QUALITY ASSURANCE

&

TESTING

CHAPTER-14

QUALITY ASSURANCE AND TESTING AND GUARANTEES

14.01.00 GENERAL REQUIREMENT

14.01.01 All equipment furnished under this specification shall be subject to test by authorized quality assurance personnel of the Bidder, representatives of the Owner during manufacture, erection and on completion. Bidder'' quality assurance personnel for these shop and site tests shall be identified in advance and shall be acceptable to the Owner. The approval of the Owner or passing of such inspection of tests will not, however, prejudice the right of the owner to reject the equipment if it does not comply with the specifications when erected or fails to give complete satisfaction in service.

14.01.02 The Bidder shall furnish details of shop and site tests proposed to be conducted by him at various stages to meet the specification requirements for each type of instrument/system along with his proposal. Bidder shall also furnish details of his proposed shop and site quality assurance organization for this contract

14.01.03 Bidder shall prepare a detailed shop and site 'Quality Assurance Programme' to meet the requirements of these specifications for Owner's approval. This document shall also contain the formats for reports and maintenance of test records specification of test equipment to be used for site tests.

14.01.04 All equipment and systems furnished under this specification shall be subjected to shop & site tests in accordance with the Quality Assurance Program approved by the Owner and shall be adequate to ensure full compliance with these specification, all applicable codes & standards and detailed engineering drawings and documents approved by the Owner.

14.01.05 The Bidder shall provide all required test equipment and simulation devices for performing all shop and site tests. All tests equipment shall be of reputed make, required accuracy class and shall be recently calibrated. The record of calibration of test equipment shall be made available to the Owner on demand.

14.01.06 The cost of all tests as per the requirements of this specification and approved quality assurance programme shall be included in Bidder's lump sum price for this package and no extra price shall be payable by the Owner for conducting any test as per the intent and requirements of this specification.

14.01.07 All approval/Inspection are to be carried out by the Owner only.

14.02.00 SHOP TESTS

14.02.01 General Requirement

14.02.01.00 Shop tests shall include all tests to be carried out at Bidder's works at of this sub-bidder and at works where raw materials used for manufacture of equipment is produced.

14.02.01.01 Individual components, instruments and devices furnished in accordance with specification sheets, and I&C device list enclosed with these specifications shall be shop tested by manufacturer prior to shipment. The manufacturer shall conduct these tests for certifying compliance with published specifications for the equipment and provide test results to the Owner in writing. These tests and test certificates shall be in accordance with the agreed 'QA' programme for major systems/equipments. However, manufacturer's standard methods shall be followed if details of tests for any equipment are not covered under this agreed 'QA Programme'.

14.02.01.02 Whenever tested quality material is specified and wherever called upon by Indian Boilers Regulations or by the design code, the test pieces are to be prepared and tested to Owner's satisfaction.

14.02.01.03 In the event of Owner being furnished with certified particulars of tests, which have been carried out by the suppliers of material, the Owner may, at his discretion, dispense with these tests.

14.02.02 Material Tests

14.02.02.01 Whenever tested quality material specified and whenever called upon by Indian Boilers Regulations or by design code, the test pieces, are to be prepared and tested to Owner's satisfaction.

14.02.02.02 In the event of Owner being furnished with certified particulars of tests, which have been carried out by the suppliers of material, the Owner may, at his discretion, dispense with these tests.

14.02.03 Test at Manufacturer's Works

14.02.03.01 Works tests are to include electrical, mechanical performance and hydraulic tests in accordance with relevant IS, IBR or any other approved standard or any other tests called for by the Owner under these specifications to ensure that the equipment being supplied fulfills the requirements of these specifications. For equipments not covered by any IS or other approved standards, the tests to be carried out shall be in accordance with Bidders' quality assurance programme approved by the Owner.

14.02.03.02 Control systems, monitoring systems ,control panels instrument enclosures ,and power supply systems shall be shop tested according to unique requirements specified in the applicable section of these specifications for each item and quality assurance program approved by the owner.

14.02.03.03 All shop tests shall be performed prior to shipment and the Owner shall be given the opportunity to witness these tests. The Bidder shall notify the Owner regarding readiness for shop test at least 10 days before the scheduled date if the tests to be conducted within Indian and at least 60 days before the schedule date if the test is to be conducted abroad.

14.02.04 Factory Tests

14.02.04.01 Automatic Control and Monitoring system (DDCMIS, PLC & any other microprocessor based control system) including alarm annunciation system furnished as per this specification shall be subject to shop and site tests as per the requirements of this specification, applicable codes and Owner approved Quantity Assurance Program so as to demonstrate to the Owner that the equipment furnished by the Bidder meets the intent and requirement of this specification. These tests shall include but shall not be limited to the tests indicated in the subsequent clauses.

14.02.04.02 **Surge Protection Test for Solid State Equipment**

All solid state equipment shall be able to withstand the noise and surge inherent in a Power House, and shall strictly comply with SWC tests ANSI C 37.90A, 1974 for IEEE-472 (1974). Complete details of the features incorporated in electronic system to meet this requirement, the relevant test carried out, and the test certificates shall be submitted along with the proposal.

14.02.04.03 **Burn-in and Elevated Temperature Test**

All solid state electronic equipment shall be tested as a complete system/equipment with all devices connected for a minimum of 168 hours continuously under energized conditions prior to shipment from manufacturer's works, as per the following cycle :-

During the first 48 hours of testing the ambient temperature shall be maintained at 50 deg.C and relative humidity at 95%. The equipment shall be interconnected with all devices, which will cause it to repeatedly perform all operations; it is supposed to perform in actual service, with load on various components being equal to those, which will be experienced in actual service.

The 48 hours tests period shall be continuous but shall be divided into four 12 hours segments. The input voltage during each 12-hour segment shall be nominal voltage for 11 hours, followed by 110% of normal voltage for 30 minutes followed by 90 percent of nominal voltage for 30 minutes.

The 48 hours elevated temp test shall be followed by 120 hours of burn in test as specified in the above paragraphs except that the temperature is reduced to ambient temperature prevalent at that time. Alternatively copy of type test certificate for burn-in test shall be submitted.

14.02.04.04 The Bidder shall furnish full details regarding shop tests and site tests, as per good engineering practices. The Owner shall approve all such tests and the supplier shall conduct all such tests without calling for additional price.

The tests shall cover factory tests, burn-in and elevated temperature tests, simulation and functional tests, insulation tests as applicable, the rating of the contact devices and components, surge withstand capability test, conformity of interconnection cables, testing and checking of other conditions deemed to be necessary with the system/equipment items.

14.02.04.05 All instruments and control equipment supplied against this contract shall be factory calibrated at least at five (5) points through out the range and checked for their

functional/performance requirements. The instruments shall also be calibrated at site prior to commissioning.

14.02.04.06 All panels, instruments enclosures, junction boxes, etc. shall be type tested for degree of protection and applicable in accordance with IS: 2147. 8.02.04

14.02.04.07 Type, routine and acceptance testing of all equipments, supplied under this contract, shall be in accordance with relevant NEEA/IS/IEC/ANSI/BS/ISA standards, in addition to the requirements of Owner approved Quality Plans. Six (6) copies of test reports shall be submitted to the Owner for approval prior to dispatch of respective equipment

14.02.04.08 The representative of Owner shall be given opportunity to witness the factory tests which shall be mutually finalized during the progress of the contract.

14.02.04.09 All control systems to be furnished for this project, shall be factory tested for circuit continuity and direction of response. The Components to be tested shall include all controllers, HAND/AUTO station, other system modules, alarm contactors and multi-conductor interconnecting cables. The tests shall be performed with all of the system components supplied by the Bidder connected to form a complete system with the sole exception of transmitters. The tests shall include a means of confirming the mathematical design response of the control system by simulating changes in system input. The tests shall be a qualitative functional test of each component of control system, which simulates dynamic inputs and monitors system outputs.

14.02.04.10 Certain control loops shall be factory tested using closed loop mathematical simulation techniques. Control loops to be tested by closed loop methods are broadly as under. However, owner has discretion to test and all control loops during simulation testing.

ii) Firing rate control (fuel and air flow control)
iii) Furnace draft control
iv) Boiler separator level control
(d) **Response time for Turbine Control System.**

The input simulation equipment shall be designed to produce effects from control system outputs based on mathematical model of the predicted performance and process dynamics of the main unit equipment. The control constants of various control loop components shall be adjusted to produce a stable and optimum control adjusted to produce a stable and optimum control when connected to the simulation equipment.

14.02.04.11 Simulation data including factory adjustment of control system constants, and simulation equations shall be tabulated and shall be made available by the Bidder for owner's use during field check out and the start up of the control system.

14.02.04.12 Availability of a simulated type test for automatic control loops specified with a detailed description of testing methods utilized, shall be indicated.

14.02.04.13 The availability of facilities for carrying out the model test for the control systems shall be indicated by the bidder. Also details of test procedures and copies of test results conducted for a similar fossil fuel fired unit shall be furnished. The data required from Boiler and Turbo generator supplies shall also be furnished by the Bidder.

14.02.04.14 Brief description of all tests proposed to be conducted on each control system components during various stages of manufacture, installation and commissioning shall be furnished. Copies of test data accumulated during the tests shall be submitted to the mutually agreed formats.

14.02.04.15 The owner shall witness the factory tests which shall be performed at a time mutually agreeable to the Bidder and the owner.

i TESTS TO BE PERFORMED FOR FIELD INSTRUMENTS

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 : ± 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 (≤ 500 MΩ at 500V DC) as per ISA, Hydro test for TW. Bore concentricity: ± 5% of wall thickness, Accuracy test.
8.	Thermocouple assembly
	Calibration / Material test, Insulation test (≥ 500 Ω at 500 V, DC) as per ISA, Hydro static test (1.5 times max. pr.), Bore concentricity : ± 5% of wall thickness.
9.	Thermowells
	Material test / Bore concentricity : ± 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)

10.	Level Guages
	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 11.
17.	Position transmitters
	Calibration / hysteresis and Accuracy test
18.	Electro Pneumatic Convertors
	Calibration test / Accuracy test
19.	Solenoid valves
	Hydrotest / 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-emf 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 :

	Hydro test, IBR Certificate
28.	Sampling racks :
	Hydro test, IBR Certificate for tubes and fittings.
29.	S02 / 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 DegC) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) 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 DegC) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) 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
	Routine test: Conductor resistance test/High voltage test/Impulse dielectric test/insulation test/Humidity test/Temperature rise test on power circuits/short time current test on power circuits.
	Type test:Annealing test/Test for insulation and sheath/ Flame retardance test - a) Oxygen index, b) Flammability / Test for acid gas generation/test for water absorption/wet dielectric test
39	Marshalling/System cabinets
	Verification of degree of protection/Electrical tests as detailed under wiring Termination& accessories/Type test and routine test as per relevant Indian standards.
	Notes:
	1. Test Certificates in addition to inspection at manufacturers works shall be furnished for all the instruments for Owner's review. 2. Above Test to be witnessed shall be finalized by Owner.
	3. In addition to above test, test as per approved QAP shall also be witnessed by owner.

17.02.05 TYPE TESTING

The BIDDER shall furnish the Type test reports of all type tests as per relevant standards and codes. As well as other specifics test indicated in the specification. A list of such test are given for various equipment in table titled, TYPE TEST REQUIREMENT FOR C&I SYSTEM and under the item special requirement for solid state requirements/systems. For the balance equipments/instruments. type test may be conducted as per manufacturer standards or if required by relevant standards.

A. Out of these test listed , the bidder /subvendor/manufacturer is required

to conduct certain type test specifically for this contract (and witnessed by employer or his authorized representative). Even if the same have been conducted earlier as clearly indicated subsequently such tests.

B. For the rest, submission of type test , results, and certificates shall be acceptable provided following points

i. The same have been carried out by the bidder/ subvendor on exactly the same model/rating of equipment. (For control valves this shall be same size, type & design).
ii. There has been no change in the components from the offered equipments and tested equipments.
iii. The test has been carried out as per the latest standards along with amendemends as on the date of bid opening.

C. In case the approved equipment is different from the one on which the type test had been conducted earlier or any of the above grounds, then the tests have to be repeated and the cost of such tests shall be borne by the bidder/sub-vendor within the quoted price and no extra cost will be payable by the owner on this account.

17.02.05.1 As mentioned against certain items, the test certificates for some of the items shall be reviewed and approved by the main bidder or his authorized representative and balanced have to be approved by the employer.

The schedule of conduction of type test/submission of reports shall be submitted and finalized during pre award discussion.

17.02.05.2 For the type test to be conducted, bidder shall submit detailed test procedure for approval by owner. This shall clearly specify test setup, instruments to be used, procedure, acceptance norms (wherever applicable). , recording of different parameters, intervals of recording precaution to be taken etc. for the test to be carried out.

17.02.05.3 **SPECIAL REQUIREMENTS FOR SOLID STATE EQUIPEMNTS /SYSTEMS**

The minimum type test report, over and above the requirements of above clause which are to be submitted for each of the major C&I systems like DDCMIS, DCS, PLC etc shall be as indicated below:

i. Surge Withstand Capability (SWC) for solid state equipments/equipments

All solid state systems/equipments shall be able to withstand the electrical noise and the surges as encountered in actual service conditions and inherent in the power plant . All the solid states systems /equipments shall be provided with all required protection that needs the surge withstand capability as defined in ANSI 37.90.1/IEEE 472. Hence, all front end cards which receive external signals like analog input and output modules, Binary input and output modules etc including power supply , data highway, data links shall be provided with protection that meets the surge withstand capability as

defined in ANSI 37.90.1/IEEE 472. Complete details of th features incorporated in the electronic system to meet this requirement the relevant test carried out, the test certificates ,etc shall be submitted along with the proposal. As an alternative to the above , suitable class of EN 61000-4-12 which is equivalent to ANSI 37.90.1/IEEE 472 may also be adapted for SWC test.

ii. The dry heat test as per IEC-68-2-2 or equivalent
iii. Damp heat test as per IEC 68-2-3 or equivalent
iv. Vibration test as per IEC 68-2-6 or equivalent
v. Electrostatic Discharge test as per EN 61000-4-2 or equivalent
vi. Radio frequency immunity test as per EN 61000-4-6 or equivalent
vii. Electromagnetic Field Immunity test as per EN 61000-4-3 or equivalent

Test listed at Item no v, vi, vii above are applicable for electronic cards only as defined under item no. (i) above

17.02.05.4 TYPE TEST REQUIREMENTS FOR C&I SYSTEMS

S.No.	Item	Test requirement	Standard	Test to be specifically conducted	Owner's Approval required on Test Certificate
1	Electrical metering instruments	As per standards	IS 1248	No	Yes
2	Thermocouple	Degree of Protection Test	IS - 13947	No	No.
3	Junction Box	Degree of Protection Test	IS - 13947	Yes	Yes
4	RTD	As per standards	IEC-60751	No	No
5	Electronic Transmitter	As per standards	BS 6447/IEC 60770	No	Yes
6	E/P convertor	As per standards	Manufacturing standard	No	Yes
7	Instrumentation cable (Twisted and shielded) (Refer Vol. V, Chapter 9)				
8	Battery	As per standard	IS 10918	Yes	YES
9.	Voltage stabiliser	Over load test	Approved procedure	No	YES
		Temp. rise test without redundant fans	Approved procedure	No	YES
		Input voltage variation test	Approved procedure	No	YES
10	**DDCMIS**				
	CLCS	Model Test	Approved	No	No

	system		procedure		
	BMS & MFT	Safety requirement	VDE 0116, SEC 8.7	No	YES
11	Conductivity type level switch	Degree of protection test	IS 13947	No	No
12	Local gauges	Degree of protection test	IS 13947	No	No
13	Process actuated switches	Degree of protection test	IS 13947	No	No
14	Control valves	CV test	ISA 75.02	No	YES
15	PLCs	As per Standard	IEC 1131	No	YES
16	LIE/LIR	Degree of protection test	IS 13947	YES	YES
17	Flue gas O2 analyser, other Flue gas Analysers	Degree of protection test	IS 13947	No	YES
18	Flow nozzles & Orifice plates	calibration	ASME PTC BS 1042	YES	YES

Note:
Type test are to be conducted only for the items, which are being supplied as part of this package.

A. For batteries with electric power supply system of main plant C&I, the bidder shall submit for owner's approval the reports of all the type tests as per IS-10918 carried out within last 5 years from the date of bid opening and the test should have been either conducted at an independent laboratory or should have been witnessed by a owner/client. The complete type test report shall be for any rating of battery in a particular group, based on plate dimensions being manufactured by supplier.

For batteries with electric power system of auxiliary plants, type test reports for batteries shall be as per standard –practice of manufacturer.

14.02.06 Testing at Site [Prior to commercial operation]

a. All equipment shall be checked thoroughly in respect of the following:

i. Visual and mechanical testing

ii. Complete system configuration loading functions; system diagnostics; system proper operation specified power supply specifications.

LIST OF

MANDATORY

SPARES

2x660 MW ENNORE SEZ PROJECTOF TANGEDCO					
MANDATORY SPARES					
III.	CONTROL & INSTRUMENTATION PACKAGES				
TANGEDCO				Total Ex-Works price	*Remarks
Sl no	Name of spares	Unit	Qty	in INR	
1.0.0		INSTRUMENTATION			
(I)	Each type of lamps, PBs, ILPBs, fuse, MCB, MCCB used in the equipment/system.	Nos.	20 % of Installed of each type.		PEM-For Fuel Oil Unloading System, included under clause Fuel oil system of Mech. List of mandatory spares
1.00.01	**Measuring Instruments**			87,87,625	PEM-For CAS included in clause Compressor Air System of Mech. List of mandatory spares AND For Fuel Oil Unloading System, included under clause Fuel oil system of Mech. List of mandatory spares AND For Air Conditioning system, price included under clause Air Conditioning system of Mech. List of mandatory spares
1.00.01.01	**Indicators, Recorders, Electrical Metering and Skid Mounted Instruments**				price included at s.no. 1.00.01 above
(i)	Indicators, recorders and meters offered from each model for the project. These instruments shall be supplied with three sets of blank scales.	Nos.	10 % of Installed of each type/Model or a minimum of one number for each model and type, whichever is more		price included at s.no. 1.00.01 above
(ii)	For skid mounted instruments	Nos.	10% of total number of instruments for each Type and model or a minimum of one number for each model and type, whichever is more		price included at s.no. 1.00.01 above
1.00.01.02	**Temperature Elements and Thermowells**			12,60,000	TRY-LOT PRICE FOR THE APPLICABLE ITEMS UNDER THIS SL NO 1.00.01.02

1. C&I Mandatory spares are indicated in above list. These spares shall be considered as per the applicable items in main supply of AC system package.
2.The spares shall be considered as unit wise except for any item/equipment supplied as common for both units.

TANGEDCO				Total Ex-Works price	*Remarks
Sl no	Name of spares	Unit	Qty	in INR	
(i)	Thermocouple/RTD elements	Nos.	10% spare for each type and length of element furnished with thermocouple/RTD assemblies, or a minimum of one number of each type & length, whichever is more.	50,20,675	HYD-Price included forSl no 1.00.01.02 and 1.00.01.03 For items applicable for Pulverisers-refer NOTE-1 below Items applicable for Pumps and BFPDT shall be supplied
(ii)	Thermowells	Nos.	10% for each type of temperature sensors or a minimum of one for each type, whichever is more	8,960	
1.00.01.03	**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.**	Nos.	10% of total number of Instruments/transducers offered for each model and type for the project or a minimum of one number, whichever is more.	1,17,63,957	Meters are considered for ROTAMETERS AND For CAS included in clause Compressor Air System of Mech. List of mandatory spares AND For Mill Reject Sytem, included in clause Mill Reject System of Mech. List of Mandatory Spares AND For Fuel Oil Unloading System, included under clause Fuel oil system of Mech. List of mandatory spares AND For Electrochlorination , price included under clause HORIZONTAL CENTRIFUGAL PUMP FOR EACH TYPE of Mech. List of mandatory spares AND For Air Conditioning system, price included under clause Air Conditioning system of Mech. List of mandatory spares
~~1.00.01.04~~	**Flue Gas Analyzers & CEMS (**Spareparts shall be furnished in accordance with manufacturer's recommendations for five years continuous operation or minimum quantities indicated as below (whichever is more)				price included at s.no. 1.00.01 above

1. C&I Mandatory spares are indicated in above list. These spares shall be considered as per the applicable items in main supply of AC system package.
2.The spares shall be considered as unit wise except for any item/equipment supplied as common for both units.

Anshul
S A Khan
Praveen Kishore

TANGEDCO				Total Ex-Works price	*Remarks
Sl no	Name of spares	Unit	Qty	in INR	
1.00.02.30	Mouse	Nos.	20 nos. of each type/model.	11,900	
1.00.03	**Steam and Water Analysis System (SWAS)**			50,56,170	Lot price has been given for items under Sl no. 10.00.03
1.00.03.01	High pressure reducing elements for sample flow.	Nos.	10% spare of qty installed.		
1.00.03.02	Ion exchange columns with resin as utilized with cation conductivity analysers	Nos.	Four No		
1.00.03.03	Conductivity cells as utilised with conductivity monitors	Nos.	Two nos of each type		
1.00.03.04	pH flow-through type cells used with pH monitors	Nos.	Two nos. of each type		
1.00.03.05	Chemical reagents for all analysers	Set	12 months continuous operation of all analysers from date of taking over.		
1.00.03.06	Chemical reagents for colorimetric silica analyzers	Set	12 months continuous operation of all analysers from date of taking over.		
1.00.03.07	Electronic Modules	Nos.	One (1) no. for each type of Analyser.		
1.00.03.08	Pressure gauge, solenoid valves, temperature gauge, Back Pressure regulating valves, 3 way grab valves, needle valves, isolation valves, PRV, flow switch, flow indicator and temperature switch, erection hardware's, valves in SWAS.	Nos.	Two (2) no. of each type		
1.00.03.09	Primary coolers/secondary coolers.	Nos.	Three (3) No of each type		
1.00.04	**Relay based Control Panels**			17,150	PEM-For Air Conditioning system, price included under clause Air Conditioning system of Mech. List of mandatory spares EDN-Lot Price has been given
1.00.04.01	LEDs for indicating lights	Nos.	10% of qty installed.		
1.00.04.02	Control circuit fuses/MCB/MCCB/ Semiconductor Fuses	Nos.	300% of installed of each type, current rating.		
1.00.04.03	Relays modules & contactors.	Nos.	20% spare of qty Installed of each type & rating.		

1. C&I Mandatory spares are indicated in above list. These spares shall be considered as per the applicable items in main supply of AC system package.
2.The spares shall be considered as unit wise except for any item/equipment supplied as common for both units.

Anshul
S A Khan
Praveen Kishore

TANGEDCO				Total Ex-Works price	*Remarks
Sl no	Name of spares	Unit	Qty	in INR	
1.00.05	**Alarm Annunciation System**			22,295	PEM-For Electrochlorination , price included under clause HORIZONTAL CENTRIFUGAL PUMP FOR EACH TYPE of Mech. List of mandatory spares AND For Air Conditioning system, price included under clause Air Conditioning system of Mech. List of mandatory spares EDN-Lot Price has been given
1.00.05.01	logic modules, group card modules, power supply modules, Hooters and any other electronic module.	Nos.	20% spares of each type installed		
1.00.05.02	un-engraved window boxes complete with LED etc.	Nos.	5% spares of each size installed		
1.00.05.03	LEDs for annunciation facia windows and LEDs box assemblies offered for the project	Nos.	20% of qty installed		
1.00.05.04	Annunciator hooter	Nos.	One (1) No. of each type		
1.00.06	**Un-interrupted Power Supply System and DC Control Power Supply System**			5,36,620	
1.00.06.01	As per Manufacturer's Recommendation for Three Years Continuous Operation or minimum quantities indicated as below (whichever is more)				
1.00.06.02	Fuses/Semiconductor Fuses	Nos.	300% of installed of each type, current rating with each panel /board		
1.00.06.03	Miscellaneous parts for the power supplies such as SCRS, transistors, resistors, diodes, light bulbs, static switches , blocking diodes etc	Nos.	Minimum of 10% or atleast two (which ever is more) of each type		
1.00.06.04	Battery cells complete with contactor,cover plates etc	Nos.	10% of qty installed		
1.00.06.05	Electronic Modules like Rectifier control card, inverter control card, Driver card, IGBT Module, DC-DC converter card or any other card as listed in approved BOM for UPS, AC supply & 24 V DC supply etc.	Set	1 Set of each type & rating		

1. C&I Mandatory spares are indicated in above list. These spares shall be considered as per the applicable items in main supply of AC system package.
2.The spares shall be considered as unit wise except for any item/equipment supplied as common for both units.

Anshul
S A Khan
Praveen Kishore

TANGEDCO				Total Ex-Works price	*Remarks
Sl no	Name of spares	Unit	Qty	in INR	
1.00.06.06	Miniature Circuit breakers for AC and DC supply.	Nos.	20 % of installed or 10 Nos of each type (which ever is more) for ACDB and DCDB.		
1.00.06.07	Digital/analog panel meters/indicators	Nos.	5% or 2 no. of each type (whichever is more)		
1.00.06.08	CT's, CVT's VT's chokes, AC/DC isolators, contactors, timers, relays.	Nos.	10% or 2 nos. of each type and rating, (whichever is more)		
1.00.06.09	Cooling Fans in UPS & 24 V DC charger panels	Nos.	10% or 2 nos. of each type and rating, (whichever is more)		
1.00.06.10	following accessory equipment for the battery shall be furnished :	Set	Two sets		
	a) Cell lifting facilities				
	b) Assembly wrenches				
	c) Vent plug hydrometer d) Vent plug thermometer				
	e) Supply of corrosion-preventive grease.				
	f) 10% spare cells.				
1.00.06.11	Electronic modules of each type & rating for UPS and DC control power supply system.	Set	One set of with each set consisting of at least one number of each type of electronic module for inverters, chargers, static switch, stabiliser etc. as per approved BOM.		
1.00.06.12	MCCB for UPS & 24 V DC charger panels, ACDB, DCDB.	Nos.	20 % of installed or 5 Nos of each type (which ever is more)		
1.00.07	**Erection hardware**			9,50,250	TRY-LOT PRICE FOR THE APPLICABLE ITEMS UNDER THIS SL NO 1.00.07 PEM-For Air Conditioning system, price included under clause Air Conditioning system of Mech. List of mandatory spares EDN-Lot price has been given for items Sl no 1.00.07
1.00.07.01	Instrument valves	Nos.	Ten (10) percent of each type & Size installed		

1. C&I Mandatory spares are indicated in above list. These spares shall be considered as per the applicable items in main supply of AC system package.
2.The spares shall be considered as unit wise except for any item/equipment supplied as common for both units.

TANGEDCO				Total Ex-Works price	*Remarks
Sl no	Name of spares	Unit	Qty	in INR	
1.00.07.02	Condensate pots of each type & Size installed	Nos.	Ten (10) percent of total number of Installed or four numbers whichever is higher .		
1.00.07.03	Manifold	Nos.	Ten (10) percent of each type & Size installed		
1.00.07.04	Fittings	Nos.	Ten (10) percent of each type & Size installed		
1.00.08	**LVS**			8,58,305	EDN-Lot price has been given for items Sl no 1.00.08
1.00.08.01	LEDs	Nos.	20% (Installed) spares of each type & size.		
1.00.08.02	LVS Filters	Nos.	50% spare or min 6 nos.		
1.00.08.03	Electronic cards of each type for LVS	Nos.	3 nos. or 20% whichever is more		
1.00.08.04	Interfacing cables	Set	Two Set of each type & size.		
1.00.08.05	Power supply modules of each type for LVS	Nos.	3 nos. or 20% whichever is more		
1.00.08.06	Cooling modules of each type for LVS	Nos.	3 nos. or 20% whichever is more		
1.00.08.07	LVS Controller of each type for LVS	Nos.	2 nos.		
1.00.09	**Master Slave Clock system**			1,45,950	EDN-Lot price has been given for items Sl no 1.00.09
(i)	As per Manufacturer's Recommendation for Three Years Continuous Operation or minimum quantities indicated as below (whichever is more)	Set			
(ii)	Electronic cards	Nos.	One No. of each type & model		
(iii)	Signal Conditioner cards	Nos.	One No. of each type & model		
(iv)	Slave clocks of each type used for Master slave clock system	Nos.	Two No. of each type & model		
(v)	Cubicle power supply power supply modules	Nos.	Ten (10) percent or 2 nos (whichever is more) of Installed of each type and rating		
1.00.10	**Plant Security and survillance system**			5,10,020	EDN-Lot price has been given for items Sl no 1.00.10

1. C&I Mandatory spares are indicated in above list. These spares shall be considered as per the applicable items in main supply of AC system package.
2.The spares shall be considered as unit wise except for any item/equipment supplied as common for both units.

Anshul
S A Khan
Praveen Kishore

TANGEDCO				Total Ex-Works price	*Remarks
Sl no	Name of spares	Unit	Qty	in INR	
1.00.13	**Mandatory Spares for Control valves, Power Cylinder, Control Dampers, Actuators and Accessories**			1,03,31,251	LOT PRICE FOR THE APPLICABLE ITEMS UNDER THIS SL NO 1.00.13
(A)	Following spares shall be furnished for control valves, Power Cylinder, Control Dampers as applicable.			38,32,031	PC-LOT PRICE OFFERED FOR SUBITEMS AS APPLICABLE TO ALL TYPES OF CONTROL VALVES IN PC SCOPE. HYD-lot price has been given for Sl no 1.00.13 (A) (Items applicable for BFP control valve shall be supplied.)
	One set of spare control valve stem packing for each control valve.			1,21,34,359	PEM-C&I control valves AND For Fuel Oil Unloading System, included under clause Fuel oil system of Mech. List of mandatory spares AND For Air Conditioning system, price included under clause Air Conditioning system of Mech. List of mandatory spares
	Two moulded rubber diaphragms for each control valve.				
	One sets of each of O-rings and rubber gaskets for each control valve.			3,73,310	
d)	100 percent qty. of lubricants for gaskets for each control valve on one year consumption basis.			1,86,690	PEM-For Fuel Oil Unloading System, included under clause Fuel oil system of Mech. List of mandatory spares AND For Air Conditioning system, price included under clause Air Conditioning system of Mech. List of mandatory spares

1. C&I Mandatory spares are indicated in above list. These spares shall be considered as per the applicable items in main supply of AC system package.
2.The spares shall be considered as unit wise except for any item/equipment supplied as common for both units.

Anshul

S A Khan

Praveen Kishore

TANGEDCO				Total Ex-Works price	*Remarks
Sl no	Name of spares	Unit	Qty	in INR	
	2 sets of limit switches and 1 set of valve positioner for each control valve.			21,75,950	HWR-Limit switches are not applicable PEM-C&I control valves included above under clause no A1 -1.0013 of C&I list AND For Fuel Oil Unloading System, included under clause Fuel oil system of Mech. List of mandatory spares AND For Air Conditioning system, price included under clause Air Conditioning system of Mech. List of mandatory spares.
f)	20 percent of position transmitter (4-20mA) for total qty. of control valve.			1,56,520	
g)	One (1) set of valve trims (such as plug, stem, seat ring /cage, guide bushing, stem lock pin, packing retaining ring, etc) for each control valve.			23,28,270	
h)	One completes actuator of each type or min 10% for each type and size whichever is more.			36,01,710	TRY-VALVES REMARKS: Price already Quoted in Mechanical section under the Spares ACTUATOR FOR MOTOR OPERATED VALVES
i)	20 percent of Solenoid valves or min 2 no. of each type for total qty. of control valves.				Not Applicable
j)	20% of I to P converters, Pressure regulators.				
B)	Mandatory spares for each critical applications special control valves as specified in NIT			1,17,72,635	PEM-For APRDS AND For Fuel Oil Unloading System, included under clause Fuel oil system of Mech. List of mandatory spares AND For Air Conditioning system, price included under clause Air Conditioning system of Mech. List of mandatory spares
C)					

1. C&I Mandatory spares are indicated in above list. These spares shall be considered as per the applicable items in main supply of AC system package.
2.The spares shall be considered as unit wise except for any item/equipment supplied as common for both units.

Anshul
S A Khan
Praveen Kishore

TANGEDCO				Total Ex-Works price	*Remarks
Sl no	Name of spares	Unit	Qty	in INR	
i)	Feedback transmitter	2 NOS.			under HP BYPASS SYSTEM
ii)	Electronic positioner	2 NOS.			
iii)	Proportional Valve	2 NOS.			
iv)	Quick opening device	2 NOS.			
v)	Seal sets	4 Sets			
vi)	Solenoid Valves	2 NOS.			
vi)	Filters for Oil Units	1 set			
vii)	Supply manifold for oil units	1 No			
viii)	Hose for each service	1 each			
ix)	Seal set for oil unit	1 Set			
x)	Complete actuator for each type and model	1 set			
E)	1 NO of Nozzle for each PRDS De Super heater & Spray water desuperheater and orifice plate for CEP flow.				1 No. Nozzle for Spray water Desuperheater is included in our price. Rest of the flow nozzles not included in our offer as 'Mandatory spares' are provided for items or components that require replacement during plant operation. Flow nozzles and orifice plates do not require replacement and hence are not provided as mandatory spares. We have never supplied nozzles and orifice plate as mandatory spares in any of the existing as well as previous projects.
1.00.14	**Mandatory Spares for Boiler Tube leak Detection System**			17,81,920	LOT PRICE FOR THE APPLICABLE ITEMS UNDER THIS SERIAL NO 1.00.14
	Following mandatory spares along with their individual price required for maintaining boiler tube leak detection system to supply along with the package.				
1)	2nos. acoustic transducer with rear connector sealed to IP-65				
2)	2 nos. flexible high temperatures lead, 3metre long for acoustic transducer.				
3)	2 nos. acoustic s field amplifier / processor mounted in a die cast aluminum or polycarbonate box sealed to IP-65 with mounting brackets, pairs.				
4)	1 no. A/D Convertor cards/field signal interface module for 32 or more channels.				
5)	1 no. Alarm relay output card.				

1. C&I Mandatory spares are indicated in above list. These spares shall be considered as per the applicable items in main supply of AC system package.
2.The spares shall be considered as unit wise except for any item/equipment supplied as common for both units.

Anshul

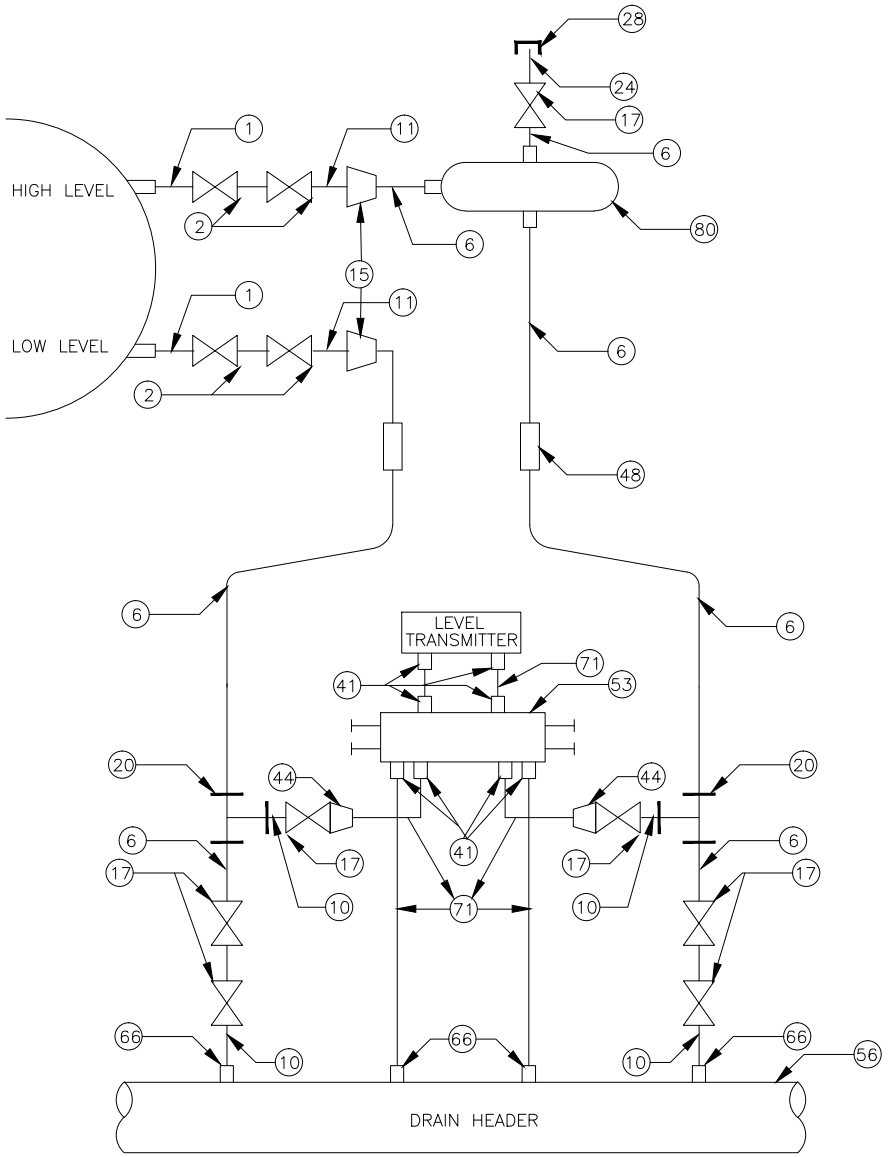
S A Khan

Praveen Kishore

TANGEDCO				Total Ex-Works price	*Remarks
Sl no	Name of spares	Unit	Qty	in INR	
6)	Consumables like batteries, fuses etc. for two years operation of boiler tube leak detection system.				
1.00.15	**Mandatory spares not covered above**			59,50,000	LOT PRICE FOR THE APPLICABLE ITEMS UNDER THIS SERIAL NO 1.00.15
	Bidder to supply 10% or 1 no. (whichever is more) of each type of sensor/instrument, instrumentation/mechanical fittings etc for any other electronic system, feeder control cabinets, hydrastep (EWLI), Vibration Monitoring System, CCTV, C&I Lab Instruments, On line Carbon in Ash analyser system, On line Coal mass flow/speed measurement system, On line secondary air flow measurement system Mass Flow meter, Solid flow meter, 3 D Acoustic type level transmitters, Nucleonic & non nucleonic density transmitter etc.				
1.00.16	**OTHER RELATED CONTROL AND INSTRUMENTATION SYSTEMS/EQUIPMENTS**				
1.00.16.01	**Other SG related sub-systems**				
1	**Flame Monitoring System**				
(i)	Complete Flame Scanner Assembly including scanner head assembly, scanner housing, and fibre optic cables.	20% or 4 nos. whichever is more.		39,05,356	
(ii)	Flame Scanner Lens.	100%		1,08,570	
(iii)	Electronic cards for scanners	10% or 2 nos. of each type whichever is more.		17,69,852	
(iv)	Power Supply Modules	10% or 2 nos. of each type whichever is more.			INCLUDED IN SL NO (III) ABOVE
2	**Coal Feeders**				
(i)	Calibration Motor	10% or 2 nos. whichever is more.			NOT APPLICABLE
(ii)	Correction Motor	10% or 2 nos. whichever is more.			NOT APPLICABLE

1. C&I Mandatory spares are indicated in above list. These spares shall be considered as per the applicable items in main supply of AC system package.
2.The spares shall be considered as unit wise except for any item/equipment supplied as common for both units.

DRAWINGS



TRANSMITTER MOUNTED BELOW INST. SOURCE POINT

TAG NO.	DESCRIPTION	ROM
80	CONDENSATION CHAMBER	1
71	1/2"OD IMPULSE TUBE, SS-316	AS REQD.
66	1/2" GI SOCKET / FUNNEL	4
56	2"NB GI DRAIN HEADER	AS REQD.
53	5-VALVE MANIFOLD, SS-316	1
48	1/2" SW, CS/AS BULK HEAD PIPE UNION	2
44	1/2"BWX1/2"OD COMPRESSION TUBE FITTING,SS-316	2
41	1/2"NPT(M)X1/2"OD TUBE COMPRESSION FITTING,SS-316	8
28	1/2" NPT (F) CS CAP	1
24	1/2" NPS SCH-80/160X1/2"NPT(M) CS/AS NIPPLE	1
20	1/2" SOCKET WELDED EQUAL TEE CS/AS	2
17	1/2" SOCKET WELDED CS GLOBE VALVE	7
15	1"TO 1/2" SOCKET WELD REDUCER	2
11	1" NPS SCH 80/160 CS/AS NIPPLE	2
10	1/2" NPS SCH 80/160,CS/AS NIPPLE	4
6	1/2" NPS SCH 80/160 CS/AS PIPE	AS REQD.
2	1/2"/3/4"/1" SOCKET WELDED GLOBE VLV/ROOT VLV.	4
1	1/2" NPS SCH 80 NIPPLES OF MATERIAL SAME AS MAIN PIPE WITH NECESSARY ATTACH TO FLANGES	AS REQD.

Anshul

S A Khan

Praveen Kishore

NOTE:-

1. FOR HIGH TEMP. SERVICE (MORE THAN 80°C) A 'U' TUBE(REF. DWG NO. 114-04-0100) SHALL BE PROVIDED BETWEEN THE MANIFOLD AND THE TRANSMITTER
2. FOR HIGH PR.(MORE THAN 40kg/sqcm) ONE NO. OF ISOLATING VLV. IS PROVIDED IN EACH LINE BETWEEN VLV. MANIFOLD AND 1/2"SW EQUAL TEE AND 2NO. DRAIN VLV. ARE ALSO

REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. BULK HEAD FITTING SW TYPE SHALL BE PROVIDED AT LIE/LIR
4. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
5. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
6. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

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DESEIN
CONSULTING ENGINEERS
NEW DELHI - INDIA

CLIENT: TAMILNADU GEN. & DIST. CORPORATION
PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.
TITLE :- INST. DRAWING FOR LEVEL TRANSMITTERS
FOR BID PURPOSE ONLY:

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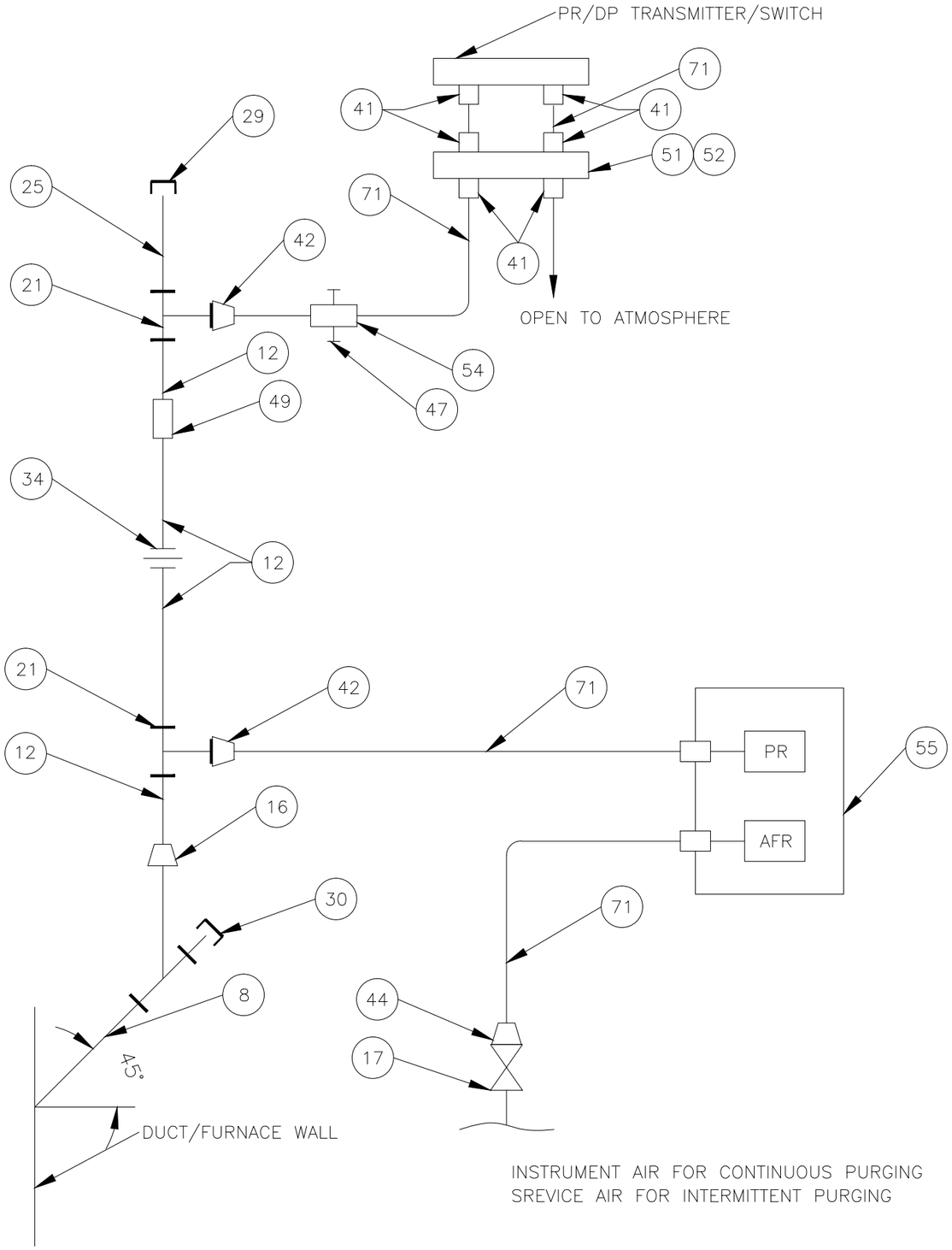
JOB. No. D-4027
DWG.No. 114-04-0110
REV. 0
Sheet No. 1 of 19



TAG NO.	DESCRIPTION	QTY.
	BILL OF MATERIAL	
71	1/2"OD IMPULSE TUBE,SS-316	
55	CONTINOUS PURGING ARRENGEMENT	1
54	3-WAY VALVE WITH 1/2" SWAGE LOCK CONNECTION	1
51or52	5-VALVE MANIFOLDS/3-VALVE MANIFOLDS/2-VALVE MANIFOLDS,SS-316	1
49	3/4"SW,CS/AS BULK HEAD PIPE UNION	1
47	QUICK DISCONNECT FITTING,CS	1
44	1/2"BW X 1/2"OD TUBE FITTING,SS-316	1
42	3/4"BW X 1/2"OD TUBE FITTING,SS-316	1
41	1/2"NPT(M) X 1/2"00 TUBE COMPRESSION FITTING,SS-316	6
34	3/4" SW,CS PIPE UNION	1
30	MS BLACK PIPE CAP	1
29	3/4"NPT(F) CS CAP	1
25	3/4"NPS,SCH-80 X 3/4"NPT(M)CS NIPPLE	2
21	3/4" EQUAL TEE,CS	2
17	1/2" SW GLOBLE VALVE, CS	1
16	MS BLACK PIPE TO 3/4" SW,CS REDUCER	1
12	3/4" NPS SCH-80 CARBON STEEL PIPE	AS REQD.
8	MS BLACK PIPE	AS REQD.

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Praveen Kishore

NOTE:-

FOR DP TRANSMITTER THE SECOND IMPULSE LINE SHALL BE CONNECTED SIMILAR TO FIRST IMPULSE LINE (TAG NO-12)

AFR- AIR FILTER REGULATOR

PR- PURGE ROTAMETER

REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. BULK HEAD FITTING SW TYPE SHALL BE PROVIDED AT LIE/LIR
4. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
5. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
6. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

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PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE :- INST. DRAWING FOR AIR PURGING

FOR BID PURPOSE ONLY:

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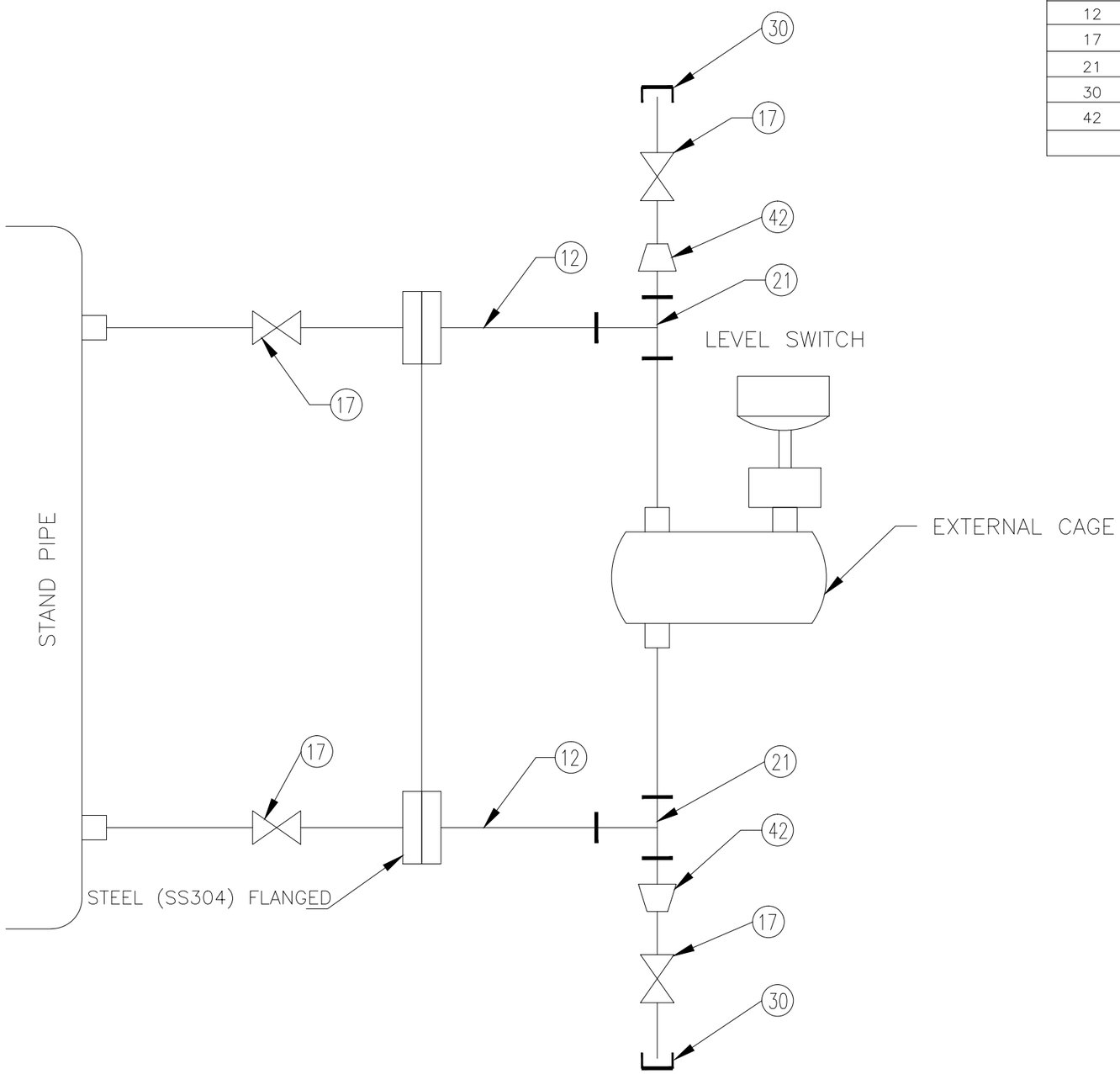
Sheet No. 16 of 19

	BILL OF MATERIAL	
TAG NO.	DESCRIPTION	QTY.
12	3/4" NPS SCH-80 CARBON STEEL PIPE	AS REQD.
17	1/2"/3/4"/1" SOCKET WELDED GLOBE VLV/ROOT VLV.	4
21	3/4" EQUAL TEE,CS	2
30	1/2" NPT (F) CS CAP	2
42	3/4"BW X 1/2"OD TUBE FITTING,SS-316	2



Anshul

S A Khan

Praveen Kishore

REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. FLANGED CONNECTION ARE FOR LOW PRESSURE APPLICATION IN BOP PACKAGE ONLY.
4. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

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PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE :- INST. DRAWING FOR LEVEL SWITCH OPTION-1 WITH FLANGED CONNECTION

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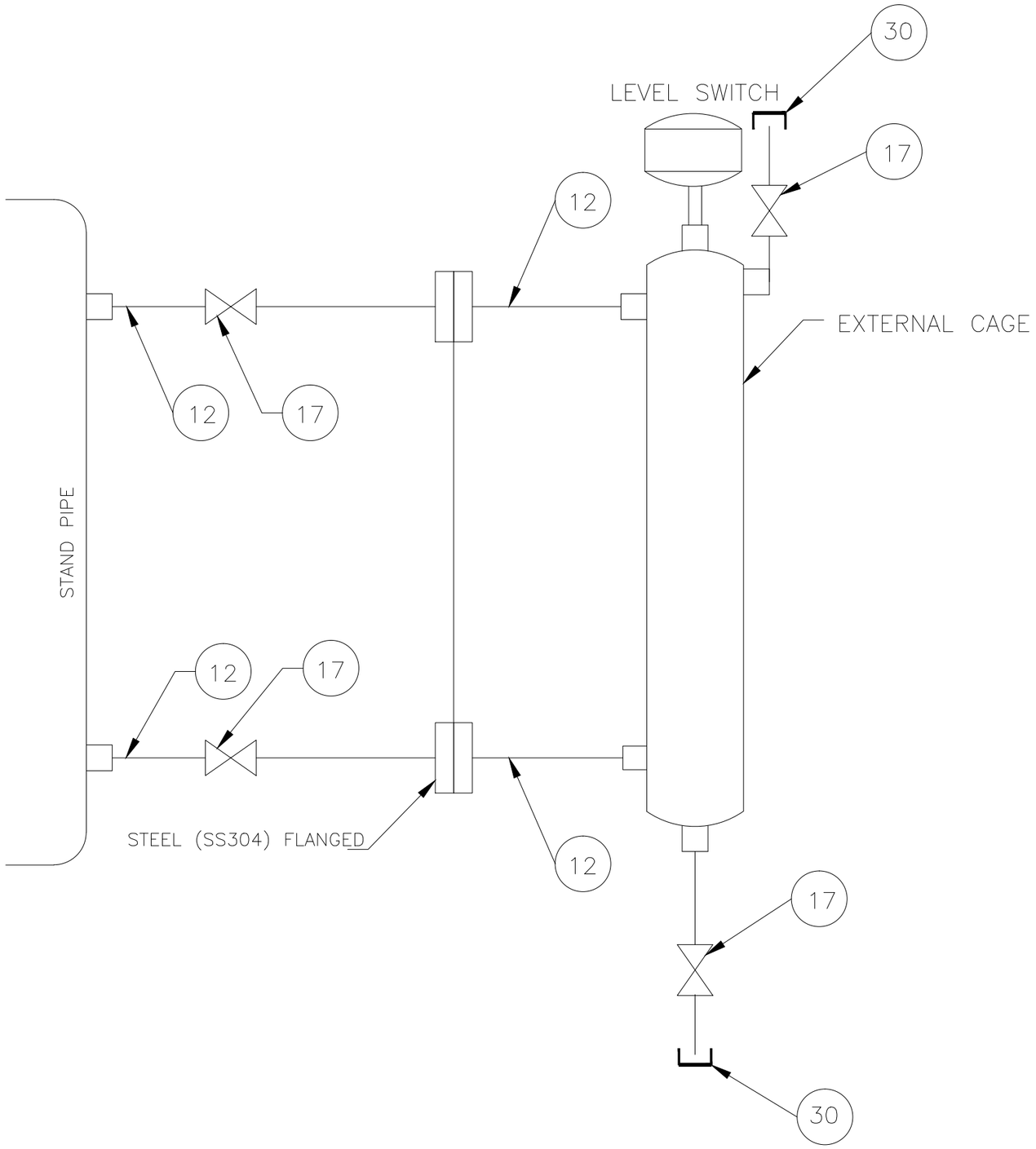
BILL OF MATERIAL		
TAG NO.	DESCRIPTION	QTY.
12	3/4" NPS SCH-80 CARBON STEEL PIPE	AS REQD.
17	1/2"/3/4"/1" SOCKET WELDED GLOBE VLV/ROOT VLV.	4
21	3/4" EQUAL TEE,CS	2
30	1/2" NPT (F) CS CAP	2
42	3/4"BW X 1/2"OD TUBE FITTING,SS-316	2



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S A Khan

Praveen Kishore

REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. FLANGED CONNECTION ARE FOR LOW PRESSURE APPLICATION IN BOP PACKAGE ONLY.
4. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

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PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE :- INST. DRAWING FOR LEVEL SWITCH OPTION-2 WITH FLANGED CONNECTION

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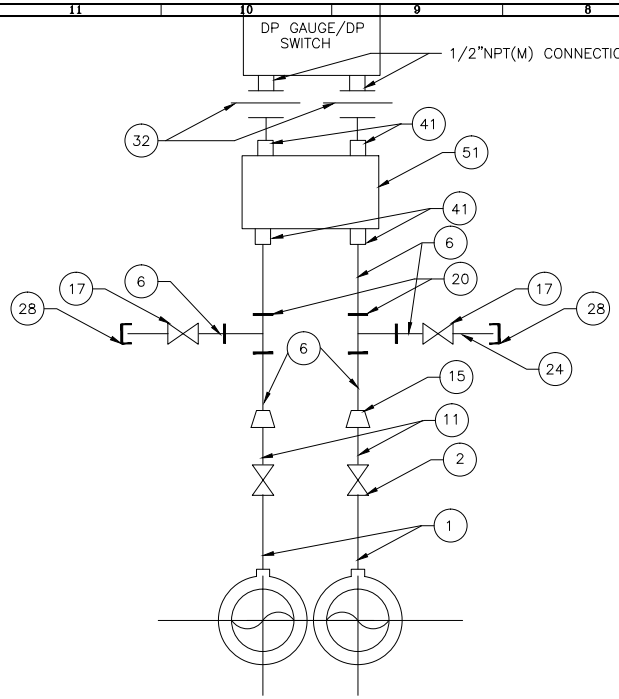
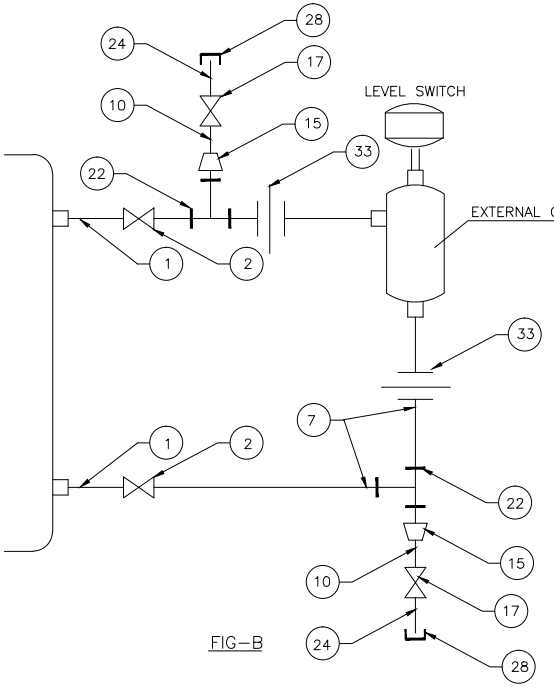
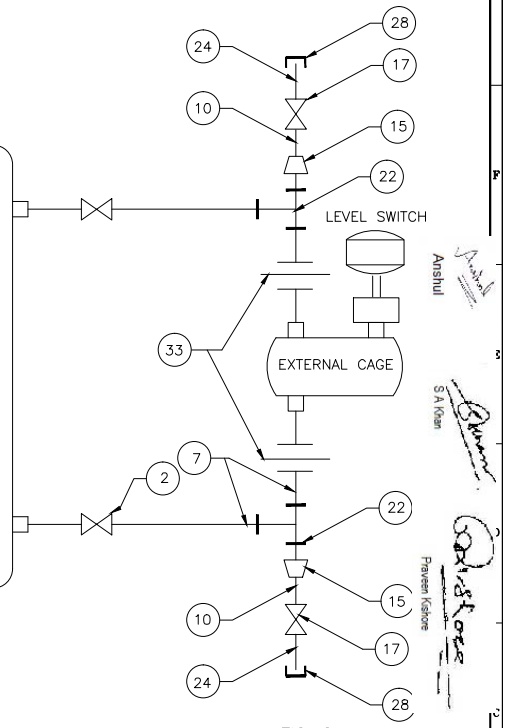


FIG–A



FIG–B



FIG–C

78	1/2" NPT(F) X 1/2" NPT(M) SNUBBER/PULSATION DAMPNER	1	–	–
51	5 VALVE MANIFOLDS, SS–316	–	–	–
41	1/2" NPT(M) X 1/2" OD TUBE COMPRESSION FITTING,SS–316	–	–	–
38	3 WAY GAUGE VALVE 1/2"NB SW	1	–	–
33	1" SW EQUAL PIPE UNION	–	2	2
32	1/2" NPS,3 PIECE PIPE UNION 1/2" NPT(F) SCREWED AND 1/2" SW CONNECTION	1	–	–
28	1/2" NPT(F) CS. CAP	1	2	2
24	1/2" NPS,SCH 80/160 X 1/2" NPT(M) CS/AS NIPPLE	1	2	2
22	1" SW EQUAL TEE CS/AS	–	1	2
20	1/2"SW EQUAL TEE CS/AS	1	–	–
17	1/2" SW,CS/AS, GLOBE VALVE	1	2	2
15	1" TO 1/2" SOCKET WELD REDUCER	1	2	2
11	1"NPS SCH 80/160 CS/AS NIPPLE	1	–	–
10	1/2"NPS,SCH 80/160 CA/AS NIPPLE	–	2	2
6	1/2"NPS,SCH 80/160 CARBON/ALLOY STEEL PIPE	AS REQD.		
7	1" NPS,SCH 80/160 CS/AS STEEL PIPE	AS REQD.		
2	1/2"3/4"/1" ROOT VALVE – SW GLOBE VALVE	2	2	2
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL SAME AS THAT OF MAIN PIPE (AS PER PROCESS REQD.)	AS REQD.		
TAG NO.	DESCRIPTION	A	B	C
		QTY.		

NOTE:–
WITH VALVE OF SIZE 1/2"SW NIPPLE PIECE IS NOT REQUIERED

REFERENCE DRAWINGS.

NOTES

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2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
4. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
5. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

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NEW DELHI – INDIA

CLIENT: TAMILNADU GEN. & DIST. CORPORATION

PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI

TITLE :– INST. DRAWING FOR DIFF. PRESS. SWITCH/GAUGE/LEVEL SWITCHES

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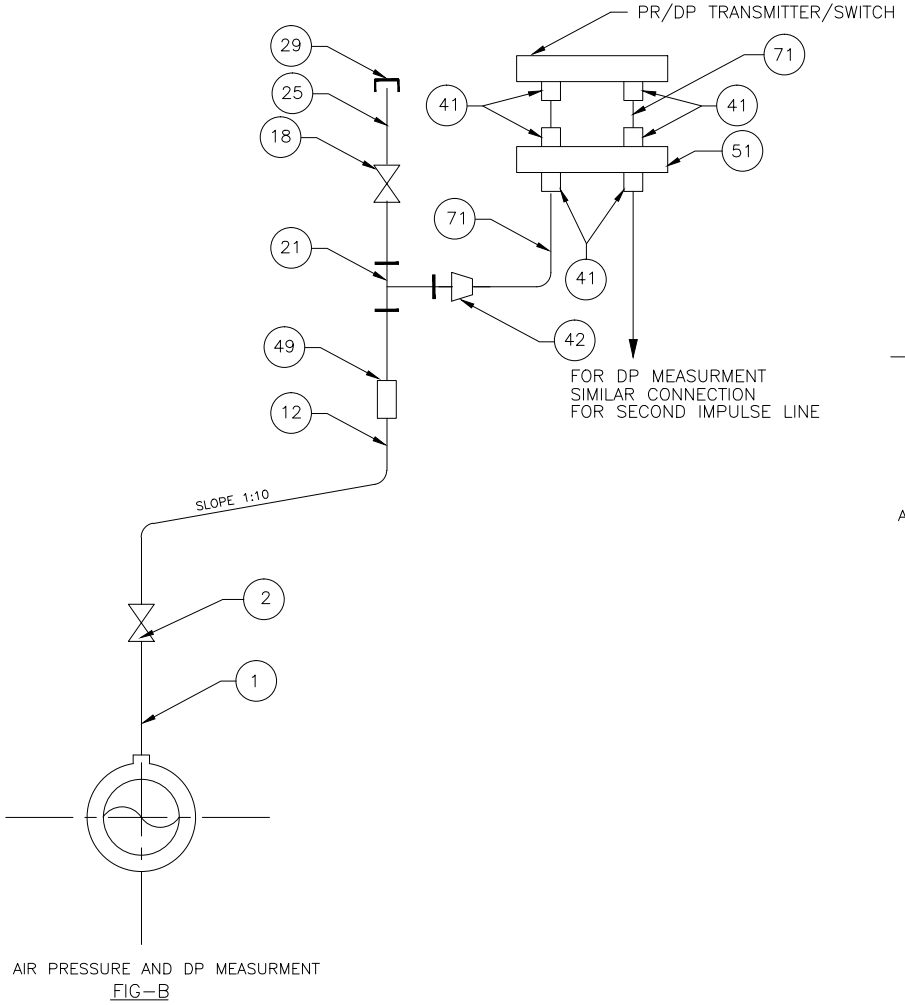
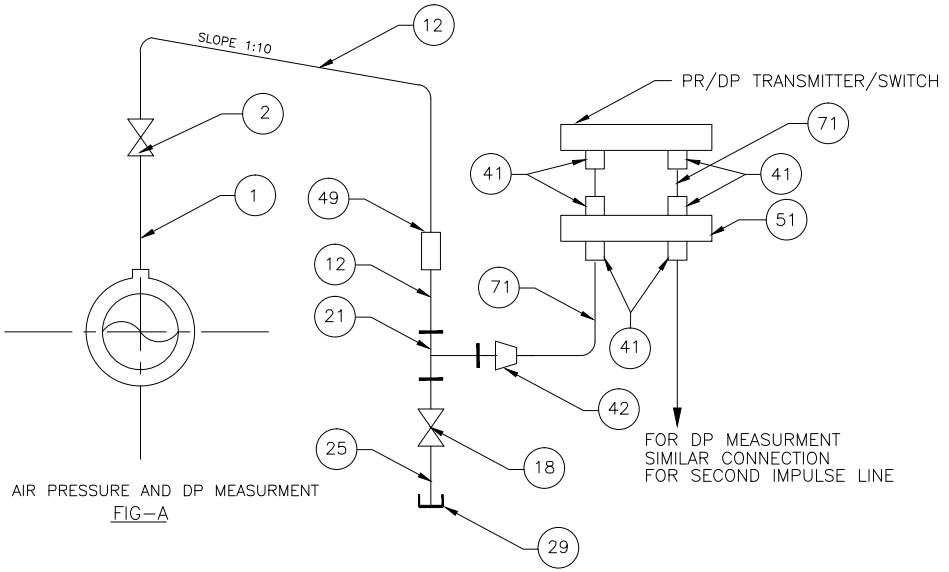


AIR PRESSURE AND DP MEASURMENT
FIG–B



AIR PRESSURE AND DP MEASURMENT
FIG–A

TAG NO.	DESCRIPTION	A	B
		QTY.	
71	1/2"OD IMPULSE TUBE,SS–316	AS REQD.	
51	5/3/2–VALVE MANIFOLDS,SS–316	1	1
49	3/4"SW,CS/AS BULK HEAD PIPE UNION	1	1
42	3/4"BW X 1/2"OD TUBE FITTING,SS–316	1	1
41	1/2"NPT(M) X 1/2"00 TUBE COMPRESSION FITTING,SS–316	6	6
29	3/4"NPT(F) CS CAP	1	1
25	3/4"NPS,SCH–80 X 3/4"NPS(M)CS NIPPLE	1	1
21	3/4" EQUAL TEE,CS	1	1
18	3/4" SW,CS GLOBE VALVE	–	1
12	3/4" NPS. SCH–80 CARBON STEEL PIPE	AS REQD.	
2	1/2"/3/4"/1" ROOT VALVE – SW GLOBE VALVE	1	1
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	AS REQD.	

BILL OF MATERIAL

NOTE:–
QUANTITY IN COLUMN A&B TO BE DOUBLED
FOR DP TAPPING EXCEPT ITEM NO. 51

Anshul
S A Khan
Praveen Kishore

REFERENCE DRAWINGS.

NOTES
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NEW DELHI – INDIA

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PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.
TITLE :– INST. DRAWING FOR PRESS. & DIFF. PRESS. TRANSMITTERS/SWITCH (AIR SERVICE)
FOR BID PURPOSE ONLY:

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DWG.No.	114–04–0103	REV.	0

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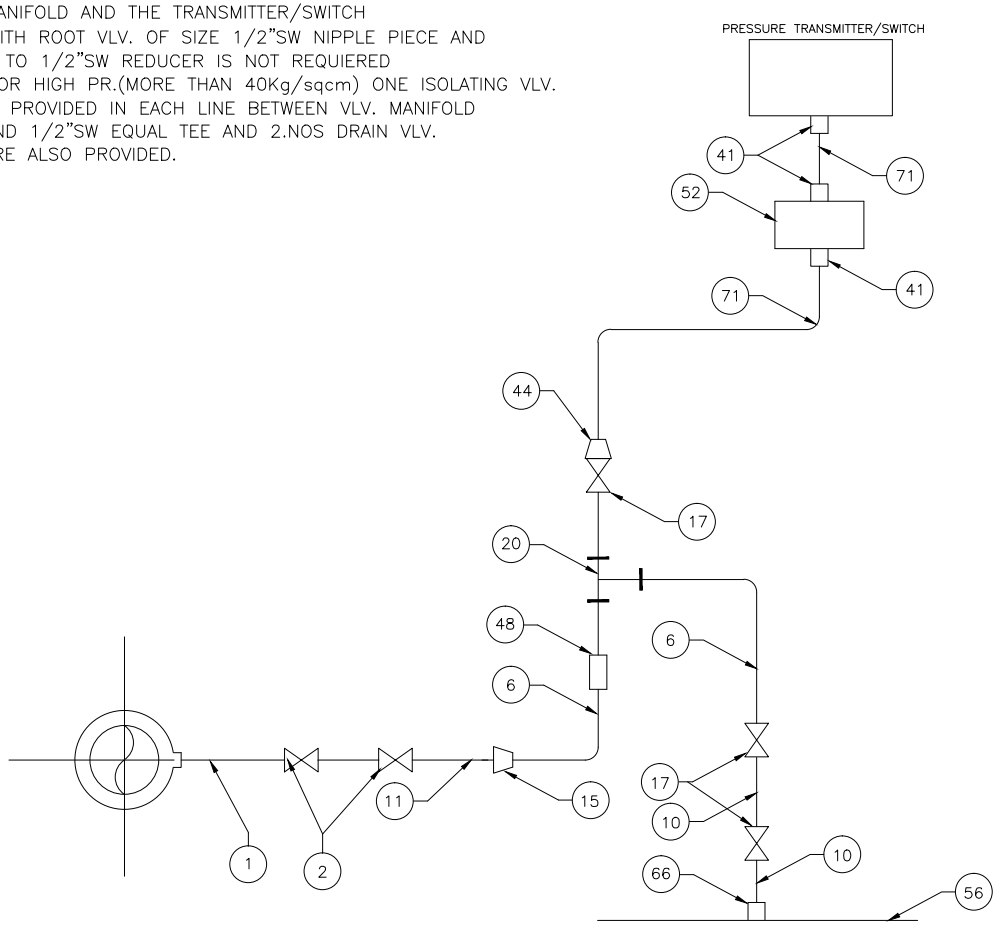
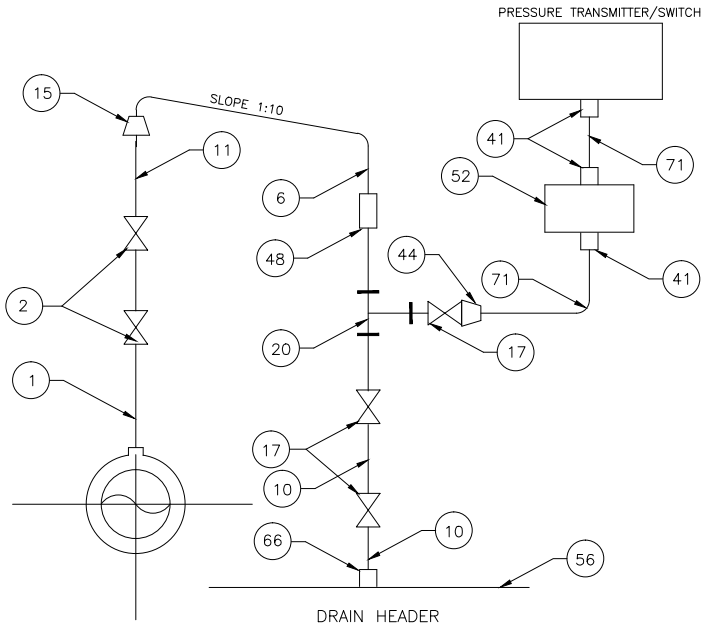
NOTE:–

1. FOR HIGH TEMP. SERVICE (MORE THAN 80C) A 'U'–TUBE / SYPHON (REF. DWG NO. IN–114–04–0100)SHALL BE PROVIDED BETWEEN THE MANIFOLD AND THE TRANSMITTER/SWITCH
2. WITH ROOT VLV. OF SIZE 1/2"SW NIPPLE PIECE AND 1 TO 1/2"SW REDUCER IS NOT REQUIERED
3. FOR HIGH PR.(MORE THAN 40Kg/sqcm) ONE ISOLATING VLV. IS PROVIDED IN EACH LINE BETWEEN VLV. MANIFOLD AND 1/2"SW EQUAL TEE AND 2.NOS DRAIN VLV. ARE ALSO PROVIDED.



TRANSMITTER MOUNTED ABOVE INSTRUMENT SOURCE POINT

FIG–D



TRANSMITTER MOUNTED ABOVE INSTRUMENT SOURCE POINT

FIG–C

TAG NO.	DESCRIPTION	C	D
		QTY.	
71	1/2"OD IMPULSE TUBE,SS–316		
66	1/2" GI SOCKET		
56	2"NB GI DRAIN HEADER		
52	5/3/2–VALVE MANIFOLDS,SS–316		
48	1/2"SW,CS/AS BULK HEAD PIPE UNION		
44	1/2"BW X 1/2"OD COMRESSION TUBE FITTING,SS–316	1	1
41	1/2"NPT(M) X 1/2"00 TUBE COMPRESSION FITTING,SS–316	3	3
20	1/2"SW EQUAL TEE,CS	1	1
17	1/2" SW,CS GLOBE VALVE / NEEDLE VALVE	3	3
15	1" TO 1/2" SW REDUCER	1	1
11	1" NPS SCH–80 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 REQD.	
2	1/2"/3/4"/1" ROOT VALVE	2	2
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	AS REQD.	

BILL OF MATERIAL

REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. BULK HEAD FITTING SW TYPE SHALL BE PROVIDED AT I/E/I/R
4. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
5. QUANTITIES OF INSTRUMENTS,/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
6. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

NOTICE

THIS DRAWING IS THE PROPERTY OF DESEIN PRIVATE LIMITED, NEW DELHI, AND IS LENT SUBJECT TO THE CONDITION THAT IT SHALL NOT BE REPRODUCED, COPIED, LENT OR OTHERWISE DISPOSED OF, DIRECTLY OR INDIRECTLY. IT SHALL NOT BE USED TO FURNISH ANY INFORMATION FOR THE MAKING OF DRAWINGS, APPARATUS, OR PARTS THEREOF EXCEPT FOR THE PROJECT SPECIFICALLY PROVIDED FOR BY CONTRACT AGREEMENT WITH DESEIN.

ZONE	MARK	PARTICULARS	DATE	CIVIL	MECH.	ELEC.	C&I	H.O.D.
	A	PRELIMINARY	25.04.13				SLN	

REVISIONS

APPROVED

FOR BID PURPOSE ONLY:

DESEIN
CONSULTING ENGINEERS
NEW DELHI – INDIA

CLIENT: TAMILNADU GEN. & DIST. CORPORATION

PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

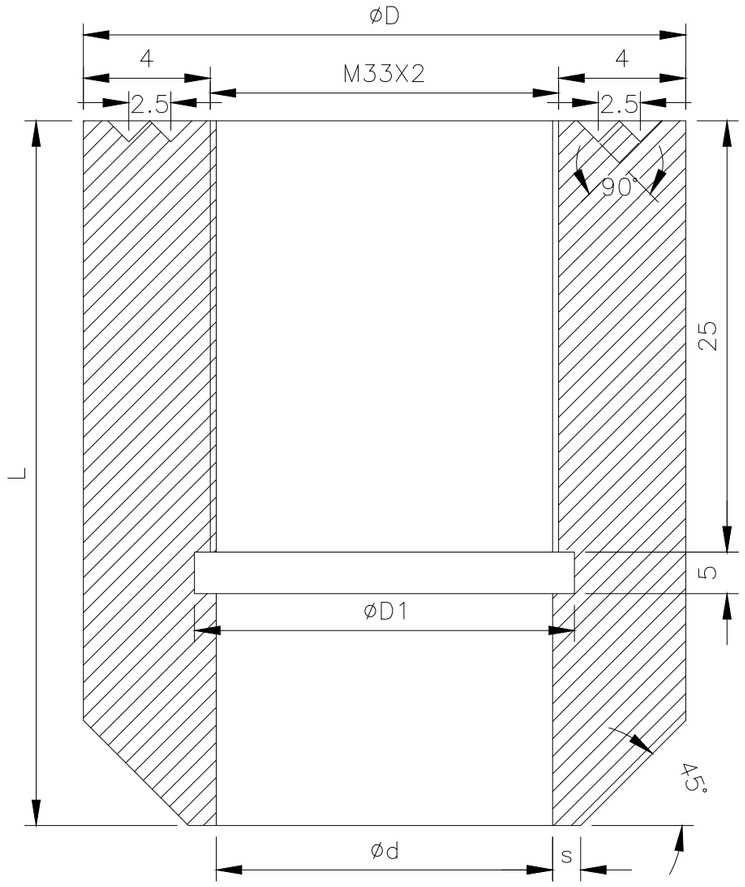
TITLE :– INST. DRAWING FOR PRESS. & DIFF.PRESS. TRANSMITTERS/SWITCH (STEAM & LIQUID SERVICE)

	NAME	SIGN.	DATE
CAD/DRAWN	VIKAS		23.04.13
DESIGNED	SKM/SN		23.04.13
CHECKED	S.K.M.		24.04.13
SCALE	N.T.S.		

JOB. No. D–4027

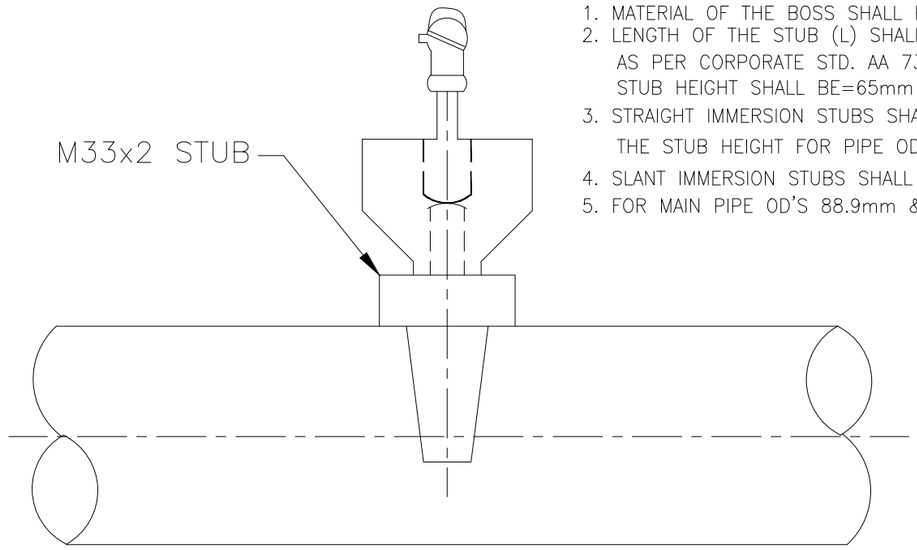
DWG.No. 114–04–0104 REV. 0

Sheet No. 7 of 19



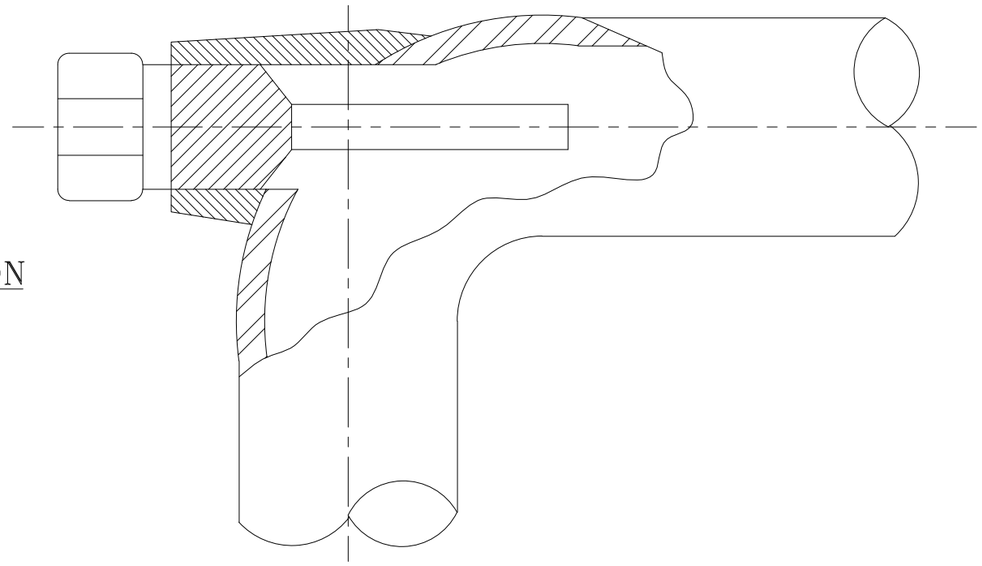
TEMPERATURE STUB FOR STRAIGHT IMMERSION

FOR PIPE OD BELOW 219.1mm	29	55	33.5	1.5	65
FOR PIPE OD 219.1mm & ABOVE	29	55	33.5	1.5	45
MAIN PIPE SIZES	d	D	D1	S	L



INSTALLATION TYPE-1

(FOR MAIN PIPE OD 168.3mm & ABOVE)



INSTALLATION TYPE-2

(FOR MAIN PIPE OD 88.9mm & BELOW)

NOTE :-

1. MATERIAL OF THE BOSS SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED.
2. LENGTH OF THE STUB (L) SHALL BE 65/45 mm DEPENDING UPON PIPE SIZE, AS PER CORPORATE STD. AA 7326102.(FOR PIPE OD 88.9mm TO 159mm STUB HEIGHT SHALL BE=65mm & FOR PIPE OD >219.1mm STUB HEIGHT SHALL BE=45mm)
3. STRAIGHT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 168.3mm & ABOVE. THE STUB HEIGHT FOR PIPE OD, 168.3mm TO <219.1mm SHALL BE 65mm.
4. SLANT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 88.9mm TO 159mm.
5. FOR MAIN PIPE OD'S 88.9mm & bELOW SUITABLE EXPANDER SHALL BE USED.

Anshul

S A Khan

Praveen Kishore

REFERENCE DRAWINGS.

SR. No. | PARTY

PRINT DISTRIBUTION

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. BULK HEAD FITTING SW TYPE SHALL BE PROVIDED AT LIE/LIR
4. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
5. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
6. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

NOTICE

THIS DRAWING IS THE PROPERTY OF DESEIN PRIVATE LIMITED, NEW DELHI, AND IS LENT SUBJECT TO THE CONDITION THAT IT SHALL NOT BE REPRODUCED, COPIED, LENT OR OTHERWISE DISPOSED OF, DIRECTLY OR INDIRECTLY. IT SHALL NOT BE USED TO FURNISH ANY INFORMATION FOR THE MAKING OF DRAWINGS, APPARATUS, OR PARTS THEREOF EXCEPT FOR THE PROJECT SPECIFICALLY PROVIDED FOR BY

ZONE	MARK	PARTICULARS	DATE	CIVIL	MECH.	ELEC.	C&I	H.O.D.
	6							
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	A	PRELIMINARY	25.04.13				SLN	

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FOR BID PURPOSE ONLY:

DESEIN
CONSULTING ENGINEERS
NEW DELHI – INDIA

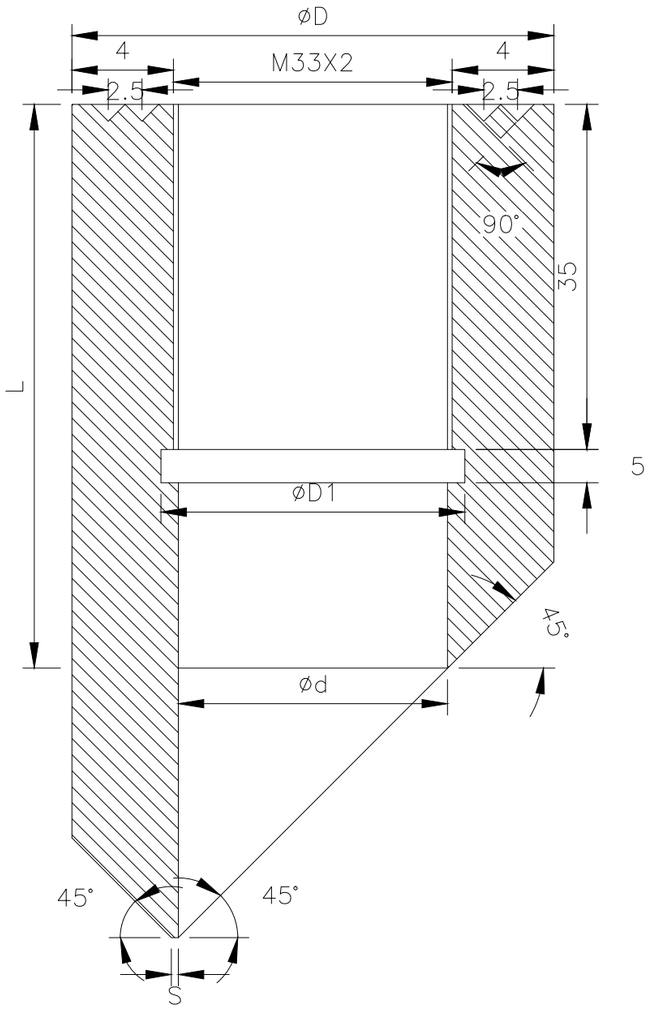
CLIENT: TAMILNADU GEN. & DIST. CORPORATION

PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE :- INST. DRAWING FOR TEMPERATURE STUB

	NAME	SIGN.	DATE
CAD/DRAWN	VIKAS		23.04.13
DESIGNED	SKM/SN		23.04.13
CHECKED	S.K.M.		24.04.13
SCALE	N.T.S.		
JOB. No.	D-4027		
DWG.No.	114-04-0111		REV. 0

Sheet No. 14 of 19

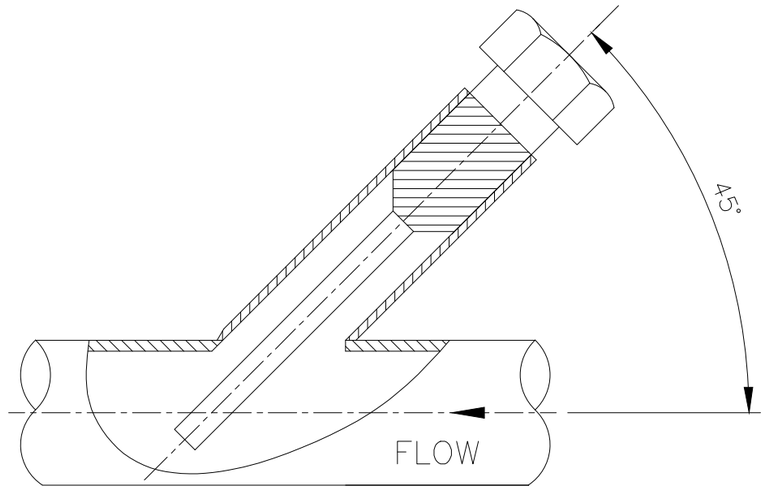


TEMPERATURE STUB FOR SLANT IMMERSION

FOR PIPE OD BELOW 219.1mm	29	55	33.5	1.5	65
FOR PIPE OD 219.1mm & ABOVE	29	55	33.5	1.5	45
MAIN PIPE SIZES	d	D	D1	S	L

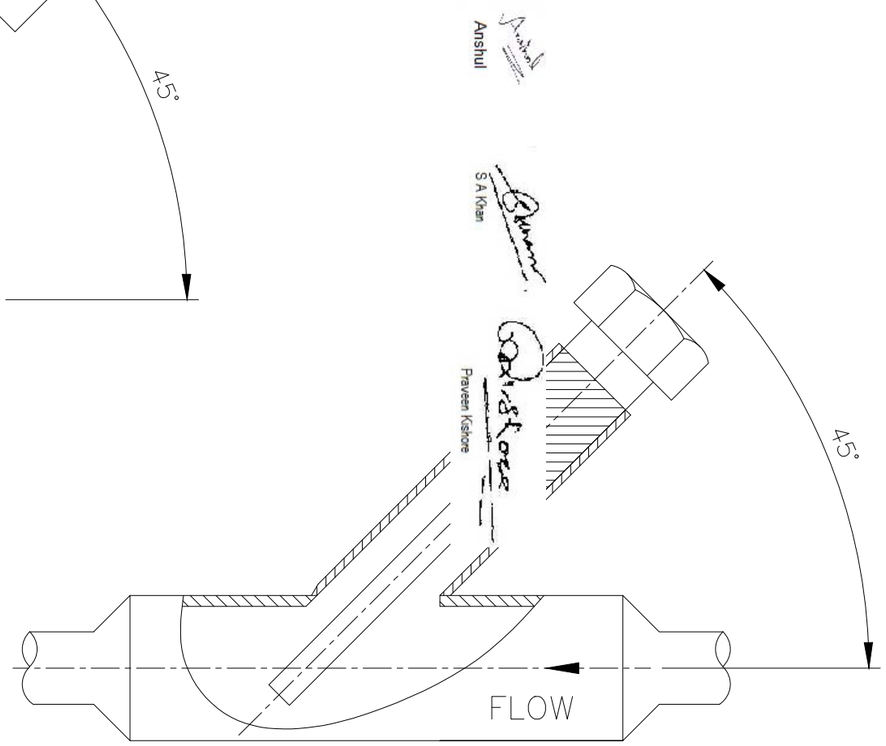
NOTE :–

1. MATERIAL OF THE BOSS SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED.
2. LENGTH OF THE STUB (L) SHALL BE 65/45 mm DEPENDING UPON PIPE SIZE, AS PER CORPORATE STD. AA 7326102.(FOR PIPE OD 88.9mm TO 159mm STUB HEIGHT SHALL BE=65mm & FOR PIPE OD >219.1mm STUB HEIGHT SHALL BE=45mm)
3. STRAIGHT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 168.3mm & ABOVE. THE STUB HEIGHT FOR PIPE OD, 168.3mm TO <219.1mm SHALL BE 65mm.
4. SLANT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 88.9mm TO 159mm.
5. FOR MAIN PIPE OD'S 88.9mm & bELOW SUITABLE EXPANDER SHALL BE USED.



INSTALLATION TYPE–3

(FOR MAIN PIPE OD 88.9mm TO 159mm)



INSTALLATION TYPE–4

(FOR MAIN PIPE OD 88.9mm & BELOW)

REFERENCE DRAWINGS.	NOTES	NOTICE
	1. DO NOT SCALE, ASK WHEN IN DOUBT. 2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE. 3. BULK HEAD FITTING SW TYPE SHALL BE PROVIDED AT LIE/LIR 4. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR. 5. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING 6. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.	THIS DRAWING IS THE PROPERTY OF DESEIN PRIVATE LIMITED, NEW DELHI, AND IS LENT SUBJECT TO THE CONDITION THAT IT SHALL NOT BE REPRODUCED, COPIED, LENT OR OTHERWISE DISPOSED OF, DIRECTLY OR INDIRECTLY. IT SHALL NOT BE USED TO FURNISH ANY INFORMATION FOR THE MAKING OF DRAWINGS, APPARATUS, OR PARTS THEREOF EXCEPT FOR THE PROJECT SPECIFICALLY PROVIDED FOR BY

SR. No.	PARTY
PRINT DISTRIBUTION	

MARK	PARTICULARS	DATE	CIVIL	MECH.	ELEC.	C&I	H.O.D.
A	PRELIMINARY	25.04.13				SLN	

APPROVED

FOR BID PURPOSE ONLY:

DESEIN
CONSULTING ENGINEERS
NEW DELHI – INDIA

CLIENT: TAMILNADU GEN. & DIST. CORPORATION

PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE :– INST. DRAWING FOR TEMPERATURE STUB

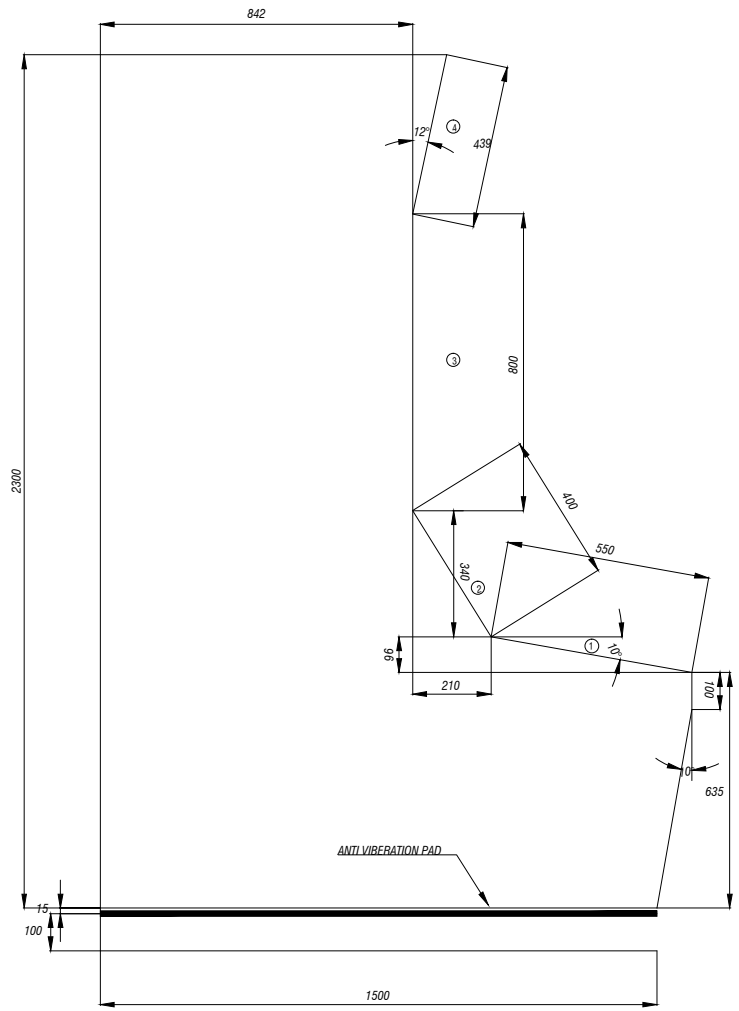
	NAME	SIGN.	DATE
CAD/DRAWN	VIKAS		23.04.13
DESIGNED	SKM/SN		23.04.13
CHECKED	S.K.M.		24.04.13
SCALE	N.T.S.		
JOB. No.	D–4027		
DWG.No.	114–04–0111	REV.	0

Sheet No. 15 of 19

Anshul

S A Khan

Praveen Kishore



NOTE:-

1 : Panel for Mounting annunciation P.B., Desk release PB, Emergency Trip P.B.

2 : Panel for Mounting ILPB for OLCS / Sequential Operation.

3 : Sheet metal panel for mounting MIMIC , Ammeters,Indicator, Totalizer, recorder etc.

4. Inclined Sheet metal panel for mounting Annunciation Facia windows.

Anshul

S A Khan

Praveen Kishore

NOTES	NOTICE
1. DO NOT SCALE, ASK WHEN IN DOUBT. 2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE. 3. DETAILS OF PANELS/ DESK SHALL BE AS PER SPECIFICATION.	THIS DRAWING IS THE PROPERTY OF DESEIN CONSULTING ENGINEERS, NEW DELHI, AND IS LENT SUBJECT TO THE CONDITION THAT IT SHALL NOT BE REPRODUCED, COPIED, LENT OR OTHERWISE DISPOSED OF DIRECTLY OR INDIRECTLY. IT SHALL NOT BE USED TO FURNISH ANY INFORMATION FOR THE MAKING OF DRAWINGS, PRINTS OR APPARATUS OR PARTS THEREOF EXCEPT FOR THE PROJECT SPECIFICALLY PROVIDED FOR BY CONTRACT AGREEMENT WITH DESEIN.

ZONE	MARK	PARTICULARS	DATE	C&I	MECH.	ELEC.
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	A	PRELIMINARY	25.04.13	SLN		

REVISIONS | APPROVED

DESEIN
CONSULTING ENGINEERS
NEW DELHI – INDIA

CLIENT– TAMILNADU GEN. & DIST. CORPORATION

PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE :– GEN.ARRG.OF DESK CUM PANEL (TYP) FOR BOP PACKAGES

FOR BID PURPOSE | SHEET NO. 1 of 1

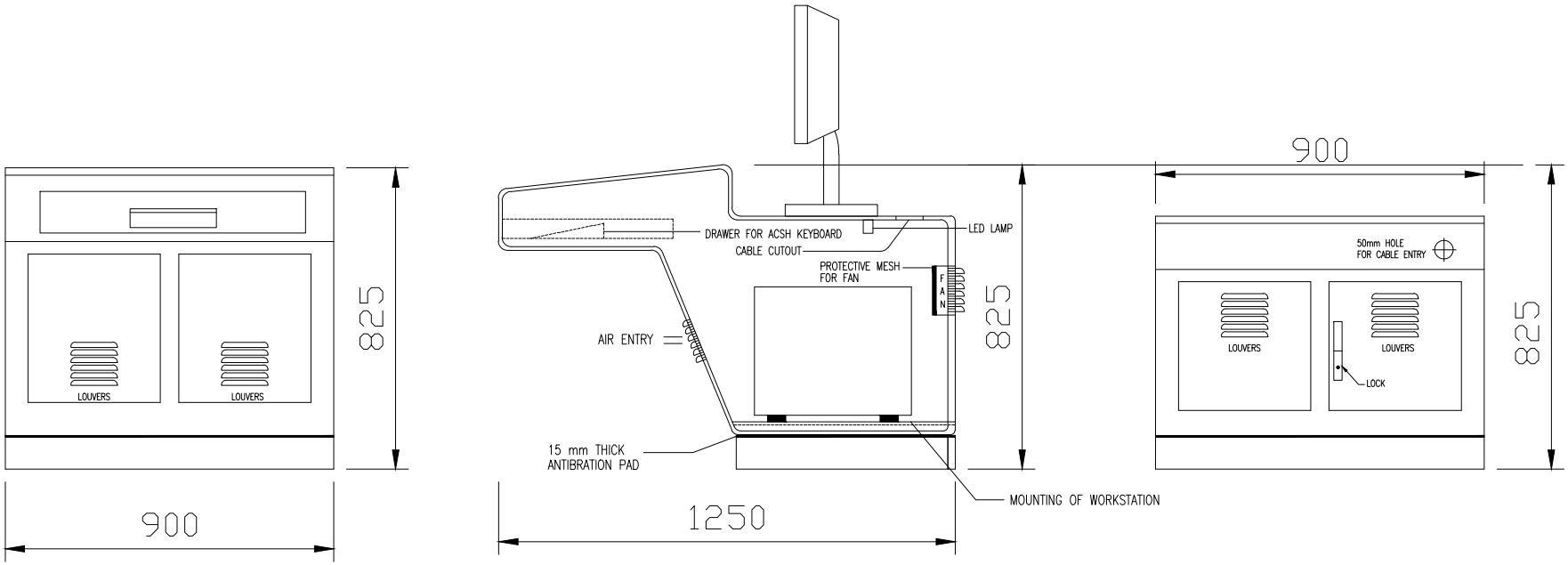
DRAWN	DESIGNED	CHECKED
VIKAS	SKM/SN	SKM
23.04.13	23.04.13	24.04.13

SCALE NTS

JOB NO. D–4027

DRG NO. 114–05–0105 | REV. 0

DRG. NO. 114-05-0108



FRONT VIEW

SIDE VIEW

REAR VIEW

Anshul

S A Khan

Praveen Kishore

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. DETAILS OF PANELS/CONSOLE/LVS SHALL BE AS PER SPECIFICATION.
4. DESK/CONSOLE FOR PA SYSTEM SHALL ALSO BE PROVIDED BY BIDDER.

NOTICE

THIS DRAWING IS THE PROPERTY OF DESEIN CONSULTING ENGINEERS, NEW DELHI, AND IS LENT SUBJECT TO THE CONDITION THAT IT SHALL NOT BE REPRODUCED, COPIED, LENT OR OTHERWISE DISPOSED OF DIRECTLY OR INDIRECTLY. IT SHALL NOT BE USED TO FURNISH ANY INFORMATION FOR THE MAKING OF DRAWINGS, PRINTS OR APPARATUS OR PARTS THEREOF EXCEPT FOR THE PROJECT SPECIFICALLY PROVIDED FOR BY CONTRACT AGREEMENT WITH DESEIN.

ZONE	MARK	PARTICULARS	DATE	C&I	MECH.	ELEC.
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	A	PRELIMINARY	25.04.13	SLN		

REVISIONS APPROVED

DESEIN
CONSULTING ENGINEERS
NEW DELHI – INDIA

DRAWN	DESIGNED	CHECKED
VIKAS	SKM/SN	SKM
23.04.13	23.04.13	24.04.13

CLIENT– TAMILNADU GEN. & DIST. CORPORATION

PROJECT– 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE OUTLINE GERENAL ARRANGEMENT (OGA) OF HMI SYSTEM FOR DDCMIS & PLC SYSTEM.

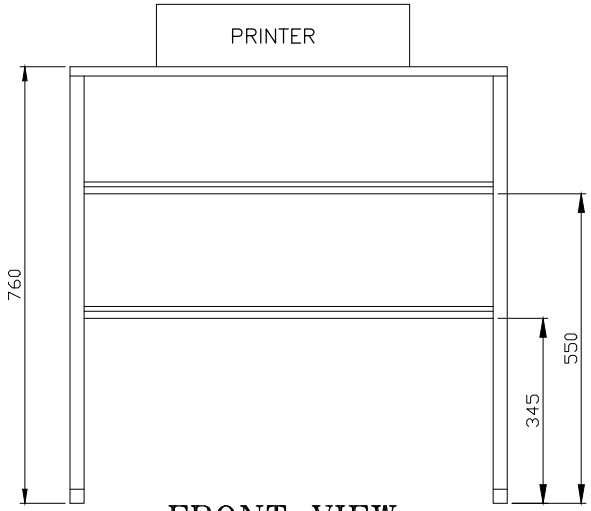
SCALE N.T.S

JOB NO. D–4027

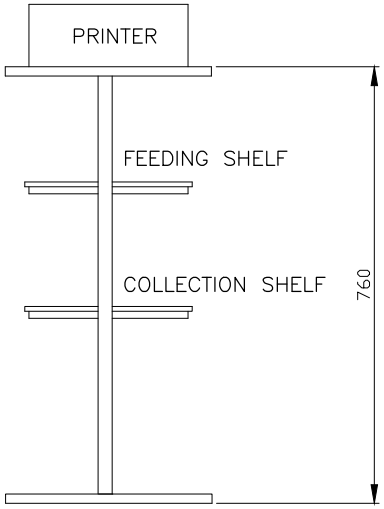
DRG. NO. 114–05–0108

REV. 0

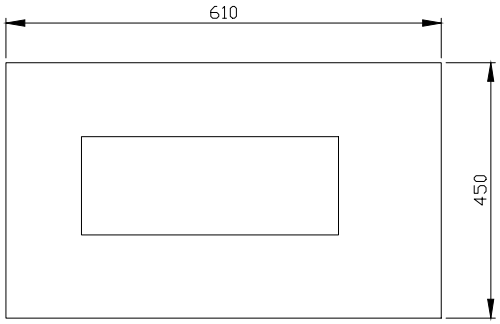
SHEET NO. 3 of 4



FRONT VIEW



SIDE VIEW



TOP VIEW

Anshul

S A Khan

Praveen Kishore

NOTES	NOTICE										
1. DO NOT SCALE, ASK WHEN IN DOUBT. 2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE. 3. DESK/CONSOLE FOR PA SYSTEM SHALL ALSO BE PROVIDED BY BIDDER.	THIS DRAWING IS THE PROPERTY OF DESEIN CONSULTING ENGINEERS, NEW DELHI, AND IS LENT SUBJECT TO THE CONDITION THAT IT SHALL NOT BE REPRODUCED, COPIED, LENT OR OTHERWISE DISPOSED OF DIRECTLY OR INDIRECTLY. IT SHALL NOT BE USED TO FURNISH ANY INFORMATION FOR THE MAKING OF DRAWINGS, PRINTS OR APPARATUS OR PARTS THEREOF EXCEPT FOR THE PROJECT SPECIFICALLY PROVIDED FOR BY CONTRACT AGREEMENT WITH DESEIN.										
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		A	PRELIMINARY	25.04.13	SLN						
		ZONE	MARK	PARTICULARS	DATE	C&I	MECH.	ELEC.			
		REVISIONS			APPROVED						

DESEIN
CONSULTING ENGINEERS
NEW DELHI – INDIA

DRAWN	DESIGNED	CHECKED
VIKAS	SKM/SN	SKM
23.04.13	23.04.13	24.04.13

CLIENT– TAMILNADU GEN. & DIST. CORPORATION

SCALE N.T.S

PROJECT– 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

JOB NO. D–4027

TITLE:– OGA–PRINTER TABLE FOR DDCMIS AND PLC SYSTEM

DRG. NO. 114–05–0108

REV. 0

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SHEET NO. 4 of 4

BHEL-PEM'S

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VENODR LIST

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Sl No	Package Code	Package Name	Vendor Code	Vendor Name	Reg Status	Vendor Address
1	145-14000-A	TRANSMITTERS	B049	ABB LIMITED	REGULAR	MR. RAJIV GOVIL 14, MATHURA ROAD, FARIDABAD Phone- 09971085678 Pincode : 121003 Email : vipin.swami@in.abb.com
2	145-14000-A	TRANSMITTERS	E057	Endress + Hauser (India) Pvt. Ltd.,	REGULAR	Mr. Prakash Vaghela 215-216, DLF Tower 'A', Jasola District Centre, New Delhi, Phone- 9717593001, Pincode : 110025, Email : prakash.vaghela@in.endress.com,
3	145-14000-A	TRANSMITTERS	M091	Moore Industries International Inc.	REGULAR	Leonard.W. Moore/ Matt Moren 16650 Schoenborn St. North Hills Phone- +1 818 830 5548 Pincode : 91343 Email : mmoren@miinet.com
4	145-14000-A	TRANSMITTERS	R002	EMERSON PROCESS MANAGEMENT (INDIA) PVT.LTD.	REGULAR	Mr. Amit Paithankar/Vikram Raj Singh 206-210,BALARAMA BUILDING 2ND FLR. BANDRA EAST MUMBAI Phone- 9619121500 Pincode : 400051 Email : vikramraj.singh@emerson.com
5	145-14000-A	TRANSMITTERS	S001	SIEMENS LIMITED	REGULAR	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com
6	145-14000-A	TRANSMITTERS	S039	SMART INSTRUMENTS LTD, BRAZIL	REGULAR	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
7	145-14000-A	TRANSMITTERS	S106	SBEM PVT. LTD.	REGULAR	MR.N.K. BEDARKAR/MR. VISHWANATH KARANDIK 39, ELECTRONIC CO.OP. ESTATE, PUNE SATARA ROAD PUNE, Phone- 912041030100 Pincode : 411009 Email : newdelhi@sbem.co.in
8	145-14000-A	TRANSMITTERS	T031	Honeywell Automation India Limited	REGULAR	Mr. Ritwij Kulkarni 917, INTERNATIONAL TRADE TOWER, NEHRU PLACE, NEW DELHI Phone- 9890200584 Pincode : 110019 Email : rajesh.chaudhary@honeywell.com
9	145-14000-A	TRANSMITTERS	T111	TOSHNIWAL INDUSTRIES PVT. LTD.,	REGULAR	Industrial Estate, Makhupura, Ajmer, Phone- 9352009000, Pincode : 305002, Email : info@tipl.com,
10	145-14000-A	TRANSMITTERS	V040	V. AUTOMAT & INTRUMENTS (P) LTD.	REGULAR	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
11	145-14000-A	TRANSMITTERS	Y10	YOKOGAWA INDIA LIMITED,	REGULAR	PLOT NO.96, ELECTRONICS CITY COMPLEX, HOSUR ROAD, BANGALORE, Phone- 080-41586000, Pincode : Email : uday.shankar@in.yokogawa.com

Anshul

S A Khan

Praveen Kishore

PEM APPROVED VENDOR LIST

Sl No	Package Code	Package Name	Vendor Code	Vendor Name	Reg Status	Vendor Address
1	145-10000-A	TEMPERATURE GAUGE	A010	A.N. INSTRUMENTS PVT. LTD.	REGULAR	MARKETING DIVISION, 5th FLOOR, 59-B, CHOWRINGHEE ROAD, KOLKATA Phone- 24757784,22472509 Pincode : 700020 Email : anidel@bol.net.in
2	145-10000-A	TEMPERATURE GAUGE	A126	ASHCROFT INDIA PVT LTD.	REGULAR	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 9999464663 Pincode : 382729 Email : ajay@aurainc.com
3	145-10000-A	TEMPERATURE GAUGE	B014	BUDENBERG GUAGE CO.LTD.	REGULAR	PO BOX-5, ALTRINCHAM CHESHIRE Phone- 0161-9285441 Pincode : WA14 4ER Email : dhbdelhi@vsnl.net
4	145-10000-A	TEMPERATURE GAUGE	F016	FORBES MARSHALL (HYD) LTD.	REGULAR	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
5	145-10000-A	TEMPERATURE GAUGE	G032	GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	REGULAR	D2/5, Mapusa Industrial Estate, Mapusa, Goa, Phone- 09326054551, Pincode : 403507, Email : sumukh@goainstruments.com.
6	145-10000-A	TEMPERATURE GAUGE	G047	GOA THERMOSTATIC INSTRUMENTS PVT.LTD.	REGULAR	FLAT -B , GF, HILL CROWN APTS., COLLEGE ROAD, MAPUSA Phone- Pincode : 403525 Email : gtilworks@pyro-electric.in
7	145-10000-A	TEMPERATURE GAUGE	G071	GAUGE BOURDON INDIA PVT. LTD.	REGULAR	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com.
8	145-10000-A	TEMPERATURE GAUGE	H023	H.GURU INDUSTRIES	REGULAR	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
9	145-10000-A	TEMPERATURE GAUGE	H040	H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	REGULAR	32,INDUSTRIAL SUBURB YESWANTHAPUR BANGALORE Phone- 080-23370300, Pincode : 560022 Email : info@hgurusouth.com
10	145-10000-A	TEMPERATURE GAUGE	W017	Baumer Technologies India Pvt. Ltd.	REGULAR	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

Anshul

S A Khan

Praveen Kishore

PEM APPROVED VENDOR LIST

Sl No	Package Code	Package Name	Vendor Code	Vendor Name	Reg Status	Vendor Address
1	145-13000-A	TEMP. ELEMENT	G007	GENERAL INSTRUMENT CONSORTIUM	REGULAR	Mr. Amarendra Kulkarni 511, EROS APARTMENTS, 56, NEHRU PLACE, NEW DELHI Phone- 011-26433201,5160746 Pincode : 110019 Email : amarendra@general-gauges.com
2	145-13000-A	TEMP. ELEMENT	G032	GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	REGULAR	D2/5, Mapusa Industrial Estate, Mapusa, Goa, Phone- 09326054551, Pincode : 403507, Email : sumukh@goainstruments.com,
3	145-13000-A	TEMP. ELEMENT	I022	DETRIVE INSTRUMENTATION & ELECTRONICS LTD.	REGULAR	320, TV INDUSTIAL ESTATE, OFF.DR.A.BESANT ROAD, BEHIND GLAXO, WORLI, MUMBAI Phone- 24934125,24938403 Pincode : 400025 Email : trivtech@vsnl.com
4	145-13000-A	TEMP. ELEMENT	P061	PYRO ELECTRIC INSTRUMENTS GOA PVT.LTD.	REGULAR	M. D. BICHU/R. M. BICHU G.B, HILL CROWN APARTMENTS, COLLEGE ROAD, MAPUSA Phone- 9326114601 Pincode : 403507 Email : priyanka.marketing@pyro-electric.in
5	145-13000-A	TEMP. ELEMENT	T106	TECHNO INSTRUMENTS	REGULAR	Abhijit Gohel/Mr. Amit Pandya Plot No. 1145/1, Uma Convertor Lane, Santej,Ta. Kalol, Gandhinagar Phone- 9909925223 Pincode : 382721 Email : amit@techno-instruments.com
6	145-13000-A	TEMP. ELEMENT	T107	Tempsens Instrument (I) Pvt Ltd	REGULAR	MR. V.P.RATHI/MR. HEMANT RATHI B-188A ROAD NO.5 , M.I.A UDAIPUR Phone- 09352420069 Pincode : 313003 Email : info@tempsens.com
7	145-13000-A	TEMP. ELEMENT	T108	TM TECNOMATIC SPA	REGULAR	MR. ANTONIO NOVIELLO/Mrs. Enrica Bazzocc VIA DELLE INDUSTRIE, 36 CREMONA Phone- 39037221574 Pincode : 26100 Email : info@tmtecnomatic.com
8	145-13000-A	TEMP. ELEMENT	T111	TOSHNIWAL INDUSTRIES PVT. LTD.,	REGULAR	Industrial Estate, Makhupura, Ajmer, Phone- 9352009000, Pincode : 305002, Email : info@tipl.com,
9	145-13000-A	TEMP. ELEMENT	W017	Baumer Technologies India Pvt. Ltd.	REGULAR	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

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PEM APPROVED VENDOR LIST

Sl No	Package Code	Package Name	Vendor Code	Vendor Name	Reg Status	Vendor Address
1	145-25000-A	JUNCTION BOX	A101	AJMERA INDUSTRIAL & ENGINEERING WORKS	REGULAR	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
2	145-25000-A	JUNCTION BOX	K043	K.S.INSTRUMENTS PVT.LTD.	REGULAR	B-81 IND ESTATE , RAJAJINAGAR BANGALORE Phone- 23386530,9980666033 Pincode : 560044 Email : enquiry.ksi@gmail.com
3	145-25000-A	JUNCTION BOX	S095	SUCHITRA INDUSTRIES	REGULAR	NO-2,OPP-27 AECS LAYOUT 2ND STG REJAMAHALVILAS EXTN 2ND STG BANGALORE Phone- Pincode : Email : suchitra.industriesblr@gmail.com
4	145-25000-A	JUNCTION BOX	S114	Shrenik & Company,	REGULAR	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

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PEM APPROVED VENDOR LIST

Sl No	Package Code	Package Name	Vendor Code	Vendor Name	Reg Status	Vendor Address
1	145-36000-A	LEVEL SWITCH-CONDUTIVITY TYPE	B077	BLISS ANAND PVT. LTD.	REGULAR	Mr. Vikas Anand/ Mr.RGRajan 92B & 93 B , IMT MANESAR Gurgaon Phone- 0124-4366000 TO 9 Pincode : 122001 Email : sales@blissanand.com
2	145-36000-A	LEVEL SWITCH-CONDUTIVITY TYPE	F039	FLOWTECH INSTRUMENTS SERVICRS	REGULAR	Mr.Nilesh M. Shah/Mr.N.R.Rao. 900/2/B, G.I.D.C. Estate, Makarpura, VADODARA Phone- (0265) - 6508171 Pincode : 390010 Email : flowtechinstruments@yahoo.com
3	145-36000-A	LEVEL SWITCH-CONDUTIVITY TYPE	H047	HI-TECH SYSTEMS & SERVICES LTD.	REGULAR	Mr. Vikash Agrawal/Mr. Tarun Debnath 119, PARK STREET , KOLKATA Phone- 033-22290045 Pincode : 700016 Email : sandeep@hitech.in
4	145-36000-A	LEVEL SWITCH-CONDUTIVITY TYPE	L005	LEVCON INSTRUMENTS PVT. LTD.	REGULAR	Mr Shayak Gupta/Badal Jana Rajkamal', 7th floor, 13, Camac Street KOLKATA Phone- 0 33 2283 2766 Pincode : 700017 Email : b_jana@levcongroup.com
5	145-36000-A	LEVEL SWITCH-CONDUTIVITY TYPE	R047	RAMAN INSTRUMENTS PVT.LTD.	REGULAR	Mr. N R Shenoy/Mr G B Vijh 8, First Floor.Plot : 160A Bait-Ush-Sharaf, 29th Road,Bandra(W) MUMBAI Phone- 09892331381 Pincode : 400050 Email : ramanbpl@vsnl.com
6	145-36000-A	LEVEL SWITCH-CONDUTIVITY TYPE	S008	SIGMA INSTRUMENTS CO.	REGULAR	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.in
7	145-36000-A	LEVEL SWITCH-CONDUTIVITY TYPE	S010	SOR INC.	REGULAR	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdhesh@sherman-india.com
8	145-36000-A	LEVEL SWITCH-CONDUTIVITY TYPE	S123	Sapcon Instrument Pvt Ltd.	REGULAR	131, PALSHIKAR COLONY Contact Person- Mr. Ashwin (9826080207) INDORE Phone- +91-731-4085751, Pincode : 452004 Email : sales@sapconinstruments.com, sapcon.vtelang@gmail.com
9	145-36000-A	LEVEL SWITCH-CONDUTIVITY TYPE	V040	V. AUTOMAT & INTRUMENTS (P) LTD.	REGULAR	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

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S A Khan

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PEM approved vendor list

Sl No	Package Code	Package Name	Vendor Code	Vendor Name	Reg Status	Vendor Address
1	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	A010	A.N. INSTRUMENTS PVT. LTD.	REGULAR	MARKETING DIVISION, 5th FLOOR, 59-B, CHOWRINGHEE ROAD, KOLKATA Phone- 24757784,22472509 Pincode : 700020 Email : anidel@bol.net.in
2	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	A126	ASHCROFT INDIA PVT LTD.	REGULAR	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 9999464663 Pincode : 382729 Email : ajay@aurainc.com
3	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	F016	FORBES MARSHALL (HYD) LTD.	REGULAR	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
4	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	G071	GAUGE BOURDON INDIA PVT. LTD.	REGULAR	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com
5	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	H023	H.GURU INDUSTRIES	REGULAR	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
6	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	H040	H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	REGULAR	32,INDUSTRIAL SUBURB YESWANTHAPUR BANGALORE Phone- 080-23370300, Pincode : 560022 Email : info@hgurusouth.com
7	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	W017	Baumer Technologies India Pvt. Ltd.	REGULAR	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

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SECTION: D

STANDARD SPECIFICATION

SECTION-D

AIR WASHER

1. GENERAL

1.1.1 This specification covers the design, manufacture, construction features, installation, commissioning and conducting performance test at site.

2. CODES AND STANDARDS

The design/manufacture and performance of air washer shall comply with all currently applicable statutes, regulations and safety codes in the locality where the air washer is installed. The equipments shall also conform to the requirements of the latest editions of applicable Indian/British/US standards. Nothing in this specification shall be construed to relieve the vendor of this responsibility. In particular the equipments shall conform to the latest editions of the following standards:-

2.1.1 IS:277: Galvanised steel sheets

2.1.2 IS:1239: Mild steel tubes

2.1.3 IS: 2062:

3. DESIGN/CONSTRUCTION FEATURES

3.1 GENERAL

3.1.1 The air washer shall be designed for max. air velocity of 2.8M/sec. Circulating water quantity shall be 1.0 CMH for every 1000 CMH of air flow, unless otherwise stated in data sheet A. The minimum saturating efficiency of air washer shall not be less than 90% Minimum length of air washer shall be 2500 mm.

3.2 TANK (SUMP)

3.2.1 The air washer tank shall either be masonry or metallic construction as specified in data sheet A. Masonry tank shall be provided by purchaser whereas metallic tank shall be of welded construction, fabricated from not less than 6mm thick MS plates, and inside, outside surfaces shall be provided with anti corrosive paint (Zinc sprayed to coating thickness of 75 micron min.).

3.2.2 The air washer tank shall have a minimum depth of 600mm and tank construction shall be such that the suction screen can be replaced while the air washer is under operation. The inlet and outlet ends of tank shall be suitably constructed to accommodate distribution plates and eliminator plates.

3.3 DISTRIBUTION PLATE

3.3.1 The distribution plate shall be fabricated from minimum 18 gauge thick GSS and shall have minimum 50% free area. The angles used for supports shall be galvanised.

3.3.2 The distribution plate shall be built up of number of sections for easy handling.

3.4 HEADERS AND STAND PIPE

3.4.1 The air washer shall be of two bank construction (one cross flow and other unit flow). The piping up to and including 100mm dia meter shall be of galvanised steel and above 100mm dia shall be black steel (subsequently spray galvanized to coating thickness as per approved TDS). All piping shall be adequately supported.

3.5 SPRAY NOZZLES

3.5.1 Spray nozzles shall be made of HDP (High density polyethylene) and shall be self cleaning type. The nozzles shall be designed to produce fine atomised spray and shall be spaced to give, uniform coverage of the air washer section. The pressure drop through the nozzle shall be in the range of 1.4 kg/cm2 g to 2.4 Kg/cm2g

3.6 ELIMINATOR PLATE

3.6.1 Eliminator plate shall be fabricated from 22 gauge thick GSS (Zinc coating thickness as per approved TDS).The eliminator section shall have minimum 6 bends. Spacer bars, tie rods and supports shall be of galvanised steel construction. Eliminator box shall be complete with suitable drop tray and drain pipe.

3.7 SUCTION SCREENS

3.7.1 Suitable no. of suction screens shall be provided by vendor and one set of spare screens shall be furnished along with each air washer.

3.8 INSPECTION DOOR AND MARINE LIGHT

3.8.1 Air tight inspection door of 600x700mm, metallic construction shall be provided. The air washer shall be equipped with marine light as required.

3.9 MAKE UP, DRAIN AND QUICK FILL CONNECTION

3.9.1 The air washer shall be provided with quick fill and make up connection. The quick fill valve shall be a globe valve. Float valve for making connection shall be backed up by a gate valve. Drain connections complete with isolating valves shall be provided for both suction and main tank. Over-flow pipe shall be provided for main tank and shall be connected to drain pipe, before the isolating valve or drain. In case of masonry tanks suitable pipe pieces with stiffener plates shall be provided by Vendor for use during casting of masonry tank.

4. DATA TO BE FURNISHED BY VENDOR AFTER AWARD OF CONTRACT

4.1.1 Performance curve for air washer

4.1.2 GA drg.

4.1.3 Foundation drag. weight, dynamic loading etc.

4.1.4 O&M manual

TITLE

AIR WASHER

DATA SHEET - A

VOLUME II-B

SECTION D

REV 00

S.No.	DESCRIPTION	DETAILS
	GENERAL	
1.	Designation	Air washers for power house building.
2.	Nos. required	Refer Section-C of Specific Technical Requirement
3.	Service	Evaporative Cooling of TG Hall & electrical bay
4.	Location	As per section-C/ Tender Layout Drg.
	DESIGN DATA	
5.	Type	Sheet metal type, as per schedule of Ventilation system.
6.	Capacity M3/hr	Refer Section-C of Specific Technical Requirement
7.	Inlet air temperature	(Refer design data.)
8.	Saturation Efficiency	To achieve saturation efficiency of 90% (min).
9.	Allowable Pressure drop through Spray nozzle	2.4 Kg/cm2 (g) max.
9.	Pressure drop across Spray chamber	15 to 20 mm WG.
	MATERIALS	
11.	Moisture Eliminators plates	24 SWG Galvanized Sheet (Vertical and brake type)./ 100% Virgin die extruded PVC construction of minimum finished thickness of 2 mm.
12.	Moisture Eliminators Frame	22 SWG G.I. Sheets.
13.	Distribution plates	18 G GSS to have 50% free area.
14.	Tank	MS
15.	Casing	Black M.S. (10 SWG min.)
16.	Louvers	20 G GSS sheet & frame of 16 G galvanized steel angle, baffle made of 18G sheet. Louvers with Bird screen of galvanized wire mesh of 10 mm square.
17.	Piping	MS Heavy Class Galvanized to IS: 1239 Part I, OR IS –3589 depending upon size.
18.	Suction Screen Water	Brass (40 mesh size 2 nos for each air washer)
19.	Spray nozzles	SS/Brass/Bronze with chrome plating or suitable plastic material (Nylon/Polymer) and shall be self cleaning type.

Anshul S A Khan Praveen Kishore

20.	Flooding Nozzles	SS/Nylon/Polymer.
21.	Banks	Two spray banks each connected to individual header

EQUIPMENT SELECTION CRITERIA

22.	Face Velocity through louver.	Not to exceed 2.5 m/s
23.	Max. Pressure drop	Not to exceed 6.5 mm Wg when clean
24.	Saturation efficiency	Not less than 90%.
25.	Face velocity of air through spray chamber. & fill section	Not to exceed 2.5 m/s. & 2.25 M/s (Max.)
26.	Allowable pressure drop for washing chamber.	15 to 20 mm Wg.

NOTE:

1) All parts coming in contact with moisture for air washer shall be spray galvanized/epoxy painted (2 coat of rust preventing epoxy primer & 2 coat of finished paint from both sides.)
2) Moisture eliminator shall have bends at 30 Degree with the direction of air flow & shall have effectively hooked edges for traping the water.

SECTION-D

LOW PRESSURE AIR DISTRIBUTION SYSTEM

1. GENERAL

This specification covers the design, manufacture, construction features, installation, inspection testing and air balancing of air distribution system upto a total pressure of 95mm w.g. The specification is intended to cover the air distribution for airconditioning system and ventilation system not involving localised exhaust.

2. CODES AND STANDARDS

2.1.1 The design, construction and performance of complete system shall conform to all currently applicable stuatues, regulations, safety codes in the locality where the equipment are to installed.

2.1.2 Unless specified otherwise the equipments shall generally conform to latest applicable Indian Standards. Nothing in this specification shall be construed to relieve the vendor of this responsibility. In particular the equipment shall generally conform to latest editions by the following standards:-

a) IS: 655 - Specifications for metal air ducts

b) IS:277 - Specifications for galvanised steel sheets

c) IS:737 - Specification for wrought aluminium and aluminium alloy sheet and strip.

3. MATERIAL

3.1.1 Metal air ducts shall be either of galvanised steel sheets or aluminium sheets, as indicated in data sheet-A.

3.1.2 The rolled steel sheets before galvanising shall be properly annealed or normalised so as to allow fabrication of ducts without developing cracks. Zinc coating on the steel shall be as per IS 277 Gr. 275 / as specified in Data Sheet A.

3.1.3 The aluminium sheets shall be of grade S1C or NS3 and shall be suitable for duct fabrication work as per IS-737 latest.

4. CONSTRUCTION/FABRICATION

The thickness of sheets, the type of bracing and other fabrication details shall generally conform to requirements given hereunder unless specified otherwise in data sheet A and/or indicated on drawings.

4.1 RECTANGULAR DUCTS

4.1.1

S.No.	Max Side	Sheet Thickness		Type of transverse Joint connections	Bracings
		(mm) GI	(mm) Al		
a)	Up to 600	0.63 (24G)	0.80	S-drive, pocket or bar slips or flanged joints on 2.5m centres	None
b)	601 to 750	0.63 (24G)	0.80	S-drive, 25mm pocket or 25mm bar slips or flanged joints on 2.5m centres	25x25x3 mm MS angles, 1.2m from joints
c)	751 to 1000	0.80 (22G)	1.00	S-drive, 25mm pocket or 25mm bar slips or flanged joints on 2.5m centres	25x25x3 mm MS angles, 1.2m from joints

Anshul S A Khan Praveen Kishore

d)	1001 to1500	0.80 (22G)	1.00	40x40x3mm MS angle, flanged connections or 40mm pocket or40mm bar slips with 35x3mm bar reinforcing on 2.5m centres	40x40x3 mm MS angles, 1.2m from joints
e)	1501 to2250	1.00 (20G)	1.50	40x40x3mm MS angle, flanged connections or 40mm pocket or40mm bar slips, 1M maximum centres, with 35x3mm bar reinforcing	40x40x3 mm diagonal angles or 40x40x3mm angles, 600mm from joints
f)	2251 & above	1.25 (18G)	1.80	50x50x3mm MS angles,connections or 40mm pocket or 40 mm bar slips, 1M maximum centres with 35x3mm bar reinforcing.	50x50x3mm diagonal angles or 50x50x3mm angles 600 mm from joints.
g)	No bracing is required if transverse joints are less than 600mm apart				
h)	For ducts larger than 2250mm, special handling and supporting methods shall be provided as per the approval of Purchaser				

4.1.2 All rectangular ducts having either dimension larger than 450mm shall be cross broken except these ducts which are insulated with sand cement plaster. Air outlet connections on ducts need not be cross broken.

4.1.3 The seams on duct cones shall be of Pittsburgh type. Longitudinal seams shall be smooth inside the ducts.

4.1.4 The flanges used for transverse joints shall be joined together with GI bolts (grade 4.6) and nuts spaced at 125mm centres as per following:

a) Upto 1000mm - 6 mm dia GI bolts
b) 1001 to 1500 - 8 mm dia GI bolts
c) 1501 and above - 10mm dia GI bolts

4.1.5 The MS angle flanges shall be connected to ducts with rivets at approx. 100mm centres. The flanged joints shall have 6mm thick felt packing stuck to flanges with shellac varnish. The holes in the felt packing shall be burnt through. The ducts are to be tapped 6mm across the MS flanges.

4.1.6 MS angles used for bracings shall be tack welded to the ducts or rivetted at 125mm centres, as applicable.

4.2 ROUND DUCTS

4.2.1

S.No.	Duct dia-mm	Sheet Thickness		Reinforcing
		(mm) GI	(mm) Al	
a)	Up to 150	0.63 (24G)	0.80	None
b)	151 to 600	0.80 (22G)	1.00	None
c)	601 to 1000	1.00 (20G)	1.50	40x40x3mm girth MS
d)	1001 to1250	1.00	1.50	40x40x3mm girth MS angles at 2.0 meter centres

		(20G)		
e)	1251 & above	1.25 (18G)	1.80	40x40x3mm girth MS angles at 1.2m centres

4.2.2 The seams on round ducts may be continuously welded or grooved longitudinal seam. In case of welding of GI sheet, zinc rich paint shall be applied on the welded zone.

4.2.3 Round ducts shall either be joined by welding or the ducts shall be swedged 40mm from the ends such that larger end will butt against the swedge and is held in place with sheet metal screws.

4.3 DUCT SUPPORTS

Unless specified otherwise on drawings, rectangular ducts with larger side of 2250mm or above shall be supported by 15mm MS rods and 50x50x3mm and MS angles while those below 2250 mm shall be supported by 10mm MS rods and all angles shall be given a coat of primer paint. The duct supports shall be at a distance not exceeding 1800mm. The MS rods shall be fixed to MS angle cleats, which in turn are fixed to ceiling slab by suitable anchor fasteners. All anchor fasteners, MS angle cleats, coach screws, hooks and other supporting material required shall be provided by vendor.

However, If ducts are thermally insulated, the MS angles and supports shall not be in direct contact with ducts, for which purpose wooden pieces/ Resin bonded fibre glass sheets (50 mm thick) shall be used in between.

4.4 FLEXIBLE CONNECTIONS

Wherever the sheet metal ducts connects to intake or discharge of fan units a flexible connection of at least 150mm width made by closely woven double layer Fire resistant or canvas shall be provided. The same shall be attached to angle iron frames on equipment and to similar frame on duct or casing by means of a steel band or collar fitting over the end of the flexible connection and bolted through angle iron frame so as to clamp securely between the band and the angle frame.

4.5 TRANSFORMATIONS AND BREACHES

All curves, bends, offsets and other transformations shall be made for easy and noiseless flow of air. The throat of every branch duct shall be sized to have a velocity not exceeding that in the main duct to which the branch is connected.

4.6 CAULKING

Wherever duct passes through wall, the opening between masonary and duct work shall be neatly caulked or sealed to prevent movement of air from one space to adjoin by space with a rated fire resistant material.

4.7 EASEMENT

Normally pipe hangers, light fitting rods etc. shall not be allowed to pass through the ducts. Wherever, It becomes absolutely essential to pass these hangers/rods etc. Through the ducts, prior approval of purchaser shall be taken and light streamlines easement around the same shall be provided to maintain smooth air flow.

4.8 ACCESS DOORS

Access doors shall be provided in ducts, plenums etc. on both sides to allow access and servicing of equipment viz. pipes, dampers, coils, valves, heaters etc.

All access doors shall be adequately sized and lined suitably with felt to prevent air leakage. The doors shall be of built-up construction, structurally strong and shall have

at least two hinges each, and shall be with two rust proof window sash locks of approved type. All doors shall be so set as to flush with outer finish of duct insulation etc.

4.9 DAMPERS AND SPLITTERS

4.9.1 Dampers and splitters shall be provided at suitable points for proportional volume control of the system. Splitters and dampers shall be made of minimum 18 gauge GSS of quadrant type with locking device mounted outside the duct at accessible location.

4.9.2 Fire Dampers

Fire dampers/fire doors shall be provided as specified in Data Sheet -A and shall be installed at locations indicated on drawings and/or as required/approved by purchaser, including all openings in passage of duct work through fire walls and floors etc. The fire damper shall be of electrical type with damper motor actuated by thermal sensor or fusible link type.

4.9.3 Gravity operated back draft dampers shall be provided to ensure pressurisation of rooms as specified. These dampers shall be designed such as not to allow infiltration of outside air while forced exit of air shall be achieved through this damper. The louvres shall be freely mounted on spindles to allow the dampers to open with the pressure developed by the fan. The dampers shall be provided with flange at inlet.

4.9.4 Vanes

Unless otherwise shown in the drawings all elbows shall be such that the throat radius is 75% of the duct width. In case throat radius is smaller, suitable single thickness vanes of approved details shall be provided.

4.9.5 Flashing

For the ducts penetrating roofs or outside walls, provision of flashing shall be made by the ducting vendor.

4.10 DIFFUSERS AND GRILLS

The type and quantity of diffusers and grills is indicated on enclosed drawings/data sheet A. The size/quantity of diffusers/ grills indicated in the drawing/data sheet is indicative and is for vendor's reference purpose only. Vendor shall ensure that the diffusers/grills offered are of requisite capacity, throw and terminal velocity. The pressure drop and noise levels shall be as per data sheet. A enclosed. The diffusers/grills shall be approved by purchaser.

Unless specified otherwise the diffusers/grills shall be of mild steel land painted with two coats of primer paint. Supply air grills shall be complete with volume control dampers. Supply air grills shall be double deflection type while Return Air grills can be single deflection type. Ceiling outlets/diffusers shall have volume control dampers, fixed grids and blanking baffles. All volume control dampers shall be operated by a key from the front of grills/diffusers.

Suitable vanes shall be provided in duct collars to have uniform air distribution. Blank-off baffles wherever required, shall also be provided.

4.11 PLENUMS AND RA BOXING

All plenum chambers and/or connections to fans, dampers etc. shall be constructed in 18 gauge GI sheet. supported on 40x40x6mm MS angle frames. All vertical angles shall be riveted at appox. 125mm. centres to the casing. Suitable caulking compound (Pecora or equivalent) shall be inserted between the base of the angle and all masonary construction to which angles are fastened.

Return air boxing requirements if any are indicated in data sheet-A and the same shall be provided by vendor. The return air box ~~shall be~~ fabricated out of GI sheets shall be insulated with 25mm thick fibre-glass.

4.12 ACCOUSTIC LINING

The ducts shall be lined acoustically from inside as given in data- sheet A and/or section C of the specification.

4.13 PAINTING

Wherever specified the ducts shall be painted or lined with suitable anti-corrosive paint/ lining as per approval of purchaser. In particular the ducts coming in contact with acid fumes shall be epoxy coated, inside and outside.

4.14 THERMAL INSULATION

Thermal insulation shall be as per data sheet - A and the insulation shall conform to enclosed spec. no. PES-553-08.

5. INSPECTION AND TESTING

5.1 INSPECTION & TESTING DURING FABRICATION–BY MAIN VENDOR

5.1.1 Visual inspection of GI sheets and angles, channels etc. – dents, black spots, chipping of zinc coating, white dust on galvanised sheets shall be avoided. Pitting , lamination in angles and channels shall be avoided.- visual inspection by Main Vendor.

5.1.2 Galvanised sheets - Test certificate shall be furnished for visual check, coating thickness, adhesion test, sheet thickness, uniformity of coating –review of TC by BHEL/Customer

5.1.3 Check for dimensions & mass as per latest IS-277.

5.1.4 Check for defect, twists, ungalvanised spots as per IS-2629.

5.1.5 Bend test & wrapping test as per IS-277.

5.1.6 Zinc coating test on samples as per IS-6745.

5.2 INSPECTION & TESTING AT SITE.

5.2.1 The duct branches, elbows etc. shall be inspected and the joints and connections etc, are to be checked before they are assembled in position.

5.2.2 After completion, all duct systems shall be checked and tested for air leakage, tightness, velocity, pressure drop, vibration and noise etc.

6. BALANCING

6.1.1 The entire air distribution system shall be balanced by vendor to supply the air quantities as required in various rooms so as to maintain the requisite temperature and air flow in the conditioned spaces. The final balance of air quantities through each grill/diffuser etc. shall be recorded and submitted to purchaser for approval. Proper steps shall be taken to have a uniform temperature in all enclosures, with utmost care for noise level to be within tolerance limit

6.1.2 All instruments required for testing/balancing etc. of the air distribution system shall be provided by vendor.

7. DATA TO BE FURNISHED BY VENDOR AFTER THE AWARD OF CONTRACT

7.1 Fabrication drawings of ducts and grilles, louvers, dampers, etc, including typical details of grilles dampers etc.

7.2 Test certificates in line with scope of inspection.

7.3 Other dimensional drawings & documents as may be required by purchaser for better understanding of the system & for preparation of operation, maintenance & instruction manual.

Anshul S A Khan Praveen Kishore

TITLE

LOW PRESSURE
AIR DISTRIBUTION SYSTEM
DATA SHEET - A

VOLUME II-B
SECTION D
REV 00
SHEET 1 OF 1

1)	General (List of areas)	As per schedule/tender drgs of Ventilation system.
2)	i) GSS Duct Work	
	a) Type	Zinc coating (Refer Section-C of Specific Technical Requirement)
	b) 1.25 mm thk ducting	Bidder to estimate as per Drawings/sketch
	c) 1.0 mm thk ducting	Separately for Ventilation system.
	d) Any other size	(area wise)
	e) Battery Room ducting.	MS with epoxy painting on both sides.
3)	Special painting	MS Ducts in Battery Room to be epoxy painted. Both interior & exterior)
4)	Thermal Insulation	Required in duct for vent. System exposed to Sun only (furnished by Cement sand plaster)
5)	SA grilles (for each size) (SQ.M)	To suit airflow as per schedule/tender drgs.
6)	Exhaust Gravity/Manual relief dampers (for each size & to maintain a slight positive pressure inside.)	-do-
	a) Frame	1.6mm M.S.
	b) Louver	0.8mm Al.

NOTE:

1) Ducting shall be as per IS-655 standard.
2) Opposed blade type volume control damper (gang operated) shall be provided at each supply air grilles.
3) Bidder to provide suitable gasketing at each duct flange.(Asbestos shall not be used).
4) Supply Air Grills shall have 2 (two) set of adjustable louvres.
5) Bidder to indicate unit rates for variable items like ducting, grilles with & without volume control damper, gravity damper, thermal insulation, etc.
6) Grilles, frames & louvres shall be of at least 18 SWG sheet and 20 SWG MS respectively.
6) Fire damper shall be solenoid operated in accordance with NFPA. The solenoid shall be charged during open condition and shall be de-energising to close.
7) Access door in ducting system shall be provided as required.
8) MS Angle (painted) shall be used only as duct supports.
9) Velocity thru duct shall not exceed 12 M/sec for Ventilation system.
10) All exhaust/return air grilles shall have one set of louvres in the front or thick rat-proof wire net guards.

Anshul S A Khan Praveen Kishore

SECTION-D

VENTILATION FANS

1. GENERAL

This specification covers the design, manufacture, testing of performance at manufacturer's/sub-contractors works, delivery at site, handling at site, erection and commissioning of ventilation fans.

2. CODE AND STANDARDS

The design, manufacture and performance of equipment shall comply with all currently applicable statutes, regulations and safety codes in the locality where it is to be installed. The equipment shall conform to latest edition of applicable Indian Standards or their equivalent standards. Nothing in this specification shall be construed to relieve the vendor of this responsibility. In particular the equipment shall conform to the latest editions of the Following standards.

2.1.1	IS:4894	-Centrifugal fans
2.1.2	IS:3588	-Electric Axial Flow fans
2.1.3	IS:2312	-Propeller type A.C. ventilation fans
2.1.4	IS-3963	-Roof extractor units
2.1.5	BS:848	-Method of performance test for fans.
2.1.6	AMCA publication 99 standards handbook	
2.1.7	AMCA standard 210, Test code for air moving devices.	

3. DESIGN AND CONSTRUCTION

3.1 THE ENCLOSED DATA SHEET A GIVES THE NECESSARY DETAILS FOR CENTRIFUGAL/AXIAL/ROOF EXTRACTOR UNITS ETC.

3.2 WELDING PROCESS AND WELDERS EMPLOYED FOR FABRICATION SHALL BE QUALIFIED AS PER ASME SEC. IX

3.3 CASING

3.3.1 The centrifugal fans casing shall be of welded construction fabricated with heavy gauge material (min 3 mm) with flanges (min. 5 mm) on inlet and out let side for direct connection and shall be rigidly reinforced and supported by structural angles. The seams shall be permanently sealed airtight. Horizontal Split casings shall be provided on large size fans. Casing drain (at bottom) with threaded plug/ with valve shall be provided, as required. All mounting/ connecting holes shall be drilled off centre.

3.3.2 The axial flow casing for supply fans/roof extractors shall be of heavy gauge construction (min 3 mm) properly reinforced for rigidity and shall be complete with suitable supports. Access doors with suitable locking arrangement shall be provided in the casing for easy access to the motor and impeller. External junction box/ Terminal box on casing with IP-55 protection shall be provided, if required. Wiring for motor from external junction box/ Terminal box shall be through flexible conduit.

3.3.3 Suitable motor brackets designed for rigid mounting of motors, shall be provided for roof extractors and wall mounted exhaust/ supply fans.

3.4 IMPELLER

3.4.1 Centrifugal fan impeller shall have die formed, aerofoil or laminar blades welded to the rim and back plate and shall have non-overloading, self cleaning characteristics. Rim shall be spun to have smooth contour. If required, intermediate stiffening rings

shall be provided. Shaft sleeves shall be furnished, if specified. The impeller, pulley and shaft sleeve shall be secured to the shaft by key and/or nuts (threaded opposite to direction of rotation of impeller). The impeller shall be statically and dynamically balanced.

~~3.4.2~~ The axial fan impeller shall be of high efficiency aerofoil design. The blades shall be mounted on a streamlined hub and the impeller shall be mounted directly on the motor shaft. Impeller shall be in one piece however; fabricated blades will be acceptable up to 450 mm impeller diameter.

3.4.3 Roof ventilator impeller may either be centrifugal or axial type. Backward inclined blades shall be provided for centrifugal impellers. Blades may be die-formed or cast. Axial flow impeller shall be directly mounted to motor shaft whereas centrifugal impeller may either be direct-driven or belt-driven. The shaft of belt-driven centrifugal fan shall be solid cold rolled carbon steel, ground and polished. However, direct mounted impellers are preferred.

3.5 BEARINGS:

3.5.1 The centrifugal fan bearing may be ball, roller or sleeve bearings of self-aligning heavy duty type with adequate capacity and life. Make of Bearings to be specified. Bearings shall be oil/grease lubricated and provided with fittings for lubrication from outside and shall be located in easily accessible position to facilitate maintenance.

3.6 INLET CONES AND GUARDS

3.6.1 Centrifugal fans inlet shall be spun to have a smooth contour. Inlet screen, if provided, shall be galvanised wire mesh of 25 mm square with wire thickness of min. 1.5 mm.

3.6.2 Inlet cone, outlet bell and suitably designed guards shall be provided.

3.7 GUIDE VANES:

3.7.1 In case of vane axial fans guide vanes shall be provided on discharge side.

3.8 BASE PLATE AND VIBRATION ISOLATORS

3.8.1 Base plate and vibration isolators, which may be double deflection rubber in shear or rubber in compression type or spring type shall be provided. With each fan rubber bushes, washers wherever needed for vibration isolator in sufficient nos. shall be included, as required, to ensure isolation of foundation from vibration of equipment. For roof ventilators suitable mounting arrangement shall be provided such that there is no ingress of rain water into the building.

3.9 HOOD AND COWL

3.9.1 Roof exhaustors shall be provided with hinge type hood providing easy access to motor and impeller. Weather proof lockable type disconnect switch shall be provided such that hood can open only when the disconnect switch is in'off' position. On larger size of roof ventilators hoods may be of split construction. 15 mm mesh galvanised bird screen shall be provided.

3.9.2 Rain protection cowls shall be designed to suit wall exhausters/supply fans for protecting fans from rain. The cowls shall be provided with bird screen of heavy gauge expanded metal netting.

3.10 SPEED

3.10.1 The speed of axial flow fans/roof ventilators shall not exceed 960 RPM for impeller dia exceeding 450 mm and shall not be greater than 1440 with impeller dia less than 450 mm.

4. MOTORS

Drive motors shall be of totally enclosed type, suitable for horizontal/vertical mounting as applicable and shall comply with the requirments of the specifications furnished elsewhere for motors.

5. ACCESSORIES

Accessories as specified in Data sheet-A and as required for satisfactory trouble free & safe operation of fans shall be provided.

TESTING AND INSPECTION

List of TCs arranged as per Approved Quality Plan shall be furnished along with copy of TCs at the time of inspection by BHEL

- Visual inspection of sheets/plates, angles, channels etc. – Pitting, lamination in sheets/ plates, angles and channels shall be avoided.- visual inspection by main contractor of BHEL.
- Sheets/ Plates - Test certificate shall be furnished for physical and chemical properties for sheets / plates- for review by BHEL
- Shaft: Mechanical and chemical-– review by BHEL
- Motors (of approved make): Routine TC ,FLP TC if applicable
- Workmanship and dimensional check as per manufacturing drg. and approved Drgs.- by main contractor of BHEL.- Shall be checked by BHEL/ Customer during final inspection.
- Balancing of impellers- Dynamic balancing certificates shall be furnished –grade 6.3 or better to ISO-1940. Balancing weights shall be positively locked/ welded to avoid loosening. - witness by manufacturer - TC to be furnished for review by BHEL(consisting of weight of impeller, radius of correction and balancing rpm). For spare impellers Dynamic Balancing shall be witnessed by BHEL.
- Performance test of one Centrifugal fan or Axial Fan /per type/per size as per applicable standard – by BHEL.
- Centrifugal/ Axial fans 100% run tested by main contractor of BHEL. Run test by BHEL/Customer may be at random or 100%- Vibration shall be within satisfactory zone of VDI 2056 (group- G) machines when measured on bearing housing and noise level <85 dbA at 1 metre distance. Max. Temp. on bearing housing- 40 degrees Centigrade + ambient

TITLE

CENTRIFUGAL FAN

DATA SHEET - A

VOLUME II-B

SECTION D

REV 00

No.	Particulars	Data
1	**General Information**	
1.1	Fan Designation/application.	Refer schedule of Ventilation system/ Air washers & UAF Units.
1.2	Nos. required/capacity	Refer Section-C of Specific Technical Requirement
1.3	Location	Refer layout drg. Attached.
2.0	**Design Data**	
2.1	Type	DIDW for Air Washer and SISW for UAF
2.2	Type of blades	backward curved
2.3	Arrangement	To suit application as per layout.
2.4	Discharge direction	To suit application as per layout.
2.5	Duty	Continuous
2.6	Capacity at site (Cubic Meter/hr) & static pressure.	Refer Section-C of Specific Technical Requirement
2.7	Suction pressure (mm Wg)	As per system requirement.
2.8	Fluid	Atmospheric Air.
2.9	Suction Temperature	Refer weather data attached.
2.10	Suction humidity	Refer weather data attached.
3.0	**Materials**	
3.1	Fan Scroll	Heavy Gauge Mild Steet to IS: 2062 with galvanised
3.2	Fan Casing (side plates & stiffeners)	Heavy Gauge Mild Steet to IS: 2062 / IS: 1079 / Eq. Minimum 3 mm thick casing.
3.3	Impeller	Mild Steel/plate to IS: 2062
3.4	Impeller hub	Mild Steet/plate to IS: 2062
3.5	Impeller back plate blade & shroud	Mild Steet to IS: 2062 / IS: 1079 / Eq.
3.6	a) Shaft b) Shaft sleeve	EN-8 or eqv. -do-
3.7	Support frame and structure.	Mild Steet to IS: 2062
3.8	Flexible connection at outlet canvas with MS Flanges and cleats (3mm thick).	Fire resistant type plastic impregnated

Anshul S A Khan Praveen Kishore

3.9	V Belt	ISI marked (Reinforced rubber section to IS: 4776)
3.10	V Pulley	Cast Iron multi groove to grade FG 20 as per IS: 210. Having taper lock type
3.11	Slide rails	M.S./C.I.
3.12	Connection pieces	G.I. according to supplier's design
3.13	Bolts & nuts	M.S. Galvanized / Epoxy painted.
3.14	Vibration isolating pads, washers and spring if any.	Hard synthetic rubber
4.0	**ACCESSORIES**	
4.1	Common base plate	Required.
4.2	Anchor bolts	-do-
4.3	Vibration Isolators	Hard synthetic rubber
4.4	V-belt pulleys	-do-
4.5	V-belts	Reinforced rubber of appropriate section
4.6	Belt guard	Required.
4.7	Outlet damper	Required(M.S. Heavy Gauge)
4.8	Inlet guard	Required.
4.9	Inlet Vane (variable)	Not required.
4.10	Drain valve	Required.
4.11	Acoustic silencers	Not required.
5.0	**Motor**	
5.1	Motor by	Bidder
5.2	Starter by	BHEL
6.0	Painting of fans including base frame	Galvanized / epoxy painting (as per Section-C & painting specifications)

NOTE:

1) Motors shall have 15 % margin on duty power point.

2) Fan shall be designed to operate with in 9% and 25% of system throttling line.

3) Opposed Multiple louvers damper shall be provided at fan outlet.Louvres shall be of 2 mm thick MS (galvanized). Casing shall be of 3.15 mm thick MS (galvanized).

Anshul S A Khan Praveen Kishore

TITLE

VENTILATION FAN (R.E.UNIT)

DATA SHEET - A

VOLUME II-B

SECTION D

REV 00

SHEET 1 OF 2

General Information

1)	Designation	Roof extractor Units for areas as per schedule of ventilation system.
2)	Nos. required	As per schedule.
3)	Service	Continuous
4)	Location	Roof of respective areas.
5)	Area	As per schedule

Design Data

6)	Type	axial flow type.
7)	Air delivery capacity	as per schedule of ventilation system.
8)	Fluid	Atmospheric Air.
9)	Temperature	50 Deg. C
10)	Static Pressure required	As per Section'C' schedule of ventilation system.
11)	Outlet air velocity	Not more than 12 m/sec.

Materials

12)	Casing/cowl/hood	M.S. Sheet to IS: 2062 /IS: 1079/Eq.
13)	Impeller	Cast A1uminium alloy to A-6M IS-617 Grade LM6
14)	Support frame and structure.	M.S. of adequate thickness (IS-2062).

ACCESSORIES

15)	Vibration isolating pads	Yes.
16)	Base frame for mounting	Yes.
17)	Wire Guard at inlet.	Yes.
18)	Disconnect switch	Yes.
19)	Gravity damper at outlet	Yes

Motor

20)	Motor by	Bidder
21)	Starter by	Bidder

Anshul S A Khan Praveen Kishore

22)	Type of motor	Conforming to IS: 325 latest/as per specification.
23)	Free delivery test	Yes.
24)	Performance test at specified duty point.	Yes
25)	Speed	Not more than 1500 RPM

NOTE:

1. Motors shall have 15% on duty power Point.

TITLE

Ventilation Fan (Axial Flow Type)

DATA SHEET - A

VOLUME II-B

SECTION D

REV 00

No.	Particulars	Data
	General Information	
1)	Designation	Supply/Exhaust Fans.
2)	Nos. required	Refer schedule of Ventilation system in section-C under specific technical requirement.
3)	Service	To exhaust warm air/to supply fresh air.
4)	Location	Wall mounted.
5)	Area	Same as above in 2.
	Design Data	
6)	Type supply	Axial fans suitable for 415V/3 phase for Motor.
7)	Air delivery capacity	As per schedule of ventilation system.
8)	Fluid	Atmospheric Air.
9)	Temperature	Refer Section of specific technical requirement
10)	Static Pressure required	As per Section'C' schedule of ventilation system.
11)	Outlet Air Velocity	Not more than 12 m/sec.
	Materials	
12)	Casing	M.S. (IS-2062)
13)	Impeller	Cast A1uminium. (Alloy A-6M, IS-617)
14)	Hub	Al Alloy.
15)	Support frame and structure. (Galvanized/	M.S. of adequate thickness Painted) IS-2062.
16)	Neoprene rubber pads	As required.
17)	Coned inlet for wall exhausters/supply fans	MS (IS-2062)
18)	Supporting frame for mounting.	Required.
19)	Protective screen at inlet.	Yes (Min 14 SWG Galvanized wire knitted in 1" square mesh.
20)	Rain Protection Cowl	Aluminum or hot dip Galvanized after fabrication from M.S.

Anshul S A Khan Praveen Kishore

Motor

21)	Motor by	Bidder
22)	Starter by	BHEL

NOTE:

1) For Battery Room, motor for fan shall be of flame proof type & fan of spark proof construction with Epoxy painting.

2) Gravity type damper shall be provided at the outlet of axial fan for exhaust application.

3) Motor shall have 15% margin over Duty Point.

SECTION-D

AIR FILTER

1. GENERAL

This specification covers the design, manufacture, inspection and testing at manufacturer's work or his sub-contractor's works of Air filters to be used for air-conditioning and ventilation system:

2. CODES AND STANDARDS

This design, manufacture and performance of AIR FILTERS shall comply with all currently applicable statutes, regulation and safety codes in the locality where the equipment will be installed. The equipment shall also conform to latest applicable Indian/British/USA standards. Nothing in this specification shall be construed to relieve the vendor of this responsibility. The following standards, in particular, shall be applicable for certified ratings of filters and for conducting performance test, if required.

a) BS EN - 779 -Methods of test for air filters used in air conditioning and general ventilation.

3. GENERAL

The enclosed Data sheet A gives the type and other particulars of filters required.

3.1 POLY FIBRE AIR FILTERS

Filtering media shall consist of a suitable fibrous material (e.g. polyethylene extruded sections coir etc.) packed into a 20 gauges GSS framework, complete with handles etc. The filter element shall be supported by galvanised steel wire mesh of 10mm. sq. on either side, Velocity across the filters shall not exceed 2.5 M/sec. Average efficiency Em (%) shall be >/= 80 as per BS EN - 779..

3.2 DRY FABRIC AIR FILTERS

Filter element shall be pressed felt filter fabric or suitable material recommended by the manufacturer, stitched on to galvanised wire gauge support and crimped to form deep folds. Suitable aluminium spacers shall be provided to ensure uniform distribution of air flow through filters. Filter casing shall be provided with neoprene sponge rubber sealing, The filter shall have Average efficiency Em (%) of >/= 95 as per BS EN - 779.

3.3 PANEL TYPE METALLIC FILTERS (DRY/VISCOUS)

Filter shall consist of V-fold galvanised wire mesh interspaced with flat layers of galvanised wire mesh. The density of media shall increase in the direction of air flow. Edges of wire mesh shall be suitably hemmed to prevent abrasion during handling. The media shall be supported on either side by galvanised expanded metal casing. The framework shall be at least 18 gauge GSS. Filter shall be either dry or wetted type as per data sheet=A. The oil shall be mineral oil of approved quality and make. As a the filter frame made of Aluminium alloy conforming to IS:737 can be considered unless use of aluminium is prohibited otherwise due to site conditions being saline/corrosive.

All filters shall be capable of being cleaned of their accumulated dust by tap water flushing. The dry metallic filter shall have Average arrestance Am (%) shall be >/= 90. However oil wetted air filters shall have Average Efficiency Em (%) >/= 90 as per BS EN - 779..

3.4 ABSOLUTE FILTERS (HEPA)

Filters shall be constructed by pleating a continuous sheet of filter medium into

closely spaced pleats separated by heavy corrugated aluminium spacers. They shall be individually tested and certified to have an efficiency of not less than 99.97% when tested with 0.3 micron dioctyphalate smoke as per IS:2831. The clean filter initial static pressure drop shall not be greater than 25mm WC at rated capacity. A neoprene sponge rubber sealing shall be provided on either face of filter frame.

3.5 WATER REPELLANT NYLON FILTERS

This shall be constructed of water repellent nylon fabric with continuous water spraying on it from a header for keeping it clean. Efficiency of this filter shall be 85% down to 10 microns. This filter shall be used for unitary air filtration system only.

4. INSPECTION & TESTING

The scope of inspection for air filters shall be as below:

List of TCs arranged as per Approved Quality Plan shall be furnished along with copy of TCs at the time of inspection by BHEL.

4.1.1 Dimensional inspection of frame & filter media – TC from Manufacturer- review by BHEL/Customer.

4.1.2 Witnessing by BHEL/Customer of type tests on one per type per size air filters for the following properties.

a) Gravimetric efficiency.

b) Pressure drop in clean & dirty (choked - %age to be specified) condition.

c) Efficiency as per BS EN - 779.

4.1.3 Verification of type test certificates for similar type & size of filters for sodium flame test as per BS-3928 (if applicable- refer data sheet) - by BHEL/Customer

5. DATA TO BE FURNISHED BY VENDOR AFTER AWARD OF CONTRACT

5.1.1 GA Drawing

5.1.2 Drawing showing material/construction detail

5.1.3 Installation and\service manual

5.1.4 Rating curves/charts

5.1.5 Test certificates

5.1.6 Elect. diagrams (when automatic cleaning type)

Description		Data
1)	**General**	
1.1	Service	Ventilation system .
1.2	Location	Main power house bldg. & Blower room of both the unit.
1.3	Nos.	Refer Section 'C' of Specification.
1.4	Total air flow/type	Refer Section 'C' of Specification.
1.5	Temperature	As per project information.
1.6	Relative Humidity	100%
1.7	Gas Composition	Atmospheric Air (Dusty) as prevalent in power station.
1.8	Filter Media	Synthetic non woven
1.9	Efficiency	Average arrestance efficiency of 65-80 % for Dry panel filter (pre-filters) and average arrestance efficiency of 80-90 % for fine filters.
1.10	Allowable pressure drop	2.5 mm & 6.5 mm in clean and dirty condition respectively for **dry panel filters** (pre filters). 12 mm in clean condition for fine filters.
1.11	Frame Work	18 G, GSS.
1.12	Mounting	Ladder Type M.S Angles (galvanised)
1.13	Size	600 x 600 mm

Note:-

1) Face velocity of air across the filters shall not exceed 2.5 m/sec.

1.0 GENERAL

This specification covers the design, material, constructional features, manufacture, assembly, inspection and testing at manufacturer's of his subcontractor's works, suitable painting requirements of centrifugal pumps and drives complete with all accessories as specified hereinafter.

2.0 CODES AND STANDARDS

2.1 The design, manufacture, inspection, testing & performance of the pumps as specified hereinafter, shall comply with the requirements of the latest revision of the following standards as indicated below (as applicable):

a) IS-1520 :Horizontal centrifugal pumps for clear, cold and fresh water
b) IS-5120 :Technical requirements - Rotodynamic special purpose pump
c) IS-1710 :Vertical turbine pumps for clear, cold and fresh water
d) Hydraulic Institute Standards of USA
e) BS - 599 :Method of testing Pumps
f) PTC - '6' :Centrifugal Pumps Power test code
g) API - 610

Wherever standards for certain aspects materials etc., not mentioned, the same shall be as per the applicable Indian or International standards.

2.2 In case of any conflict between the above codes/standards and this specification, the later shall prevail and in case of any further conflict in this matter, the decision of Purchaser's engineer shall be final and binding.

3.0 DESIGN REQUIREMENTS

3.1 The pumps shall be of heavy duty suitable for long periods of uninterrupted service and shall be standard product of the manufacturer thoroughly proven for satisfactory performance and reliability

3.2 The materials of construction of various components shall be as indicated under Data Sheet-A and where not specified to the applicable Indian/British/American standards.

3.3 All pressure containing components including the pump casing, nozzles and stuffing box housing shall be designed, fabricated and tested in accordance with applicable Indian standards if not specified otherwise.

3.4 The pump shall be suitable for handling the fluid as specified in Data Sheet-A

4.0 CONSTRUCTIONAL FEATURES

4.1 Pump Casing

4.1.1 Pump casing may be axially or radially split or barrel type construction as specified in the pump data specification sheet. The casing shall be designed to withstand the maximum pressure developed by the pump at the pumping temperature.

4.1.2 Pump casing shall be provided with adequate number of vent and priming connections with valves, unless the pump is made self venting & priming. Casing drain, as required, shall be provided complete with drain valves.

4.1.3 Pump shall preferably be of such construction that it is possible to service the internals of the pump without disturbing suction and discharge piping connections.

4.1.4 Under certain conditions, the pump casing nozzles will be subjected to reactions from external piping. Pump design must ensure that the nozzles are capable of withstanding external reactions not less than those specified in API-610.

4.2 **Impeller**

Unless specifically indicated under Data Sheet-A enclosed, the pump impellers shall be of closed vane type. The impellers shall be secured to the shaft and shall be retained against circumferential movement by keying, pinning or lock rings. Impellers shall be statically and dynamically balanced individually. The assembled rotor shall be dynamically balanced and checked for eccentricity.

4.3 **Wearing Ring**

Renewable wearing rings for the casing and/or the impellers and renewable shaft sleeves, shall be provided for all pumps. Length of the shaft sleeves must extend beyond the outer faces of gland packing or seal and plate so as to distinguish between the leakage between shaft & shaft sleeve and that past the seals/gland.

4.4 **Shaft**

Shaft size selected shall take into consideration the critical speed which shall be away from the operating speed as recommended in applicable Code/Standard. The critical speed shall also be at least 10% away from runway speed.

4.5 **Bearings**

Bearings and hydraulic devices (if provided for balancing axial thrust) of adequate design shall be furnished for taking the entire pump load arising from all probable conditions of continuous operation throughout its Range of Operation and also at the shut off condition. The bearing shall be designed on the basis of 20,000 working hrs minimum for the load corresponding to the duty point. Proper lubricating arrangement for the bearings shall be provided. The design shall be such that the bearing-lubricating element does not contaminate the liquid being pumped. Where there is a possibility of liquid entering the bearing, suitable arrangement in the form of deflectors or otherwise shall be provided ahead of bearing assembly. Bearings shall be easily accessible without disturbing the pump assembly.

4.6 **Stuffing Boxes**

Packed type stuffing boxes of adequate depth with lantern rings shall be provided to minimize the leakage. In all cases where the pump suction is below atmospheric pressure, the shaft packing shall be sealed by the liquid pumped by tapping off from the pump discharge itself and all pipes, valves, fittings etc., required for this shall be furnished by the manufacturer.

4.7 **Shaft Couplings**

The pumps shall be directly coupled to their drives through heavy duty flexible coupling. Suitable coupling guards shall be provided along with the coupling. The pump and its drive motor shall be mounted on a common base plate.

4.8 **Base Plate and sole Plate**

Unless otherwise stated the data specification sheet, a common base plate mounting both for the pump and drive shall be furnished. The base plate shall be of rigid construction, suitably ribbed and reinforced. Base plate and pump supports shall be so constructed and the pumping unit so mounted as to minimize misalignment caused by mechanical forces such as normal piping strain, hydraulic piping thrust, etc. Suitable drain taps and drip lip shall be provided.

If required in the data specification sheet, steel sole plates shall be provided, below the base plate.

4.9 **Prime Mover**

The drive motor selected shall conform to the requirements of the enclosed motor specifications.

4.10 **Lifting arrangement**

Each pump and motor shall incorporate suitable lifting attachments e.g. lifting lugs or eye bolts etc., to facilitate erection and maintenance.

5.0 **Performance Requirements**

5.1 The pump shall be designed to have best efficiency at the specified duty point. The pump set shall be suitable for continuous operation at any point within the Range of Operation as stipulated in the data specification sheets.

5.2 Pump shall have a continuously rising head capacity characteristics from the specified duty point towards shut off point, the maximum being at shut off. Power capacity characteristic will be non-overloading type i.e. 110% of the design flow the power required to drive the pump will be practically the same as that at the design flow.

5.3 Wherever specified in data sheet, pumps of each category shall be suitable for parallel operation. The head vs capacity, input power vs. capacity characteristics, etc., shall match to ensure equal load sharing and trouble free operation throughout the range.

5.4 The pump motor set shall be designed in such a way that there is no damage due to the reverse flow through the pump which may occur due to any malfunction of the system.

6.0 **Drive Rating**

6.1 The power rating of the drive shall be selected such that a minimum margin of 15% is available over the pump input power required at the rated duty point. However, the drive rating shall not be less than the maximum power requirement at any point within the 'Range of Operation' specified.

6.2 In cases where parallel operation of the pumps are specified the actual drive rating is to be selected by the bidder considering overloading of the pumps in the event of tripping of one of the operating pumps.

6.3 The bidder under this specification shall assume full responsibility in the operation of the pump and the drive as one unit.

7.0 **SCOPE OF INSPECTION AND TESTING**

7.1 **Castings**

7.1.1 Witnessing pouring and thereafter physical testing of castings of 'Critical' nature such as casings, impellers, diffusers.

7.1.2 Identification and correlation with test reports for all tests as per the relevant material specifications for castings of 'Major' nature such as suction bell, discharge elbow, stuffing box, gland, wearing rings, shaft sleeves etc.

7.1.3 Foundry's conformity certificate for castings of 'Minor' nature such as base plates, covers etc.

7.1.4 Verification of neat treatment charts (as applicable)

Note: Casting effects shall not be filled by any method until an unless approved by BHEL/their customer

7.2 **Forgings and**

7.2.1 Identification and correlation with mill test certificates for all tests as per the relevant specifications for important forgings like casings, stage bodies, diffusers, shaft material.

7.2.2 Verification of neat treatment charts (time temperature) (as applicable).

7.3 **Fabricated items**

7.3.1 Identification and correlation with mill test certificates for material of items such as discharge bellows, column pipes etc.

7.3.2 Approval of welding procedure specifications and qualifications of weld procedures and personnel.

7.3.3 Dye penetrant tests of weldment as per ASTM E-165 and acceptance norm as per ASME Sec.VIII, Div.1, Appendix 8

7.3.4 Verification of heat treatment charts (time temperature), (as applicable)

7.3.5 Hydro test as per para 7.5.1 below.

Note: For para 7.1.2, 7.2.1 and 7.3.1 above; in case correlating test certificates are not available, material shall be identified by BHEL and physical tests conducted by the supplier in the presence of BHEL

7.4 **In process Inspection and Testing**

7.4.1 Dye penetrant testing after machining for impellers including vanes, pump shaft, diffusers as per applicable code; in absence of which, as per ASTM E - 165. No defect shall be permitted on moving parts. On static parts acceptance norms are as per ASME Sec.III NB 2546.

7.4.2 Ultrasonic testing of dynamic duty component, i.e. pump shafts (50mm dia and above) and static duty forgings i.e. Barrel, casting (15mm and above wall thickness) as per applicable code, in absence of which as per ASTM E388 and acceptance norms as stipulated hereunder.

7.4.3 Acceptance norms for UT for dynamic duty components. the following defects are unacceptable :

a) Cracks, flakes, seams and laps

b) Defects giving indications longer than that from a 4mm equivalent flaw.

c) Group of defects with maximum indications less than that from a 4mm equivalent flaw, which cannot be separated at testing sensitivity, if the back echo is reduced to less than 50%.

d) Defects giving indications of 2 to 4mm dia. equivalent flaw separated by distance less than four times the size of the larger of the adjacent flaw.

7.4.4 For static duty components - as per NB 2542.2 of ASME Sec. III.

7.4.5 Hydro tests of all pressure parts such as casings, column pipes, discharge elbows etc., at two times duty point pressure or 1.5 time shut off pressure, whichever is higher for 30 min., without any leakage.

Note : In case the pump is required to boost certain pressure, the inlet pressure head shall also be taken into consideration to compute test pressures.

7.4.6 Static and dynamic balancing of individual impellers and also assembled rotors as per V.D.I. 2060 Q 6.3 or ISO 1940 G 6.3.

7.5 **Performance Test**

7.5.1 Pump testing with unit supply motor as per specifications and acceptance norms cited elsewhere, in absence of which as per IS 5120 latest edition. Performance shall be checked for minimum of 7 points (including shut off head and over load) following characteristics shall be checked:

Capacity V/s Head

Capacity V/s Power absorbed by pump

Capacity V/s pump efficiency

Note : For pump of fire protection system, performance test shall be conducted up to 150% of rated capacity

7.5.2 NPSH test in case specifically mentioned elsewhere

7.5.3 Vibration and noise level measurement. Acceptance norms shall be as per manufacturers standards.

7.5.4 Overall dimensions as per GA drawings

7.5.5 Examination after selective opening up after running for pumps operating at speed over 1800 rpm and capacity exceeding 68M3/hr.

7.5.6 Painting and packing as per technical specification.

7.6 **Test at site**

The pumps will be tested at site by the purchaser to verify their performance. If the pumps fail to operate smoothly or within the required performance all such deficiencies shall be rectified by the manufacturer by making suitable alternatives in the pump set and additional tests required to show the effect of such alterations shall be performed by him.

7.7 **Performance Guarantee**

The vendor shall guarantee the material and workmanship of all components as well as the operation of the pump as per requirement of this specification.

The vendor shall also guarantee for each pump the total dynamic head at the specified rated capacity and also corresponding efficiency, brake horse power and shut off head.

8.0 **CLEANING, PROTECTION & PAINTING**

Before shipment of the equipment to be supplied under this specification the necessary cleaning, flushing etc., as per manufacturers standard shall be done to remove all dirts, scales etc. Shop coats of rust inhibiting paints, lacquers etc., shall be applied to various parts as necessary. Flanges, inlet and outlet pipe, etc shall be protected.

9.0 DRAWINGS, TECHNICAL DOCUMENTS AND OTHER INFORMATION REQUIRED WITH THE PROPOSAL

9.1 Fully dimensioned outline GA drawings of the pump motor assembly unit for each type and size offered. This drawing should include:-

i) Foundation base plate and sole plate details as applicable

ii) Civil foundation and anchor bolts details and loading data

iii) Minimum submergence required for the pump (if applicable)

9.2 Cross sectional drawing of the equipment showing the details of assembly of components and their material of construction with standard applicable codes.

9.3 Performance characteristics (Discharge capacity vs head, BHP and efficiency of the pumps.

9.4 Motor speed torque curve superimposed on pump speed torque curve. Required NPSH of pump.

9.5 Experience list about the supply and successful operation of similar pumps for similar application.

9.6 A comprehensive write up or brochure on the details of manufacturing and testing facilities in the shop of the manufacturer.

9.7 Quality plan for the equipment being offered, in BHEL format as practiced in the manufacturer's works and Field Quality Plan for receipt, storage erection, commissioning & testing at site.

9.8 Data sheet-B with all the particulars filled in.

10.0 DRAWINGS AND DATA AFTER AWARD OF CONTRACT

The vendor shall furnish the drawings and other technical documents as required in Data Sheet-C enclosed with this specification

10.1 MANUFACTURERS NAME AND TAG. PLATES

Each pump shall have a permanently attached brass/metal tag on the body indicating the following information both in Hindi and English.

a) Manufacturer's name and trade mark
b) Design Capacity and Head
c) Design
d) Purchaser's tag no. as furnished during the contract. The purchaser's tag no. will be indicated by the Purchaser on the drawing submitted for approval by the vendor.

11.0 DRAWINGS/DOCUMENTS TO BE FURNISHED BY VENDOR AFTER THE AWARD OF CONTRACT.

11.1 Certified GA drawings of pump motor assembly weights, crane

11.2 Detailed cross sectional drawings of the pump and motor assembly and all equipment & accessories supplied under the this specification along with details of material of construction with applicable standard codes

11.3 Foundation drawings with details of foundation pocket indicating static as well as dynamic load and other data with dimensions.

11.4 Certified characteristics curves (discharge capacity vs. head, BHP and efficiency) of each type of pump and motor.

11.5 Material and other test certificates as required by the application clauses of this specification.

11.6 Motor speed torque curves super imposed on pump speed torque curves.

11.7 Quality plan along with complete details of testing and inspection requirements of centrifugal pumps in BHEL format. Vendor shall also furnish Field Quality Plan.

11.8 Installation , operation and maintenance manual.

11.9 Other drawings and data, if necessary.

S.No.	DESCRIPTION	DETAILS
1)	Designation	Air washer Pumps.
2)	Type	Horizontal Centrifugal Type.
3)	Quantity	As per section-C
4)	Installation	On floating type foundation inside Air Washer Room
5)	Fluid to be handled	Filtered Water.
6)	Temperature of Fluid	To suit.
7)	Capacity Cum/Hr TDH at	To suit system requirements however head shall Not be less than 35 MWC.
8)	Duty	————Continuous (24Hr./day)————-
9)	Suction condition	————Flooded————-
10)	Type of drive	Direct (flexible coupling)
11)	Type of prime mover	LV Ac Motor.
12)	Maximum speed	Not more than 1500 RPM
13)	Type of lubrication	Grease Lubrication

MATERIALS OF CONSTRUCTION

S.No.	DESCRIPTION	DETAILS
a)	Impeller	Bronze as per IS 318 Grade 2
b)	Pump Shaft	Carbon Steel C-45, IS-1570 or class-IV, IS-1875 / SS 316
c)	Casing	Cast Iron, grade-20, IS- 210
d)	Wearing ring	Bronze
e)	Shaft Sleeve	Bronze
f)	Base Plate/frame	Carbon syeel as per IS 2062 Gr. B / Cast Iron to Grade FG-200 IS-210/ fabricated Mild steel
g)	Counter Flanges	Mild Steel
h)	Stuffing box bush	Deep Bronze packing to be renewable with Case.
i)	Stuffing box gland	Flexible graphite or PTFE (Asbestos shall not be used)
j)	Pump Motor Coupling	Pin & Bush type (Flexible)

Anshul S A Khan Praveen Kishore

k)	Bolt and Nuts	MS (Epoxy painted / Galvanozed)

15) **ACCESSORIES REQUIRED**

The following accessories shall be provided by the bidder for each pump.

a)	Priming funnel	Yes
b)	Drain piping upto Common drain point.	Yes
c)	Vent	Yes
d)	Suction & Discharge Pressure gauges	Yes
e)	Companion flanges	Yes
f)	Common base plate	Yes
g)	Suction strainer.	Yes
h)	Isolating valve.	Yes
i)	NRV at pump outlet at inlet/outlet	Yes
j)	Any special requirements	Yes
k)	Inspection & Testing	Yes

Anshul S A Khan Praveen Kishore

SECTION-D

THERMAL INSULATION FOR COLD SURFACES

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1. SCOPE

This specification covers design, manufacture, testing at manufacturers works, supply, application & finishing of insulation for cold piping, air conditioning ducting & equipment for low temperature service.

2. CODES & STANDARDS

The design, manufacture and performance of materials covered under this specification shall comply with all currently applicable statues, regulations & safety codes in the locality where the equipment/material are to be installed. The material shall also conform to the latest applicable Indian/British/American codes & standards. Nothing in this specification shall be construed to relieve the vendor of his responsibility. In particular, the material shall conform to the latest editions of the following standards :-

2.1.1 IS:3069 : Glossary of terms & symbols & units relating to thermal insulation materials.

2.1.2 IS:4671 : Expanded polystyrene for thermal insulation purposes.

2.1.3 IS:3677 : Mineral wool for thermal insulation

2.1.4 IS:8183 : Resin bonded mineral wool

2.1.5 IS:702

3. DESIGN REQUIREMENTS

3.1.1 The insulating material as well as protective covering shall be new & unused, non-corrosive, vermin/rodent proof and shall be guaranteed to withstand continuously & without deterioration the maximum/minimum temperatures to which they may be subjected to, under specified site conditions.

3.1.2 The insulation material must be light weight, strong, free from shots & coarse fibre & shall provide high insulation efficiency at low weight & coat. It should be non-hygroscopic & should not rot. It shall not settle or shake down even when subjected to prolonged vibrations.

3.1.3 The insulation material, density and thickness etc. Shall be as specified in DATA SHEET A.

4. APPLICATION DETAILS

4.1.1 The surface to be insulated shall be thoroughly cleaned and allowed to dry. Pressure/hydrostatic tests, if any, shall be carried out before application of insulation.

4.1.2 A layer of solvent free, anticorrosive paint shall be applied & allowed to dry.

4.1.3 Hot industrial bitumen of grade 85/40 or 85/25 conforming to latest IS:702 shall be uniformly applied @ 1.5 kg/sq.m on the surface to be insulated. A similar layer shall also be applied on the inside surface & edges of the insulation. A suitable cold adhesive compound may also be used in place of bitumen.

4.1.4 Insulation in the form of pipe sections/rolls slabs of specified density & thickness shall be stuck to the coated surface with joints staggered & well butted & secured. The adjoining sections shall be tightly pressed together. All the joints shall be sealed with bitumen/equivalent adhesive. Voids if any shall be packed with suitably cut pieces of insulation material.

4.1.5 In case of double layer application both circumferential & longitudinal joints shall be suitably staggered.

5. VAPOR SEALING & INSULATION FINISH

The insulation shall be treated for vapor sealing & weather proofing & finished as specified in DATA SHEET A The acceptable types of finishes are outlined below:-

5.1 FINISHING SYSTEM I: EXTERNAL INSULATION WITH PLASTER FINISH

5.1.1 A thick vapor seal of hot bitumen @ 2.5 kg/Sqm shall be applied on the outer surface of insulation & allowed to dry.

5.1.2 The surface shall then be wrapped with 20mm (3/4"_ hexagonal mesh of 24 SWG GI wire, butting all the joints & laced down with 22 SWG GI lacing wire.

5.1.3 12.5mm (1/2 inch) thick sand cement plaster in the ratio of (1:1) shall be applied in two layers, the second layer being brought to a smooth finish. A water proofing compound shall be added to the cement before its application.

5.2 FINISH SYSTEM II: EXTERNAL INSULATION WITH PLASTER FINISH OVER POLYTHENE.

5.2.1 The insulation shall be covered with 500 g polythene/polythene bonded Hessians (PBH) with 50mm overlap on longitudinal & circumferential joints. Overlaps shall be sealed with synthetic adhesive in case o-f polythene & liberal coat of bitumen in case of PBH:

5.2.2 The surface shall then be wrapped with 20mm (3/4") mesh of 24 SWG GI wire butting all the joints & laced down with 22 SWG GI lacing wire.

5.2.3 12.5mm thick (1/2 inch) sand cement plaster in ratio of(4:1) shall be applied in two layers, the second layer being brought to a smooth & even finish similarly as described above.

5.3 FINISH III:EXTERNAL INSULATION WITH SHEET METAL FINISH

5.3.1 The insulation shall be covered with 500g polythene with 50mm overlaps at joints which shall be sealed with synthetic adhesive or equivalent compound.

5.3.2 The polythene shall be covered with 24 gauge GI/aluminum sheet

5.3.3 25mm wide x 22 SWG GI/aluminum peripheral straps shall be fixed over the GI/aluminum sheet at 300mm centres to secure.

5.4 FINISH IV: EXTERNAL INSULATION WITH PLASTER & WATER PROOFING COMPOUND

For ducts & piping exposed to atmosphere, the finish shall be as follows:

5.4.1 A thick vapor seal of hot bitumen at 2.05 kg/sq.m shall be applied on the outer surface of insulation & allowed to dry.

5.4.2 The surface shall then be wrapped with 20mm (32/4") hexagonal mesh of 24 SWG GI Wire butting all the joints & laced down with 223 SWG GI lacing wire.

5.4.3 12.5mm thick (1/*2 inch) sand cement plaster in ratio of (4:1) shall be applied in two layers, the second layer being brought to a smooth finish with water proofing compound added to the cement.

5.4.4 3mm (1/8") thick coat of water proofing compound shall be applied & wrapped with fibre glass RP tissue. A final coat of 3mm thick water proofing compound shall then be applied over the fiberglass RP tissue & allowed to dry. Alternatively, in place of water proofing as desired above, tar felt type 3 grade 1 of IS 1322 with joints overlapped by 75mm shall be fixed & sealed with bitumen & over this 24 SWG. 25mm hexagonal GI mesh shall be fixed with 22 swig. GI lacing wire & finally bitumen paint shall be applied over wire netting.

6. INSULATION OF PUMPS & VALVES

For all inspection covers & hatches on equipment, pump casing & valve bodies, flanges etc. the insulation shall be applied such as to facilitate removal with minimum damage to the insulation. This shall be achieved by encasing the insulation in 22 gauge aluminum sheet metal boxes, which shall be bolted together around the equipment to permit easy removal & replacement. Proper care shall be taken to maintain continuity of vapor seal between the static & removable partitions of the insulation.

The tenderer may offer thickness of insulation & finishes other than that specified in DATA SHEET A. However, calculations/reasons in support of alternative proposal shall be furnished for purchaser's approval.

7. INSPECTION & TESTING (REFER SPEC. NO - PES-553.00)

All necessary tests, as required to ensure that the material supplied conform to the requirements of applicable codes & standards, shall be carried out at manufacturer's works & test certificates including these for material/accessories shall be furnished for purchasers approval.

8. PAINTING

8.1.1 Pipe work having insulation & cladding shall be provided with color identification for the fluids handled and for indicating direction of flow.

8.1.2 Equipment surfaces having insulation and cladding shall also have identification numbers and any other relevant data provided on the insulated surface.

8.1.3 All painting for insulated surfaces shall conform to the requirement specified elsewhere.

9. DATA TO BE FURNISHED AFTER AWARD OF CONTRACT

9.1.1 Final version of data sheet 'B' incorporating changes if any along with design data.

9.1.2 Test certificates/reports giving result of insulation to ensure conformance to applicable codes & standards & in particular the following :-

i) Thermal conductivity test

ii) Sound absorption coefficient test

iii) Corrosion test

iv) Sulphur content, moisture content, shot content, moisture absorption etc.

v) Compressive strength & cross breaking strength test.

9.1.3 Sketches/technical literature/sectional drgs. indicating insulation materials finish and method of application etc.

9.1.4 Manual dealing with safety aspects & instructions for combating fire arising out of insulation work

9.1.5 Instructions on maintenance of insulation work.

TITLE

INSULATION

DATA SHEET - A

VOLUME II-B

SECTION D

REV 00

SHEET 1 OF 1

INSULATION MATERIAL:

Insulation	Code	Thermal Conductivity MW/cm ^{0}C	Density Kg/m^3
Resin bonded mineral wool / glass wool	IS:8183	0.49 at 50 ^{0}C	At least 24 (For Thermal Insulation) 48 for Acoustic insulation
Mineral Wool Pipe Section (min. Gr.2)	IS:9842	0.43 at 50 ^{0}C	At least 81
Expanded Polystyrene	IS:4671	0.37 at 50^{0}C	At least 15

TYPE OF INSULATION:

S.No.	Surface	Insulation Material	Insulation Form	Thickness (mm)	Finish
i)	Supply ventilation Duct exposed to Sun	Resin bonded Mineral wool (IS:8183) Or	Roll / Slab	25	F-4
		Nitrile Rubber .	Roll / Slab	13	With UV Protection coating
		Self-extinguishing grade of Expanded Polystyrene (IS – 4671)	Roll / Slab	25	F-4

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ANNEXURE-I

LIST OF MAKES OF SUB-VENDOR ITEMS

S.No.	Description	Makes
1.	AIR WASHER & UAF*	HYDERABAD POLUTION CONTROL / SK SYSTEM / ADVANCE VENTILATION / DRAFT AIR / BLUE STAR / VOLTAS / STERLING WILSON & ROOTS COOLING SYSTEM / C.DOCTOR
2.	CENTRIFUGAL FAN	FLAKT / KRUGGER / DRAFT AIR / HYDERABAD POLUTION CONTROL / ADVANCE VENTILATION / PATEL AIR / NICOTRA/ SK SYSTEM / MARATHON / CB DOCTOR / SARLA
3.	AXIAL FLOW FANS/RE UNITS	HYDERABAD POLLUTION/ SK SYSTEM / ADVANCE VENTILATION / KRUGER / NICOTRA / MARATHON / FLAKT / CB DOCTOR/ PATEL AIR /SITAL
4.	CENTRIFUGAL WATER PUMP	BEST & CROMPTON / JYOTI / SAM TURBO / KBL / KSB / M&P / VOLTAS / BEACON-WEIR / WORTHINGTON / FLOWMORE / SULZER / BHARAT PUMPS & COMPRESSORS LTD / FLOWSERVE INDIA CONTROL PVT LTD / V-FLOW PUMPS & SYSTEMS CO
5.	INDUCTION MOTORS (LT)	SIEMENS / ABB / CGL / MARATHON / KEC / BHARAT BIJLEE / NGEF /JYOTI / LHP
6.	AIR FILTER	PUROLATOR / FMI / ANFILCO / TENACITY / JOHN FOWLER /SPECTRUM / AIR TECH / PUROMATIC
7.	INSULTATION MATERIAL	BEARDSHELL / K-FLEX / PARAMONT/ ARMAFLEX / SUPREME / LLOYDS / UP TWIGA
8.	FIRE DAMPER	TSC / CARRYAIRE / RAVISTAR (SYSTEM AIR)
9.	BUTTERFLY VALVE	AUDCO / FOURESS / INTER VALVE / BDK / WEIR BDK / TYCO / CRANE PROCESS / KEYSTONE
10.	NON RETURN VALVE	LEADER / H.SARKAR / FLUID LINE / HI -TECH / CRESENT / A V VALVES / BANKIM & COMPANY / SHIVADURGA
11.	GATE/GLOBE VALVES	CRESENT / BDK / AUDCO / FOURESS / KIRLOSKAR / SANT / BOMBAY METAL & ALLOYS / BANKIM / LEADER / H SARKAR / AV VALVES / VENUS PUMPS AND ENGG
12.	PIPING - ERW	SURYA ROSHNI / TISCO / DADU PIPES / INDUS TUBE / WELSPUN / TATA / BST / JINDAL / SAIL
13.	GI SHEETS FOR DUCTING	TISCO / INDIAN IRON & STEEL CO LTD. / RASHITRYA ISPAT NIGAM LTD. / ESSAR/ ISPAT INDUSTRIES / JSW STEEL / LLOYDS STEEL / BHUSHAN / TATA / SAIL / JINDAL
14.	HUMID STAT	JHONSON CONTROL / HONEYWELL / PENN
15.	PRESSURE GAUGE	GENERAL INST CONSORTIUM / BELL / H.GURU INST / WAAREE INSTRUMENTS / H. GURU IND / FORBES MARSHALL / MANOMETER / A.N. INST / GAUGES BOURDON / GLUCK / WIKA / ASHCROFT / BAUMER TECHNOLOGIES
16.	TEMPERATURE GAUGE	H. GURU IND/ H.GURU INST/ FORBES MARSHALL/DETRIVE INST & ELECTRONICS / PYRO ELECTRIC /TOSHNIWAL BROSS / WAREE INSTRUMENTS / A.N.INST / GOA INSTRUMENTS / WIKA/ ASHCROFT / H GURU (SI)
17.	LEVEL GAUGE	GENERAL INSTRUMENTS / CHEMTROLS / SBEM, PUNE/ AUTOMAT MUMBAI /SIGMA / TOSHNIWAL / TECHNOMATIC / TELACO /LEVCON / D K INSTRUMENTS / PUNE TECHTROL / FLOW STAR

18.	**PRESSURE SWITCH / DP SWITCHES**	BELLS / DANFOSS / DK INSTRUMENTS/ DRESSER / SOR INC / VASU / SWITZER / INDFOSS / TRAFAG / GIC / ASHCROFT
19.	**LEVEL SWITCH**	SBEM / BLISS ANAND / HI TECH / RAMAN INST / SIGMA / SOR INC / WAREE INST / LEVCON / DK INSTURMENT / V ATUOMATE /CHEMTROLS / SIMENS / FLOW STAR / TRAC
20.	**Y / POT STRAINER**	MULTITEX / GREAVES COTTON / JAYPEE / SANT / OTOKLIN / GRAND PRIX / GUJARAT OTOLIFT / DS ENGG / SAROJINI ENTERPRISE / BHATIA ENGINEERING / FILTERATION ENGINEERS INDIA PVT LTD / SUNGOV ENGINEERING
21.	**CONTROL PANEL**	INDUSTRIAL CONTROL & APPLIANCE/ PYROTECH /POSITRONICS / CONTROL & SWITCHGEAR /SIEMENS / L&T /GE POWER /RITTAL / HOFFMAN
NOTE		
	* Designed by C. Doctor / Blue Star / Voltas / Hyderabad Pollution Controls / SK System /Advance Ventilation / Draft Air / Sterling & Wilson / Roots cooling and fabricated by their approved fabricators.	
	Above sub-vendor are also subjected to Customer approval during detailed engineering.	

ANNEXURE-II

MANDATORY SPARE LIST

SL No	DESCRIPTION OF EQUIPMENT/ ITEM	QTY
A	**MECHANICAL AND GENERAL**	
1	**CENTRIFUGAL FANS**	
1.1	V-BELTS	2 SETS OF EACH TYPE
1.2	BLOWER BEARING SETS	2 SETS OF EACH TYPE
1.3	BLOWER MOTOR BEARINGS	2 SETS OF EACH TYPE
1.4	SEAL GASKET AND OTHER WEAR OUT PARTS IN SETS	2 SETS OF EACH TYPE
1.5	VIBRATION ISOLATORS	2 SETS OF EACH TYPE
2.	**AXIAL FANS**	
2.1	FAN BEARINGS	2 SETS OF EACH TYPE
2.2	FAN MOTOR BEARING	2 SETS OF EACH TYPE
2.3	DRY FILTERS	2 SETS OF EACH TYPE AND SIZE
3	**AIR WASHER SYSTEM**	
3.1	WATER STRAINERS	2 SETS OF EACH SIZE
2.2	SPRAY NOZZLES	2 SETS OF EACH SIZE
2.3	WATER REPELLANT TYPE FILTERS	2 SETS OF EACH SIZE
4	**HORIZONTAL CENTRIFUGAL PUMP**	
4.1	IMPELLER FOR EACH OF PUMP SET	2 SETS OF EACH TYPE
4.2	BEARINGS	2 SETS OF EACH TYPE
4.3	SHAFT SLEEVES	2 SETS OF EACH TYPE
4.4	BEARINGS MOTOR	2 SETS OF EACH TYPE

SL No	DESCRIPTION OF EQUIPMENT/ ITEM	QTY
B	**ELECTRICAL**	
1	Terminal plates	
a	For motors up to 30 KW	10 NOS. EACH FOR SMALL MOTORS UPTO 30 KW
b	For motors above 30 KW	4 NOS. EACH FOR MORE THAN 30 KW
2	Heaters	2 SETS
3	Greasing arrangements	4 SETS OF EACH TYPE OF MOTOR.
4	Motor of each type and rating	10% OF THE INSTALLED QUANTITY OR MINIMUM 1 NUMBER WHICHEVER BE HIGHER
5	Bearings (DE and NDE) for each type and rating of motor	4 SETS

SL No	DESCRIPTION OF EQUIPMENT/ ITEM	QTY
C	**CONTROL AND INSTRUMENTATION**	
	Each type of lamps, PBs, ILPBs, fuse, MCB, MCCB used in the equipment/system.	20% OF QTY INSTALLED.
a)	**Measuring Instruments**	
1	Indicators, Recorders, Electrical Metering and Skid Mounted Instruments	20% OF INSTALLED OF EACH TYPE.
1.1	Indicators, recorders and meters offered from each model for the project. These instruments shall be supplied with three sets of blank scales.	10% OF INSTALLED OF EACH TYPE/MODEL OR A MINIMUM OF ONE NUMBER FOR EACH MODEL AND TYPE, WHICHEVER IS MORE
1.2	For skid mounted instruments	10% OF INSTALLED OF EACH TYPE/MODEL OR A MINIMUM OF ONE NUMBER FOR EACH MODEL AND TYPE, WHICHEVER IS MORE
2	Temperature Elements and Thermowells	
2.1	Thermocouple/RTD elements	10% OF INSTALLED OF EACH TYPE/MODEL OR A MINIMUM OF ONE NUMBER FOR EACH MODEL AND TYPE, WHICHEVER IS MORE
2.2	Thermowells	10% OF INSTALLED OF EACH TYPE/MODEL OR A MINIMUM OF ONE NUMBER FOR EACH MODEL AND TYPE, WHICHEVER IS MORE
3	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.	10% OF INSTALLED OF EACH TYPE/MODEL OR A MINIMUM OF ONE NUMBER FOR EACH MODEL AND TYPE, WHICHEVER IS MORE
b)	**Relay based Control Panels**	
1	LEDs for indicating lights	10% OF QTY INSTALLED.
2	Control circuit fuses/MCB/MCCB/ Semiconductor Fuses	300% OF INSTALLED OF EACH TYPE, CURRENT RATING.

SL No	DESCRIPTION OF EQUIPMENT/ ITEM	QTY
3	Relays modules & contactors.	20% SPARE OF QTY INSTALLED OF EACH TYPE & RATING
c)	**Alarm Annunciation System**	
1	Logic modules, group card modules, power supply modules, Hooters and any other electronic module.	20% SPARES OF EACH TYPE INSTALLED
2	un-engraved window boxes complete with LED etc.	5% SPARES OF EACH TYPE INSTALLED
3	LEDs for annunciation facia windows and LEDs box assemblies offered for the project	20% OF QTY INSTALLED
4	Annunciator hooter	ONE (1) NO. OF EACH TYPE
d)	**Erection hardware**	
1	Instrument valves	10% OF EACH TYPE & SIZE INSTALLED
2	Condensate pots of each type & Size installed	10% OF TOTAL NUMBER OF INSTALLED OR FOUR NUMBERS WHICHEVER IS HIGHER.
3	Manifold	10% OF EACH TYPE & SIZE INSTALLED
4	Fittings	10% OF EACH TYPE & SIZE INSTALLED
e)	**Mandatory Spares for Control valves, Power Cylinder, Control Dampers, Actuators and Accessories**	
1	Following spares shall be furnished for control valves, Power Cylinder, Control Dampers as applicable.	
2	One set of spare control valve stem packing for each control valve.	
3	Two moulded rubber diaphragms for each control valve.	
4	One sets of each of O-rings and rubber gaskets for each control valve.	
5	100 percent qty. of lubricants for gaskets for each control valve on one year consumption basis.	

SL No	DESCRIPTION OF EQUIPMENT/ ITEM	QTY
6	2 sets of limit switches and 1 set of valve positioner for each control valve.	
7	20 percent of position transmitter (4-20mA) for total qty. of control valve.	
8	One (1) set of valve trims (such as plug, stem, seat ring /cage, guide bushing, stem lock pin, packing retaining ring, etc.) for each control valve.	
9	One completes actuator of each type or min 10% for each type and size whichever is more.	
10	20 percent of Solenoid valves or min 2 no. of each type for total qty. of control valves.	
11	20% of I to P converters, Pressure regulators.	
f)	**Mandatory spares not covered above**	
	Bidder to supply 10% or 1 no. (whichever is more) of each type of sensor/instrument, instrumentation/mechanical fittings etc. for any other electronic system, feeder control cabinets, hydrastep (EWLI), Vibration Monitoring System, CCTV, C&I Lab Instruments, On line Carbon in Ash analyser system, On line Coal mass flow/speed measurement system, On line secondary air flow measurement system Mass Flow meter, Solid flow meter, 3 D Acoustic type level transmitters, Nucleonic & non nucleonic density transmitter etc.	

ANNEXURE-III

PAINTING & COLOUR SCHEME

(ALREADY COVERED UNDER SECTION C2-C PAINTING SPECIFICATION)

ANNEXURE-IV

LIST OF TOOLS & TACKLES

SL NO	ITEM DESCRIPTION	UNIT	QTY
1	MEASURING TAPE	SET	1
2	TECHOMETER	SET	1
3	DOUBLE ENDED SPANNER	SET	1
4	RING SPANNERS	SET	1
5	GASKET PUNCH	NO.	1
6	CENTRE PUNCH	NO.	1
7	HAMMER WITH WOODEN HANDLES	NO.	1
8	SCISSORS FOR SHEET METAL CUTTING	NO.	1
9	TORCH WITH 2 DRY CELLS	NO.	1
10	MULTIMETER	NO.	1
11	ANIMOMETER	NO.	1
12	COMPOUND PRESSURE GAUGE	NO.	1
13	SLIDE WRENCH 8”	NO.	1
14	SLIDE WRENCH 10”	NO.	1
15	SLIDE WRENCH 6”	NO.	1
16	BOX SPANNER SET	NO.	1
17	SCREW DRIVER SET	NO.	1
18	ALIGN KEY SET	NO	1
19	MS TOOL BOX	NO	1

ANNEXURE-V

CLARIFIED WATER ANALYSIS

CLARIFIED WATER ANALYSIS

1. **Total dissolved solids: 600 ppm (max).**
2. **PH : 6.0 to 7.5**

ANNEXURE-VI

DRAWINGS / DOCUMENTS SUBMISSION PROCEDURE

(COVERED UNDER SECTION C 2B)

ANNEXURE-VII

INSPECTION AND TESTING

1.01.00 Inspection and Tests during Manufacture.

1.01.01 The method and techniques to be used by the Bidder for the control of quality during manufacture of all plant and equipment shall be agreed with the Owner.

1.01.02 The Owner's general requirements with respect to quality control and the required shop tests are set out elsewhere in this specification.

1.01.03 Before any item of plant or equipment leaves its place of manufacture the Owner shall be given the option of witnessing inspections and tests for compliance with the specification and related standards.

1.01.04 Advance notice shall be given to the Owner as agreed in the Contract, prior to the stage of manufacture being reached, and the piece of plant must be held at this stage until the Owner has inspected the piece, or has advised in writing that inspection is waived. If having consulted the Owner and given reasonable notice in writing of the date on which the piece of plant will be available for inspection, the Owner does not attend the Bidder may proceed with manufacture having forwarded to the Owner duly certified copies of his own inspection and test results.

The owner's representative shall have at all reasonable times access to bidder's or his sub-vendor's premises and shall have power to inspect/ examine materials and workmanship or equipment under manufacture.

The Bidder shall forthwith forward to the engineer duly certified copies of the Test Certificates in six copies (one to the Purchaser and five to the Consulting Engineer) for approval. Further nine (9) copies of Shop Test Certificates shall be bound with Instruction Manuals referred to elsewhere.

For electrical equipment, routine tests as per relevant IS spec are to be carried out on all equipment. Type tests are also to be carried out on selected equipment as detailed in the specs of concerned electrical equipment.

1.01.05 Under no circumstances any repair or welding of castings be carried out without the consent of the Engineer. Proof of the effectiveness of each repair by radiographic and/or other non-destructive testing technique, shall be provided to the Engineer.

1.01.06 All the individual and assembled rotating parts shall be statically and dynamically balanced in the works.
Where accurate alignment is necessary for component parts of machinery normally assembled on site, the Bidder shall allow for trial assembly prior to despatch from place of manufacture.

1.01.07 All materials used for the manufacture of equipment covered under this specification shall be of tested quality. Relevant test certificates shall be made available to the Purchaser. The certificates shall include tests for mechanical properties and chemical analysis of representative material. Equipment or parts coming under any statutory

Regulations shall be certified by a Competent Authority under the regulations in the specified format.

1.01.08 All pressure parts connected to pumping main shall be subjected to hydraulic testing at a pressure of 150% of shut-off head for a period not less than one hour. Other parts shall be tested for one and half times the maximum operating pressure, for a period not less than one hour.

1.01.09 All necessary non-destructive examinations shall be performed to meet the applicable code requirements.

1.01.10 All welding procedures adopted for performing welding work shall be qualified in accordance with the requirements of Section-IX of ASME code or IBR as applicable. All welded joints for pressure parts shall be tested by liquid penetrant examination according to the method outlined in ASME Boiler and Pressure Vessel code. Radiography, magnetic particle examination magnuflux and ultrasonic testing shall be employed wherever necessary/ recommended by the applicable code. At least 10% of all major but welding joints shall be radiographed unless otherwise stipulated.

Statutory payments in respect of IBR approvals including inspection shall be made by the bidder. Bidder's scope shall include to preparation of all necessary documents, co-ordination and follow-up for above approval. Owner shall only forward assistance/endorsement of documents /design /drawings /reports/records to be submitted for approval as stipulated/ required by Statutory Authorities till registration of the unit and clearance for commercial operation.

1.02.00 Performance Tests at Site

1.02.01 The full requirements for testing the system shall be agreed between the Owner and the Bidder prior to Award of Contract. The completely erected System shall be tested by the Bidder on site under normal operating conditions. The Bidder shall also ensure the correct performance of the System under abnormal conditions, i.e. the correct working of the various emergency and safety devices, interlocks, etc.

1.02.02 The Bidder shall provide complete details of his normal procedures for testing, for the quality of erection and for the performance of the erected plant. These tests shall include site pressure test on all erected pipe work to demonstrate the quality of the piping and the adequacy of joints made at site.

1.02.03 The Bidder shall furnish the quality procedures to be adopted for assuring quality from the receipt of material at site, during storage, erection, pre-commissioning to tests on completion and commissioning of the complete system/equipment.

1.03.00 For details of specific tests required on individual equipment refer to respective section of this specification.

All Statutory testing / clearance is in Bidder's scope including payment of all fees, etc. as required

QAP FORMAT

BHARAT HEAVY ELECTRICALS LIMITED

CORPORATE QUALITY ASSURANCE

PROJECT: SYSTEM :

VENDOR : ITEM :

SL NO	COMPONENT /OPERATION OPERATIONS	CHARACTERISTICS CHECKED	CATEGORY	TYPE /METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11

Legend: 1. BHEL 2. Vendor 3. Sub-Vendor

QP No	CQS/SQP/31	Signature	Date				
	Rev		Name				
Page No	1 of 1		Party	Customer/Consultant		Bhel	Vendor

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ANNEXURE-VIII

MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION

S. NO.	DRAWING NO	DRG./ DOC. TITLE	SCH. WEEK (FROM DATE OF LOI)
1	PE-V0-412-554-A001	INSPECTION CATEGORISATION PLAN	4
2	PE-V0-412-554-A002	QUALITY PLAN OF AIR WASHER & UAF	12
3	PE-V0-412-554-A003	QUALITY PLAN OF CENTRIFUGAL PUMPS	12
4	PE-V0-412-554-A004	QUALITY PLAN OF CENTRIFUGAL FANS	13
5	PE-V0-412-554-A005	QUALITY PLAN OF AXIAL FLOW FANS & RE UNITS	14
6	PE-V0-412-554-A006	QUALITY PLAN OF MOTOR	15
7	PE-V0-412-554-A101	VENTILATION FAN SCHEDULE.	22
8	PE-V0-412-554-A201	DATA SHEET & GA FOR AIR WASHER ALONGWITH FAN AND PUMP WITH FOUNDATION DETAILS.	12
9	PE-V0-412-554-A202	DATA SHEET & GA FOR UAF ALONGWITH FAN AND PUMP FOUNDATION DETAILS.	10
10	PE-V0-412-554-A203	DATA SHEET & GA FOR ROOF EXTRACTOR, AXIAL EXHAUST AND SUPPLY AIR FANS WITH FIXING ARRANGEMENT.	12
11	PE-V0-412-554-A204	DATA SHEET & GA FOR VALVES AND STRAINER.	8
12	PE-V0-412-554-A205	DATA SHEET FOR INSULATION.	8
13	PE-V0-412-554-A206	DATA SHEET & GA FIRE DAMPER.	8
14	PE-V0-412-554-A207	DATA SHEET FOR INSTRUMENTS (PRESSURE GAUGE, TEMP GAUGE, LEVEL GAUGE, PRESSURE SWITCH, LEVEL SWITCH).	14
15	PE-V0-412-554-A208	DATA SHEET OF PIPE.	5
16	PE-V0-412-554-A209	DATA SHEET OF GI AND MS SHEET.	5
17	PE-V0-412-554-A210	DATA SHEET & GA FOR PRE AND FINE FILTERS.	8
18	PE-V0-412-554-A211	DATA SHEET FOR MOTORS (A/W Fan, A/W pumps, UAF Fan, UAF Pump, RE units, Supply and Exhaust axial fans)	15
19	PE-V0-412-554-A401	TYPICAL Details DUCT FABRICATION DRAWING / SUPPORT / ERECTION. INSULATION OF DUCTING / PIPING & EQUIPMENTS PIPE ERECTION	7
20	PE-V0-412-554-A402	GA OF PROPELLER FAN.	9
21	PE-V0-412-554-A601	SCHEME FOR AIR DISTRIBUTION IN TG BUILDING AND ESP BUILDING.	5
22	PE-V0-412-554-A602	PID FOR AIRWASHER AND UAF UNIT.	8
23	PE-V0-412-554-A603	AIR WASHER LAYOUT OUTSIDE "A ROW" SIDE ALONGWITH FOUNDATION DETAILS - TG BUILDING	14

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S. NO.	DRAWING NO	DRG./ DOC. TITLE	SCH. WEEK (FROM DATE OF LOI)
24	PE-V0-412-554-A604	AIR WASHER LAYOUT FOR "B-C BAY" SIDE ALONGWITH FOUNDATION DETAILS - TG BUILDING	14
25	PE-V0-412-554-A605	UAF LAYOUT ALONGWITH FOUNDATION DETAILS - ESP BUILDING.	11
26	PE-V0-412-554-A606	VENTILATION DUCT LAYOUT FOR TG BUILDING - 'A' ROW SIDE (UNIT I & II).	12
27	PE-V0-412-554-A607	VENTILATION DUCT LAYOUT FOR TG BUILDING - 'BC BAY' SIDE (UNIT I & II).	12
28	PE-V0-412-554-A608	VENTILATION DUCT LAYOUT FOR ESP BUILDINGS.(UNIT I & II).	12
29	PE-V0-412-554-A609	LOCATION OF ROOF EXTRACTOR UNIT IN TG BUILDING ALONGWITH FIXING DETAILS.	12
30	PE-V0-412-554-A610	VENT. ARRANGEMENT FOR BATTERY ROOM.	13
31	PE-V0-412-554-A611	VENT. ARRANGEMENT FOR VARIOUS AUXILIARY BUILDING.	18
32	PE-V0-412-554-A701	ELECTRICAL FEEDER LIST.	18
33	PE-V0-412-554-A702	VENTILATION CABLE SCHEDULE	18
34	PE-V0-412-554-A901	P.G. TEST PROCEDURE.	12
35	PE-V0-412-554-A902	O & M MANUAL.	25

Notes:

1. The above drawing list is tentative and shall be finalized with the successful bidder after placement of order. While some of the drawings indicated above may not be applicable, some additional drawings may also be required based on scope of work.
2. Drawings shall be prepared in auto-cad latest edition. Required no. of hard and soft copies (editable) of the drawings shall be furnished as per requirement specified elsewhere in the specification.
3. Only manual calculation with authentic supporting literature (e.g. extracts of hand book/ standard/codes) shall be acceptable. All design calculations and drawings shall be in SI system only.
4. All the drawings and documents including general arrangement drawing, data sheet, calculation etc. to be furnished to the customer during detailed engineering stage shall include / indicate the following details for clarity w.r.t. inspection, construction, erection and maintenance etc.:-
   a) All drawings and documents shall indicate the list of all reference drawings including general arrangement.
   b) All drawings shall include / show plan, elevation, side view, cross - section, skin section, blow - up view; all major self-manufactured and bought out items shall be labeled and included in BOQ / BOM in tabular form.
   c) Painting schedule shall also be made as a part of general arrangement drawing of each equipment / items indicating at least 3 trade names.
   d) All the drawings required to be furnished to customer during detailed engineering stage shall include technical parameters, details of paints and lubrication, hardness and BOQ / BOM in tabular form indicating all major components including bought out items and their quantity, material of construction indicating its applicable code / standard, weight, make etc.

e) Drawings/ documents to be submitted for purchasers review/ approval shall be under revision a, b, c… etc. while drawings /documents to be submitted thereafter for customer's approval after purchaser's approval shall be under r-0, 1, 2, 3 ….etc.
f) Drawings and documents not covered above but required to check safety of machines/ system, shall be submitted during detailed engineering stage without any commercial implication.
g) All drawings shall include "B.O.M" and indicate quantity, material of construction, make along with IS/BS no., technical parameters, dimensions, hardness, machining symbol and tolerance, requirement of radiography and hydraulic tests, painting details, elevation, side view, plan, skin section and blow-up view for clarity.
h) All drawings shall be prepared as per BHEL'S title block and shall bear BHEL'S drawing no.
i) Schedule of drawings submissions, comment incorporations & approval shall be as stipulated in the specifications. The successful bidder shall depute his design personnel to BHEL'S/ customer's/ consultant's office for across the table resolution of issues and to get documents approved in the stipulated time.
j) Bidder to follow the following the drawing submission schedule:
k) 1st submission of drawings from date of LOI as per the submission schedule.
l) Every revised submission incorporating comments – within 7 days.
m) Bidder to submit revised drawings complete in all respects incorporating all comments. Any incomplete drawing submitted shall be treated as non-submission with delays attributable to bidder's account. For any clarification/ discussion required to complete the drawings, the bidder shall himself depute his personal to BHEL for across the table discussions/ finalizations/ submissions of drawings.

ANNEXURE-IX

FORMAT FOR OPERATION AND 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				

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Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
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**				

Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
	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-X

SITE STORAGE AND PRESERVATION

SITE STORAGE AND PRESERVATION GUIDELINES

FOR

MECHNANICAL BOPs

(Doc No: PE-DC-SSG-A001 REV.00)

PROJECT ENGINEERING MANAGEMENT, POWER SECTOR

BHARAT HEAVY ELECTRICALS LIMITED-NOIDA

Anshul S A Khan Praveen Kishore

CONTENT

1 SCOPE OF THE DOCUMENT

2 PURPOSE OF STORAGE & PRESERVATION

3 MEASURES TO BE TAKEN FOR STORAGE AND PRESERVATION

a) GENERAL STORAGE REQUIREMENTS

b) GENERAL PRESERVATION REQUIREMENTS

c) GENERAL INSPECTION REQUIREMENTS

4 TYPE OF STORAGE FOR VARIOUS EQUIPMENT

5. CONCLUSION

6. STACKING ARRANGEMENT FOR PLATES AND STRUCTURAL STEEL

1. SCOPE OF THE DOCUMENT

This guideline is prepared in intent to provide proper site storage and preservation of the Mechanical, Electrical and C & I items / equipment supplied under various bought out packages/items. This storage procedure shall be followed at different power plant sites by concerned agency for storage and preservation from the date of equipment received at site until the same are erected and handed over to the customer.

2. PURPOSE OF STORAGE & PRESERVATION

Many of the items may be required to be kept in stores for long period. It shall therefore be essential that proper methods of storage and preservation be applied so that items do not deteriorate, loose some of their properties and become unusable due to atmospheric conditions and biological elements.

3. MEASURES TO BE TAKEN FOR STORAGE, HANDLING & PRESERVATION

a) GENERAL STORAGE REQUIREMENTS

1. To the extent feasible, materials should be stored near the point of erection. The storage areas should have adequate unloading and handling facilities with adequate passage space for movement of material handling equipment such as cranes, fork lift trucks, etc. The storage of materials shall be properly planned to minimise time loss during retrieval of items required for erection.
2. The outdoor storage areas as well as semi-closed stores shall be provided with adequate drainage facilities to prevent water logging. Adequacy of these facilities shall be checked prior to monsoon.
3. The storage sheds shall be built in conformity with fire safety requirements. The stores shall be provided with adequate lights and fire extinguishers. 'No smoking' signs shall be placed at strategic locations. Safety precautions shall be strictly enforced.
4. Adequate lighting facility shall be provided in storage areas and storage sheds and security personnel positioned to ensure enforcement of security measures to prevent theft and loss of materials.
5. Adequate number of competent stores personnel and security staff shall be deployed to efficiently store and maintain the equipment / material.
7. The equipment shall be stored in an orderly manner, preserving their identification slips, tags and instruction booklets, etc., required during erection. The storage of materials shall be equipment-wise. Loose parts shall be stored in sheds on racks,

preserving the identification marks and tags in good condition. The group codes shall be displayed on the racks

6. At no time shall any materials be stored directly on ground. All materials shall be stored minimum 200 mm above the ground preferably on wooden sleepers

b) GENERAL PRESERVATION REQUIREMENTS

1. All special measures to prevent corrosion shall be taken like keeping material in dry condition, avoiding the equipment coming in contact with corrosive fluid like water, acid etc.
2. Materials which carry protective coating shall not be wrapped in paper, cloth, etc., as these are liable to absorb and retain moisture. The material shall be inspected and in case of signs of wear or damages to protective coating, that portion shall be cleaned with approved solution and coated with an approved protective paint. Complete record of all such observations and protective measures taken shall be maintained.
3. Generally equipment supplied at site are properly greased or rust protective oil is applied on machined/ fabricated components. However periodic inspection shall be carried out to ensure that protection offered is intact.
4. While handling the equipment, no dragging on the ground is permitted. Avoid using wire rope for lifting coated components. Use polyester slings (if possible) otherwise protective material (e.g. clothes, wood block etc.) should be used while handling the components with rope / slings
5. For Equipment supplied with finished paint, touch paint shall be done in case any surface paint gets peeled off during handling. Otherwise such surfaces shall necessarily be wrapped with polythene to avoid any corrosion. Further for equipment wherein finish coat is to be applied at site, site to ensure that equipment is received with primer coat applied.
6. It shall be ensured by periodic inspection that plastic inserts are intact in tapped holes, wherever applicable.
7. Pipes shall be blown with air periodically and it shall be ensured that there is no obstruction.
8. Silica gel or approved equivalent moisture absorbing material in small cotton bags shall be placed and tied at various points on the equipment, wherever necessary.
9. Heavy rotating parts in assembled conditions shall be periodically rotated to prevent corrosion/jamming due to prolonged storage.

10. All the electrical equipment such as motors, generators, etc. shall be tested for insulation resistance at least once in three months and a record of such measured insulation values shall be maintained.

11. Following preservatives/preservation methods can be used depending upon type of equipment

    a. Rust preventive fluid (RPF)

    b. Rust protective paints

    c. Tarpaulin covers, in case of outdoor storage

    d. De-oxy aluminate for weld-ments

c) GENERAL INSPECTION REQUIREMENTS

1. Period inspection of materials with specific reference to –

    - Ingress of moisture and corrosion damages.
    - Damage to protective coating.
    - Open ends in pipes, vessels and equipment -
        - In case any open ends are noticed, same shall be capped.

2. Any damages to equipment / materials.

    - In case of any damages, these shall be promptly notified and in all cases, the repairs / rectification shall be carried out.
    - Any items found damaged or not suitable as per project requirements shall be removed from site. If required to store temporarily, they shall be clearly marked and stored separately to prevent any inadvertent use.

4. TYPE OF STORAGE FOR VARIOUS EQUIPMENT

The types of storage are broadly classified under the following heads:

i **Closed storage with dry and dust free atmosphere**. (C)

The closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated asbestos sheets / galvanised iron sheets for roofing. Brick walls / asbestos sheets can be used to cover all the sides. The floor of the shed can be finished with plain cement concrete suitably glazed. The shed shall be provided with proper ventilation and illumination.

ii **Semi-closed storage**. (S)

The semi closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated / asbestos sheets for roofing. The floor shall be brick paved. If required a small portion of sides can be covered to protect components from rainwater splashing onto the components.

iii Open storage (O)

The open yard shall be levelled, well consolidated to achieve raised ground with the provision of feeder roads for crane approach along with access roads running all sides. One part of the open yard shall be stone pitched, levelled and consolidated with raised ground suitable for storing / stacking heavier and critical components with due space to handle them by cranes etc . Adequate number of sleepers, concrete block etc. to be provided to make raised platforms to stack critical materials.

A separate yard to be identified as “scrap yard” slightly away from main open yard to store wooden/steel scraps, which are to be disposed off. This is required to avoid mix up with regular components as well as to avoid fire hazard.

Some of the components, which are having both machined & un-machined surfaces and are bulky, shall be stored in open storage area on a raised ground and suitably covered with water proof / fire retardant tarpaulin.

The equipment listed below shall be stored and inspected as per requirement mentioned in the table below.

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
Raw material /mechanical items like pipes, plates, structure sections etc.)				
1.	Steel pipes (lined/unlined)	S	Damage , paint, corrosion, rubber lining peeling	Provide end cap
2.	MS Plates	S	Damage, paint, corrosion	
3.	SS Plates	S	Damage	
4.	Non-metallic pipes	S	Damage, cracks	Provide end cap
5.	Stainless steel pipes	S	Damage ,	Provide end cap
6.	MS sections, beams	S	Damage, paint, corrosion	
7.	Cable trays	S	Damage, condition of preservations	
8.	Insulation sheets	S	Damage	
9.	Insulation	C	Damage, packing	
10.	Hangers Rods	S	Damage, paint, packing	
11.	Tubes	S	Damage, paint , packing	Provide end cap
12.	Hume pipes	O	Damage	
13.	Castings	O	Damage, paint, corrosion	
Fabricated mechanical items (pressure vessels, tanks etc.)				
14.	Pressure vessels (unlined)	O	Damage, paint, corrosion,	Covered nozzles
15.	Atmospheric storage tanks (unlined)	O	Damage, paint, corrosion	Covered nozzles

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Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
16.	Pressure vessels (lined)	S	Damage, paint, corrosion, rubber lining	
17.	Atmospheric storage tanks(lined)	S	Damage, paint, corrosion, rubber lining	
18.	Support structures	O	Damage , paint, corrosion	
19.	Flanges	C	Damage , paint, corrosion	
20.	Fabricated pipes	S	Damage , paint, corrosion	Provide end cap
21.	Vessels internals	C	Damage , paint, corrosion ,packing	
22.	Grills	S	Damage , paint, corrosion	
23.	Angles	S	Damage , paint, corrosion	
24.	Bridge mechanism/clarifier mechanism	O	Damage , paint, corrosion	
25.	Cranes, rails	S	Damage , paint, corrosion	
26.	Stair cases	O	Damage , paint, corrosion	
27.	Ladders/handrails	O	Damage , paint, corrosion	
28.	Fabricated ducts	S	Damage , paint, corrosion	
29.	Isolation Gates	O	Damage , paint, corrosion	
30.	Fabricated boxes/panels	S	Damage , paint, corrosion	
Mechanical components like valves, fittings, cables glands, spares etc.)				
31.	Valves	S	Damage , packing	

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Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
32.	Fittings	S	Damage , packing	Provide end cap
33.	Cable glands	C	Damage , packing	
34.	Tools & tackles	C	Damage , packing	
35.	Nut , bolts, washers,	C	Damage , packing	
36.	Gasket & Packings	C	Damage , packing	
37.	Copper tubes	C	Damage , packing, corrosion	Provide end cap
38.	SS tubing	C	Damage , packing	Provide end cap
Rotating assemblies (pumps, blowers, stirrers, fans, compressors etc.)				
39.	Pumps	S	Damage , packing, corrosion	Shaft rotation
40.	Blowers/Compressors	S	Damage , packing, corrosion	Shaft rotation
41.	Agitators/stirrers/radial launders	C	Damage , packing, corrosion	Shaft rotation
42.	Rollers for chlorine tonner mounting	C	Damage , packing, corrosion	
43.	Centrifuge	S	Damage , packing,	
44.	Gear box	C	Damage , packing, corrosion	
45.	Bearings	C	Damage , packing, corrosion	
46.	Fans	S	Damage , packing, corrosion	
47.	Dosing skids	S	Damage , packing, corrosion	
48.	Pump assemblies	S	Damage , packing, corrosion	
49.	Air washers(INTERNALS)	S	Damage , packing	
50.	Air conditioners (split)	C	Damage , packing	

Anshul S A Khan Praveen Kishore

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
51.	Elevators(CONTAINERIZED)	O	Damage , packing, corrosion	
52.	Chillers/VA machines	S	Damage , packing	
53.	Air handling Unit/Package unit	S	Damage , packing	
54.	Chlorinators & Evaporators	C	Damage , packing	
55.	Ejectors	C	Damage , packing	
56.	Electrolyser	C	Damage , packing	
Miscellaneous items like chain pulley blocks, hoists etc.				
57.	Chain pulley blocks	S	Damage, Packing	
58.	Electric hoists	S	Damage, Packing	
59.	Fire extinguishers	C	Damage, expiry date	
60.	Fork Lift Truck	S	Damage, Packing	
61.	Hydraulic Mobile Crane	O	Damage, Packing	
62.	Mobile Pick Up & Carry Crane	O	Damage, Packing	
63.	Motor boats	O	Damage, Packing	
64.	Safety showers	S	Damage, Packing	
65.	Diffusers/dampers	S	Damage, Packing	
Chemicals and consumables (acid, alkali, paints, oils, reagents and special chemicals)				
66.	Hydro Chloric Acid (HCl)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical
67.	Sulphuric acid (H_2SO_4)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical

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Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
68.	Sodium hydroxide (NaOH)	Store in canes/ storage tank in dyke area	Date of production/ leakage/ fumes/ breather	hazardous chemical ,breather to be checked for air ingress
69.	Sodium hypo chlorite	To be stored under shed	Date of production/ leakage/ fumes	hazardous chemical ,self-life normally 15-30 days after which strength of chemical decays
70.	Ammonia	S	Date of production/ leakage/ fumes	Store in closed storage tanks, hazardous chemical
71.	CW treatment chemicals	S	Date of production , Self-life	Store in closed canes
72.	RO/UF cleaning chemicals	S	Date of production , Self-life	Store in closed canes
73.	Lime	C	Damage to packing , seepage	Prevent moisture, rain
74.	Alum bricks	C	Damage to packing	Prevent moisture, rain
75.	Poly electrolyte	S		Store in closed storage tanks
76.	Laboratory chemicals(powder)	C	Damage, Packing self-life	
77.	Laboratory chemicals(liquid)	C	Damage, Packing self-life	
78.	Lubrication oils	C	Leakage	
79.	Paints	S	Leakage ,air tightness	
80.	Sand	O	Damage of packing	No hooks
81.	Salt (NaCl)	C	Damage of packing, water ingress	Prevent moisture, rain
82.	Anthracite	S	Damage of packing	
83.	Activated carbon	S	Damage of packing	

Sl. No.	**Description of the equipment**	**Type of Storage**	**Check for**	**Remarks**
84.	Thermal insulation	S	Damage of packing	
85.	Cement	C	Damage of packing	Prevent moisture, rain
86.	Gravels	O	Damage of packing	
87.	ION exchange resins	C	Damage , packing	Refer manufacturer guidelines
88.	RO membranes	C	Damage , packing	Refer manufacturer guidelines
89.	UF membranes	C	Damage , packing	Refer manufacturer guidelines
90.	Cleaning chemicals	C	Damage , packing	Refer manufacturer guidelines
91.	Chemicals for analysers/calibration	C	Damage , packing	Refer manufacturer guidelines
Electrical and C & I items (motors, cables etc.)				
92.	Motors	C	Damage , packing	
93.	Cable drums	O	Damage	
94.	Control Panel /control desk, UPS ,JB	S	Damage, Packing	
95.	Instruments(gauges/analysers)	C	Damage	
Special items		As per Manufacturer's item, like Hydrogen cylinders, Ozonator, Analyser, Chlorine dioxide generators etc.		

Anshul S A Khan Praveen Kishore

5. CONCLUSION

Concerned storage agency at site should make sure that loss in equipment performance and wear & tear are minimised through proper storage and preservation. The above are broad guidelines and cover major equipment / materials. However specific storage practices shall be followed as per manufacturer recommendation. All the necessary measures even in addition to the ones mentioned above, if found necessary, should be taken to achieve the objective.

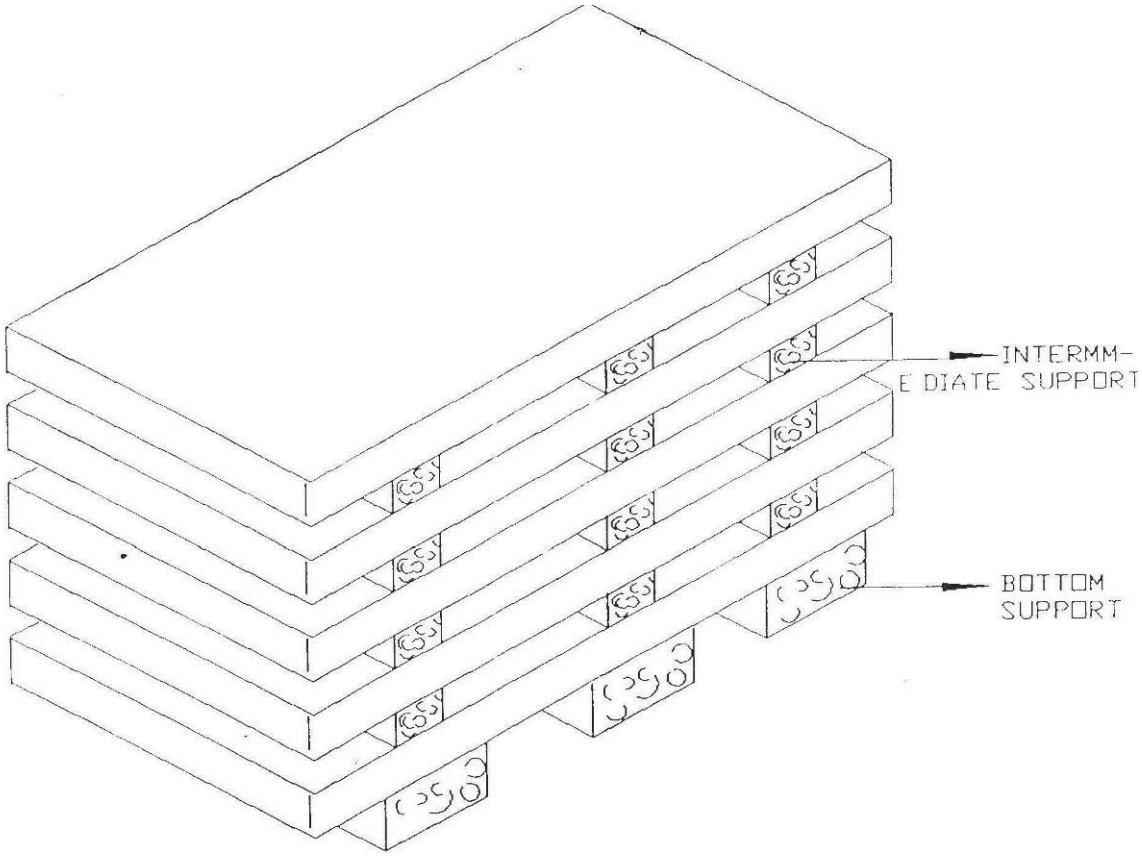

Figure – 1 – PLATE STACKING ARRANGEMENT

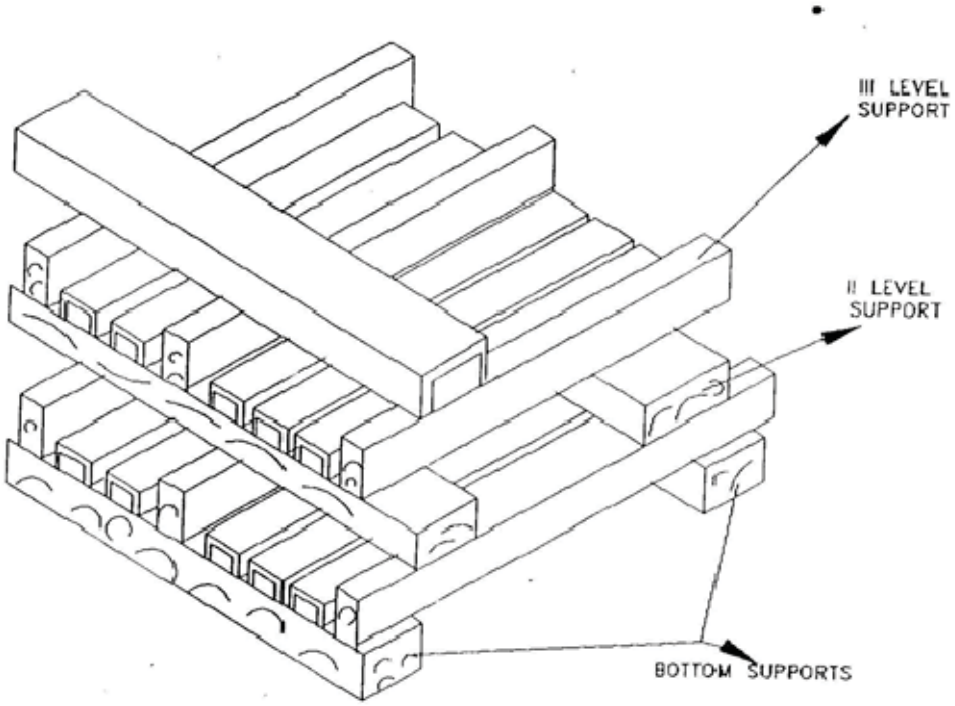

Figure – 2 – STRUCTURAL STEEL STACKING ARRANGEMENT

ANNEXURE-XI

PACKING PROCEDURE
(ALREADY COVERED UNDER SECTION C2-B)

VOLUME III

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

1. Compliance cum confirmation certificate
2. Guaranteed power consumption
3. Un priced format for main package
4. Un priced format for mandatory spare
5. Complete set of technical specification
6. No deviation certificate
7. Pre bid clarification schedule

COMPLIANCE CUM CONFIRMATION CERTIFICATE

The bidder shall confirm compliance with following by signing / stamping this compliance certificate (every sheet) and furnish same with the offer.

a) The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions, other than those mentioned under "exclusion and those resolved as per 'Schedule of Deviations', with regard to same.

b) There are no other deviations w.r.t. specifications other than those furnished in the 'Schedule of Deviations'. Any other deviation, stated or implied, taken elsewhere in the offer stands withdrawn unless specifically brought out in the 'Schedule of Deviations'

c) Bidder shall submit QP in the event of order based on the guidelines given in the specification & QP enclosed therein. QP will be subject to BHEL / CUSTOMER approval & customer hold points for inspection / testing shall be marked in the QP at the contract stage. Inspection / testing shall be witnessed as per same apart from review of various test certificates/ Inspection records etc. This is within the contracted price without any extra implications to BHEL after award of the contract.

d) All drawings/ data-sheets / calculations etc. submitted along with the offer shall not be taken cognizance off.

e) The offered materials shall be either equivalent or superior to those specified in the specification & shall meet the specified / intended duty requirements. In case the material specified in the specifications is not compatible for intended duty requirements then same shall be resolved by the bidder with BHEL during the pre-bid discussions, otherwise BHEL / Customer's decision shall be binding on the bidder whenever the deficiency is pointed out.

For components where materials are not specified, same shall be suitable for intended duty, all materials shall be subject to approval in the event of order.

f) The commissioning spares shall be supplied on 'As Required Basis' & prices for same included in the base price itself.

g) All sub vendors shall be subject to BHEL / CUSTOMER approval in the event of order.

h) Guarantee for plant/equipment shall be as per relevant clause of GCC / SCC / Other Commercial Terms & Conditions

i) In the event of order, all the material required for completing the job at site shall be supplied by the bidder within the ordered price even if the same are additional to approved billing break up, approved drawing or approved Bill of quantities within the scope of work as tender specification. This clause will apply in case during site

commissioning, additional requirements emerges due to customer and / or consultant's comments. No extra claims shall be put on this account

j) Schedule of drawings submissions, comment incorporations & approval shall be as stipulated in the specifications. The successful bidder shall depute his design personnel to BHEL's / Customer's / Consultant's office for across the table resolution of issues and to get documents approved in the stipulated time.

k) As built drawings shall be submitted as and when required during the project execution.

l) The bidder has not tempered with this compliance cum confirmation certificate and if at any stage any tempering in the signed copy of this document is noticed then same shall be treated as breach of contract and suitable actions shall be taken against the bidder.

m) Successful bidder shall furnish detailed erection manual for each of the equipment supplied under this contract at least 3 months before the scheduled erection of the concerned equipment / component or along with supply of concerned equipment / component whichever is earlier.

n) Document approval by customer under Approval category or information category shall not absolve the vendor of their contractual obligations of completing the work as per specification requirement. Any deviation from specified requirement shall be reported by the vendor in writing and require written approval. Unless any change in specified requirement has been brought out by the vendor during detail engineering in writing while submitting the document to customer for approval, approved document (with implicit deviation) will not be cited as a reason for not following the specification requirement.

o) In case vendor submits revised drawing after approval of the corresponding drawing, any delay in approval of revised drawing shall be to vendor's account and shall not be used as a reason for extension in contract completion.

PRE-BID CLARIFICATION SCHEDULE

S. NO.	SECTION/CLAUSE/PAGE NO.	STATEMENT OF THE REFERRED CLAUSE	CLARIFICATION REQUIRED

The bidder hereby clarifies that above mentioned are the only clarifications required on the technical specification for the subject package.

Signature: _____

Name: _____

Designation: _____

Company: _____

Date: _____

Company Seal

Anshul S A Khan Praveen Kishore

NO DEVIATION CERTIFICATE

SL NO	VOULME / SECTION	PAGE NO.	CLAUSE NO.	TECHNICAL SPECIFICATION/ TENDER DOCUMENT	COMPLETE DESCRIPTION OF DEVIATION	COST OF DEVIATION	PORTION OF PRICE SCHEDULE ON WHICH COST OF DEVIATION IS APPLICABLE	NATURE OF COST OF DEVIATION (POSITIVE/ NEGATIVE)	WHETHER COST OF DEVIATION INCLUDED/ EXCLUDED IN PRICE BID	REMARKS
TECHNICAL DEVIATIONS										

PARTICULARS OF BIDDERS/ AUTHORISED REPRESENTATIVE			
NAME	**DESIGNATIONS**	**SIGN & DATE**	**COMPANY SEAL**

NOTES:

1. Cost of deviation will be applicable on the basic price (i.e. excluding taxes, duties & freight) only.
2. All the bidders have to list out all of their Technical Deviations in detail in the above format on cost basis (if any).
3. Any deviation not mentioned above and shown separately will not be taken cognizance of and the offer shall be liable for rejection.
4. Bidder shall indicate "quoted" in cost of deviation column of the schedule above along with their Technical offer.
5. Bidder shall furnish priced schedule of technical deviation along with price bid in sealed envelope.
6. The final decision of acceptance/ rejection of the deviations quoted by the bidder along with its cost shall be at discretion of the Purchaser.
7. Bidders to note that any deviation not listed above and asked after Part I Bid opening shall not be considered.
8. Bidders to note that no Price Impact will be acceptable after Part I Bid opening subject to if there is any change in Technical Specification/NIT terms from BHEL side.
9. Deviation listed above without any cost of deviation, if found acceptable to BHEL, will be considered without any price implication.

Anshul S A Khan Praveen Kishore

	2x660MW ENNORE STPP VENTILATION SYSTEM GAURANTEED POWER CONSUMPTION	SPECIFICATION No: PE-TS-412-554-A001 VOLUME: III SECTION: 5 REV. NO. 00 | DATE: April 2015 SHEET: 1 OF 1

S.NO.	DESCRIPTION OF EQUIPMENT	NO OF EQUIPMENT		TOTAL GUARANTEED POWER CONSUMPTION FOR EACH EQUIPMENT AT MOTOR INPUT TERMINAL AND CONTROL PANEL (IN KW)	DUTY FACTOR	TOTAL KW
		WORKING	STAND BY			
		3A	3B	4	5	6=3Ax4x5
1	**VENTILATION SYSTEM FOR TG BUILDING**					
1.1	Centrifugal Fan of cap. 83, 500 CMH at 75 mmwc static pr for air washers.	24	0		**1**	
1.2	Pumps for circulation of water in spray chamber of above air washer	8	8		**1**	
1.3	RE Units 50,000 cmh at 15mmwc	28	0		**1**	
1.4	Centrifugal Fan of cap. 1, 00,000 CMH at 75 mmwc static pr for UAF.	2	0		**1**	
1.5	Pump for above UAF.	2	2		**1**	
				TOTAL (KW)		**1050**
NOTES:						
1	Estimated power consumption (EPC) figure for the system (for working drives only) has been considered as 1050 KW. So long bidder's quoted guaranteed power consumption (GPC) above remains within this EPC, there will be no technical loading of bid on power consumption for evaluation. However, if bidder's quoted GPC exceeds EPC, there shall be technical loading of bid for evaluation @ **Rs 64, 92,703/-** per KW of additional power over EPC.					
2	Bidder's guaranteed power consumption at motor input terminals (not shaft power) as furnished in relevant schedule shall be demonstrated by the successful bidder during performance testing at works/ site. In case power consumption is noted higher than EPC / bidder's quoted GPC whichever is higher, during inspection/ PG test, penalty @ **Rs 64,92,703/-** per KW shall be levied on vendor.					

Anshul S A Khan Praveen Kishore

VENTILATION SYSTEM FOR 2 x 660 MW ENNORE SEZ STPP --- SUGGESTIVE PRICE FORMAT															
SL No	**DESCRIPTION OF EQUIPMENT/ ITEM**	**QTY**	**UNIT**	**SUPPLY**						**ERECTION AND COMMISIONING**				**TOTAL**
				Unit Price (Rs)	**Total ex-works price (Rs)**	**ED (Inc CESS) (Rs)**	**CST / VAT (Rs)**	**Freight (Including service tax, if applicable) (Rs)**	**TOTAL FOR site price SUPPLY (Rs)**	**Unit Price (Rs)**	**Total price (Rs)**	**Service Tax (Rs)**	**TOTAL PRICE (Erection and commissioning including Service tax)**	**Total Price Supply FIOR site and E&C including service tax (Rs)**
1.0	Total lumpsum firm prices for equipment & Services as specified, Comprising Engineering, design, manufacture, inspection & Testing at manufacturer's/subvendor's works, Painting at manufactures works, duly packed for transportation, delivery to site, unloading, storage & handling at site, fabrication, erection and commissioning, performance and guarantee testing, submission of as built drawing, O&M Manual, carrying out acceptance tests at site, and final painting of complete Ventilation system on turnkey basis as per specification **PE-TS-412-554-A001** including mandatory spares, special tool & tackels for maintenance, commissioning spares, all taxes, duties etc.													
2.0	Break up prices for items covered in clause 1.0 above.In case, price indicated above does not match with item wise break-up given at 2.0, the highest price so calculated shall be considered for evaluation but in case of order, the same shall be placed at the lowest price.													
2.1	Sheet metal type air washer unit with centrifugal fan (DIDW) with motor, , pumps with motors, air washer internals, inlet air louvers, filters, piping as per IS:1239, Part-I (heavy class galvanised), valves, nozzles, level switch, temp indicators, back wash arrangement, galvanised drain piping, etc as per specification of capacity **2,50,000 CMH**. Each air washer has 3 no centrifugal fan (3 x 33% duty) of capacity **83,500 CMH each** at min. **75 mm SP**.	8	NO											
2.2	Unitary air filtration unit with centrifugal fan (SISW) with motor, pumps with motors, filters, UAF internals, piping as per IS: 1239 pt I (heavy class galvanised), valves for auto start of standby equipment, nozzles, level switch, pressure switches, Temp. indicators, back wash arrangement, galvanised drain piping etc. as per spec. of capacity **1,00,000 CMH.**Each UAF has 1 no centrifugal fan (1 x 100% duty) of capacity **1,00,000 CMH at min. 75 mm SP**	2	NO											
2.3*	Supply air ducting (finished) for above area complete with dampers, grills (with VCD & without VCD), supports (painted) and all accessories as specified.													
2.3.1*	Finished GSS (zinc coating 275 **gms/sq.m**) Ducting with support structure etc.													
a)*	18 G	4000	SQM*											
b)*	20 G	4000	SQM*											
c)*	22 G	3000	SQM*											
d)*	24 G	4000	SQM*											
2.3.2*	MS Duct With Epoxy paint for battery room.	200	SQM*											
2.3.3*	MS Grilles with VCD	200	SQM*											
2.3.4*	MS Grilles without VCD	10	SQM*											
2.3.5*	Exposed duct insulation with fibre glass insulation as per specifications.	2000	SQM*											
2.3.6*	Wall mounted dampers (gravity operated) for different areas.	30	SQM*											
2.3.7*	Inlet Louvres	20	SQM*											
2.4*	FIRE DAMPER													
a)*	Fire damper	30	SQM*											
b)*	Motorized Actuator with single phase power supply for the above Fire damper with auto resetting, limit switches, indication lamps etc	45	SQM*											
c)*	Fusible Link type Fire Damper	20	SQM*											
2.5*	Roof extractor units (axial flow type) with hood, disconnect switch and all accessories as specified. **Following fan shall have 15 mmwc static pressure.**													
a)*	Capacity 50,000 CMH with Motor rating 5.5 KW	28	Nos.*											
b)*	Capacity 40,000 CMH with Motor rating 5.5 KW	2	Nos.*											
c)*	Capacity 20,000 CMH with Motor rating 2.2 KW	1	Nos.*											

Anshul S A Khan Praveen Kishore

VENTILATION SYSTEM FOR 2 x 660 MW ENNORE SEZ STPP --- SUGGESTIVE PRICE FORMAT															
SL No	DESCRIPTION OF EQUIPMENT/ ITEM	QTY	UNIT	SUPPLY						ERECTION AND COMMISIONING				TOTAL
				Unit Price (Rs)	Total ex-works price (Rs)	ED (Inc CESS) (Rs)	CST / VAT (Rs)	Freight (Including service tax, if applicable) (Rs)	TOTAL FOR site price SUPPLY (Rs)	Unit Price (Rs)	Total price (Rs)	Service Tax (Rs)	TOTAL PRICE (Erection and commissioning including Service tax)	Total Price Supply FIOR site and E&C including service tax (Rs)
2.6*	Axial flow supply fans with pre and fine filter (wall mounted) complete with casing, TEFC sq cage induction motors & mounting frame, MS rain protection cowl, bird screen and all other accessories (suitable for 415V/3-phase supply). **Following fan shall have 30 mmwc static pressure.**													
a)*	Capacity 10,000 CMH with Motor rating 2.2 KW	8	Nos.*											
b)*	Capacity 7,500 CMH with Motor rating 1.5 KW	8	Nos.*											
c)*	Capacity 6,000 CMH with Motor rating 1.1 KW	15	Nos.*											
d)*	Capacity 4,000 CMH with Motor rating 0.75 KW	10	Nos.*											
2.7*	Axial flow supply fans with pre filter (wall mounted) complete with casing, TEFC sq cage induction motors & mounting frame, MS rain protection cowl, bird screen and all other accessories (suitable for 415V/3-phase supply) as specified. **Following fan shall have 20 mmwc static pressure.**													
a)*	Capacity 10,000 CMH with Motor rating 1.5 KW	20	Nos.*											
b)*	Capacity 7,500 CMH with Motor rating 1.1 KW	10	Nos.*											
c)*	Capacity 6,000 CMH with Motor rating 1.1 KW	2	Nos.*											
d)*	Capacity 4,000 CMH with Motor rating 0.75 KW	2	Nos.*											
2.8*	Axial flow exhaust fans (Bifurcated type, spark proof construction, wall mounted) complete with casing, flame proof motor & mounting frame, MS rain protection cowl, bird screen and all other accessories epoxy painted (suitable for 415V/3-phase supply) as specified. **Following fan shall have 15 mmwc static pressure.**													
a)*	Capacity 15,000 CMH with Motor rating 2.2 KW	5	Nos.*											
b)*	Capacity 10,000 CMH withMotor rating 1.5 KW	8	Nos.*											
c)*	Capacity 7,500 CMH with Motor rating 1.1 KW	6	Nos.*											
d)*	Capacity 2,000 CMH with Motor rating 0.55 KW	4	Nos.*											
2.9*	Axial flow exhaust fans (Wall mounted) complete with casing,TEFC sq cage induction motor & mounting frame, MS rain protection cowl, bird screen and all other accessories epoxy painted (suitable for 415V/3-phase supply) as specified.**Following fan shall have 10 mmwc static pressure.**													
a)*	Capacity 15,000 CMH with Motor rating 1.1 KW	12	Nos.*											
b)*	Capacity 10,000 CMH with Motor rating 0.75 KW	5	Nos.*											
c)*	Capacity 7,500 CMH with Motor rating 0.55 KW	4	Nos.*											
d)*	Capacity 6,000 CMH with Motor rating 0.55 KW	20	Nos.*											
e)*	Capacity 2,000 CMH with Motor rating 0.37 KW	10	Nos.*											
2.10*	Exhaust fan (propeller type) completes with induction motor & mounting frame MS rain protection cowl, bird screen and all other accessories as specified (suitable for 240V/ 1 phase). **Following fan shall have 5 mmwc static pressure.**													
a)*	Capacity 1200 CMH with Motor rating 100 watts	130	Nos.*											
2.11	Total lumpsum price for special tools & tackles for maintenance inclusive of packing forwarding, transportation up to site, etc. (Bidder shall submit item-wise price break-up).	1	LOT											
2.12	Total lumpsum price for commissioning spares inclusive of packing forwarding, transportation up to site, etc. (Bidder shall submit item-wise price break-up).	1	LOT											
2.14	**FIELD INSTRUMENTS** like pressure gauge, temperature gauge, pressure switch, differential pressure switch, velocity sensor/static pressure sensor,flow switch and other instrument required for Ventilation System etc.	1	LOT											

Anshul S A Khan Praveen Kishore

VENTILATION SYSTEM FOR 2 x 660 MW ENNORE SEZ STPP --- SUGGESTIVE PRICE FORMAT															
SL No	DESCRIPTION OF EQUIPMENT/ ITEM	QTY	UNIT	SUPPLY						ERECTION AND COMMISIONING				TOTAL
				Unit Price (Rs)	Total ex-works price (Rs)	ED (Inc CESS) (Rs)	CST / VAT (Rs)	Freight (Including service tax, if applicable) (Rs)	TOTAL FOR site price SUPPLY (Rs)	Unit Price (Rs)	Total price (Rs)	Service Tax (Rs)	TOTAL PRICE (Erection and commissioning including Service tax)	Total Price Supply FIOR site and E&C including service tax (Rs)
2.15	Any other item not indicated above, but required to make the system complete in all respects.	1	LOT											
2.16	Total lumpsum price for Mandatory Spare inclusive of packing forwarding, transportation up to site, etc. (Bidder to submit item-wise price break-up seperately).	1	LOT											

NOTES

1 The bidder shall furnish unit rates for variable item (marked *) for necessary adjustment (plus or minus) variation during detailed engg. stage. The unit rates quoted above shall be considered and no separate unit rates shall be quoted. Unit rates shall be valid throughout the contract.

2 Bidder must submit prices in the Pro Forma duly filled in signed and stamped on every page without any ambiguity. The price shall be written against each item. Term such as "refer covering letter" etc. are not acceptable. Extra sheet may be attached if the space provided is not sufficient

3 Price format shall not be changed by the bidder as the bidder may get disqualified by doing so.

4 For limitation on payment, percentages of individual items/equipments, as specified in the **Appendix-A** shall be applicable

Anshul S A Khan Praveen Kishore

VENTILATION SYSTEM FOR 2 x 660 MW ENNORE SEZ STPP --- MANDATORY SPARES SUGGESTIVE PRICE FORMAT															
SL No	DESCRIPTION OF EQUIPMENT/ ITEM	QTY	UNIT	SUPPLY						ERECTION AND COMMISIONING				TOTAL
				Unit Price (Rs)	Total ex-works price (Rs)	ED (Inc CESS) (Rs)	CST / VAT (Rs)	Freight (Including service tax, if applicable) (Rs)	TOTAL FOR site price SUPPLY (Rs)	Unit Price (Rs)	Total price (Rs)	Service Tax (Rs)	TOTAL PRICE (Erection and commissioning including Service tax)	Total Price Supply FIOR site and E&C including service tax (Rs)
A	MECHANICAL AND GENERAL													
1	CENTRIFUGAL FANS													
1.1	V-BELTS	2 SETS OF EACH TYPE												
1.2	BLOWER BEARING SETS	2 SETS OF EACH TYPE												
1.3	BLOWER MOTOR BEARINGS	2 SETS OF EACH TYPE												
1.4	SEAL GASKET AND OTHER WEAR OUT PARTS IN SETS	2 SETS OF EACH TYPE												
1.5	VIBRATION ISOLATORS	2 SETS OF EACH TYPE												
2.	AXIAL FANS													
2.1	FAN BEARINGS	2 SETS OF EACH TYPE												
2.2	FAN MOTOR BEARING	2 SETS OF EACH TYPE												
2.3	DRY FILTERS	2 SETS OF EACH TYPE AND SIZE												
3	AIR WASHER SYSTEM													
3.1	WATER STRAINERS	2 SETS OF EACH SIZE												
2.2	SPRAY NOZZLES	2 SETS OF EACH SIZE												
2.3	WATER REPELLANT TYPE FILTERS	2 SETS OF EACH SIZE												
4	HORIZONTAL CENTRIFUGAL PUMP													
4.1	IMPELLER FOR EACH OF PUMP SET	2 SETS OF EACH TYPE												
4.2	BEARINGS	2 SETS OF EACH TYPE												
4.3	SHAFT SLEEVES	2 SETS OF EACH TYPE												
4.4	BEARINGS MOTOR	2 SETS OF EACH TYPE												
B	ELECTRICAL													
1	Terminal plates													
a	For motors upto 30 KW	10 NOS. EACH FOR SMALL MOTORS UPTO 30 KW												
b	For motors above 30 KW	4 NOS. EACH FOR MORE THAN 30 KW												
2	Heaters	2 SETS												
3	Greasing arrangements	4 SETS OF EACH TYPE OF MOTOR.												
4	Motor of each type and rating	10% OF THE INSTALLED QUANTITY OR MINIMUM 1 NUMBER WHICHEVER BE HIGHER												
5	Bearings (DE and NDE) for each type and rating of motor	4 SETS												
C	CONTROL AND INSTRUMENTATION													
	Each type of lamps, PBs, ILPBs, fuse, MCB, MCCB used in the equipment/system.	20% OF QTY INSTALLED.												
a)	Measuring Instruments													
1	Indicators, Recorders, Electrical Metering and Skid Mounted Instruments	20% OF INSTALLED OF EACH TYPE.												

Anshul S A Khan Praveen Kishore

VENTILATION SYSTEM FOR 2 x 660 MW ENNORE SEZ STPP --- MANDATORY SPARES SUGGESTIVE PRICE FORMAT														
SL No	DESCRIPTION OF EQUIPMENT/ ITEM	QTY	UNIT	SUPPLY						ERECTION AND COMMISIONING				TOTAL
				Unit Price (Rs)	Total ex-works price (Rs)	ED (Inc CESS) (Rs)	CST / VAT (Rs)	Freight (Including service tax, if applicable) (Rs)	TOTAL FOR site price SUPPLY (Rs)	Unit Price (Rs)	Total price (Rs)	Service Tax (Rs)	TOTAL PRICE (Erection and commissioning including Service tax)	Total Price Supply FIOR site and E&C including service tax (Rs)
1.1	Indicators, recorders and meters offered from each model for the project. These instruments shall be supplied with three sets of blank scales.	10% OF INSTALLED OF EACH TYPE/MODEL OR A MINIMUM OF ONE NUMBER FOR EACH MODEL AND TYPE, WHICHEVER IS MORE												
1.2	For skid mounted instruments	10% OF INSTALLED OF EACH TYPE/MODEL OR A MINIMUM OF ONE NUMBER FOR EACH MODEL AND TYPE, WHICHEVER IS MORE												
2	Temperature Elements and Thermowells													
2.1	Thermocouple/RTD elements	10% OF INSTALLED OF EACH TYPE/MODEL OR A MINIMUM OF ONE NUMBER FOR EACH MODEL AND TYPE, WHICHEVER IS MORE												
2.2	Thermowells	10% OF INSTALLED OF EACH TYPE/MODEL OR A MINIMUM OF ONE NUMBER FOR EACH MODEL AND TYPE, WHICHEVER IS MORE												
3	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.	10% OF INSTALLED OF EACH TYPE/MODEL OR A MINIMUM OF ONE NUMBER FOR EACH MODEL AND TYPE, WHICHEVER IS MORE												
b)	**Relay based Control Panels**													
1	LEDs for indicating lights	10% OF QTY INSTALLED.												
2	Control circuit fuses/MCB/MCCB/ Semiconductor Fuses	300% OF INSTALLED OF EACH TYPE, CURRENT RATING.												
3	Relays modules & contactors.	20% SPARE OF QTY INSTALLED OF EACH TYPE & RATING												
c)	**Alarm Annunciation System**													
1	logic modules, group card modules, power supply modules, Hooters and any other electronic module.	20% SPARES OF EACH TYPE INSTALLED												
2	un-engraved window boxes complete with LED etc.	5% SPARES OF EACH TYPE INSTALLED												
3	LEDs for annunciation facia windows and LEDs box assemblies offered for the project	20% OF QTY INSTALLED												

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VENTILATION SYSTEM FOR 2 x 660 MW ENNORE SEZ STPP --- MANDATORY SPARES SUGGESTIVE PRICE FORMAT														
SL No	DESCRIPTION OF EQUIPMENT/ ITEM	QTY	UNIT	SUPPLY						ERECTION AND COMMISIONING				TOTAL
				Unit Price (Rs)	Total ex-works price (Rs)	ED (Inc CESS) (Rs)	CST / VAT (Rs)	Freight (Including service tax, if applicable) (Rs)	TOTAL FOR site price SUPPLY (Rs)	Unit Price (Rs)	Total price (Rs)	Service Tax (Rs)	TOTAL PRICE (Erection and commissioning including Service tax)	Total Price Supply FIOR site and E&C including service tax (Rs)
4	Annunciator hooter	ONE (1) NO. OF EACH TYPE												
d)	**Erection hardware**													
1	Instrument valves	10% OF EACH TYPE & SIZE INSTALLED												
2	Condensate pots of each type & Size installed	10% OF TOTAL NUMBER OF INSTALLED OR FOUR NUMBERS WHICHEVER IS HIGHER .												
3	Manifold	10% OF EACH TYPE & SIZE INSTALLED												
4	Fittings	10% OF EACH TYPE & SIZE INSTALLED												
e)	**Mandatory Spares for Control valves, Power Cylinder, Control Dampers, Actuators and Accessories**													
1	Following spares shall be furnished for control valves, Power Cylinder, Control Dampers as applicable.													
2	One set of spare control valve stem packing for each control valve.													
3	Two moulded rubber diaphragms for each control valve.													
4	One sets of each of O-rings and rubber gaskets for each control valve.													
5	100 percent qty. of lubricants for gaskets for each control valve on one year consumption basis.													
6	2 sets of limit switches and 1 set of valve positioner for each control valve.													
7	20 percent of position transmitter (4-20mA) for total qty. of control valve.													
8	One (1) set of valve trims (such as plug, stem, seat ring /cage, guide bushing, stem lock pin, packing retaining ring, etc) for each control valve.													
9	One completes actuator of each type or min 10% for each type and size whichever is more.													
10	20 percent of Solenoid valves or min 2 no. of each type for total qty. of control valves.													
11	20% of I to P converters, Pressure regulators.													
f)	**Mandatory spares not covered above**													

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VENTILATION SYSTEM FOR 2 x 660 MW ENNORE SEZ STPP --- MANDATORY SPARES SUGGESTIVE PRICE FORMAT														
SL No	DESCRIPTION OF EQUIPMENT/ ITEM	QTY	UNIT	SUPPLY						ERECTION AND COMMISIONING				TOTAL
				Unit Price (Rs)	Total ex-works price (Rs)	ED (Inc CESS) (Rs)	CST / VAT (Rs)	Freight (Including service tax, if applicable) (Rs)	TOTAL FOR site price SUPPLY (Rs)	Unit Price (Rs)	Total price (Rs)	Service Tax (Rs)	TOTAL PRICE (Erection and commissioning including Service tax)	Total Price Supply FIOR site and E&C including service tax (Rs)
	Bidder to supply 10% or 1 no. (whichever is more) of each type of sensor/instrument, instrumentation/mechanical fittings etc for any other electronic system, feeder control cabinets, hydrastep (EWLI), Vibration Monitoring System, CCTV, C&I Lab Instruments, On line Carbon in Ash analyser system, On line Coal mass flow/speed measurement system, On line secondary air flow measurement system Mass Flow meter, Solid flow meter, 3 D Acoustic type level transmitters, Nucleonic & non nucleonic density transmitter etc.													

NOTES

1 The bidder shall furnish unit rates for variable item (marked *) for necessary adjustment (plus or minus) variation during detailed engg. stage. The unit rates quoted above shall be considered and no separate unit rates shall be quoted. Unit rates shall be valid throughout the contract.

2 Bidder must submit prices in the Pro Forma duly filled in signed and stamped on every page without any ambiguity. The price shall be written against each item. Term such as "refer covering letter" etc. are not acceptable. Extra sheet may be attached if the space provided is not sufficient

3 Price format shall not be changed by the bidder as the bidder may get disqualified by doing so.

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PROJECT : 2X660 MW ENNORE		
PACKAGE : VENTILATION SYSTEM		
APPENDIX - A		
SL NO	**DESCRIPTION OF EQUIPMENT/ ITEM**	**Percentage of total price**
1	Total lumpsum firm prices for equipment & Services as specified, Comprising Engineering, design, manufacture, inspection & Testing at manufacturer's/subvendor's works, Painting at manufactures works, duly packed for transportation, delivery to site, unloading, storage & handling at site, fabrication, erection and commissioning, performance and guarantee testing, submission of as built drawing, carrying out acceptance tests at site, and final painting of complete Ventilation system on turnkey basis as per specification PE-TS-412-554-A001 including special tool & tackels for maintenance, commissioning spares, all taxes, duties etc. (Without mandatory spare - Sr. No. 2.16 of suggestive price format)	**100%**
2.0	**BREAK-UP OF PRICES GIVEN IN 1.0 ABOVE (To be used during contract execution for payment)**	
2.1	Total lump sum firm price for **EQUIPMENT (SUPPLY)** for Engineering, design, manufacture, inspection & Testing at manufacturers works/subvendor's work, Painting at manufactures works, duly packed for transportation, delivery to site, unloading storage & handling at site, for the complete scope of supply of Ventilation system and as defined in the technical specification (PE-TS-412-554-A001)	**80%**
2.2	**Erection & commissioning**, carrying out acceptance tests at site, final painting and handing over to customer the complete ventilation system on turnkey basis as per specification PE-TS-412-554-A001 including special tool & tackels for maintenance, commissioning spares, all taxes, duties etc	**20%**
3.0	**Break-up (%) of prices given at Sl No-2.1 above (To be used during contract execution for payment)**	**Percentage of total price of SL No 2.1 above**
3.1	Air washer - (Item no 2.1 of Suggestive price format)	**42.11%**
3.2	UAF - (Item no 2.2 of Suggestive price format)	**6.54%**
3.3	GSS Duct work - (Item no 2.3.1 of Suggestive price format)	**20.97%**
3.4	MS duct and grills (Item no 2.3.2, 2.3.3 &2.3.4 of Suggestive price format)	**2.17%**
3.5	Thermal Insulation (Item no 2.3.5 of Suggestive price format)	**2.95%**
3.6	Gravity damper, Inlet louver, Fire damper, VCD, (Item no 2.3.6 to 2.3.8 & 2.4 of Suggestive price format)	**1.55%**
3.7	RE units (Item no 2.5 of Suggestive price format)	**6.08%**
3.8	Supply air fans (Item no 2.6 and 2.7 of Suggestive price format)	**7.60%**
3.9	Exhaust fans (Item no 2.8 to 2.10 of Suggestive price format)	**8.60%**
3.10	Tools and tackles & Commissioning Spares (Item no 2.11 to 2.12 of Suggestive price format)	**0.52%**
3.11	Field Instruments and any other accessories/item (Item no 2.14 to 2.15 of Suggestive price format)	**0.91%**

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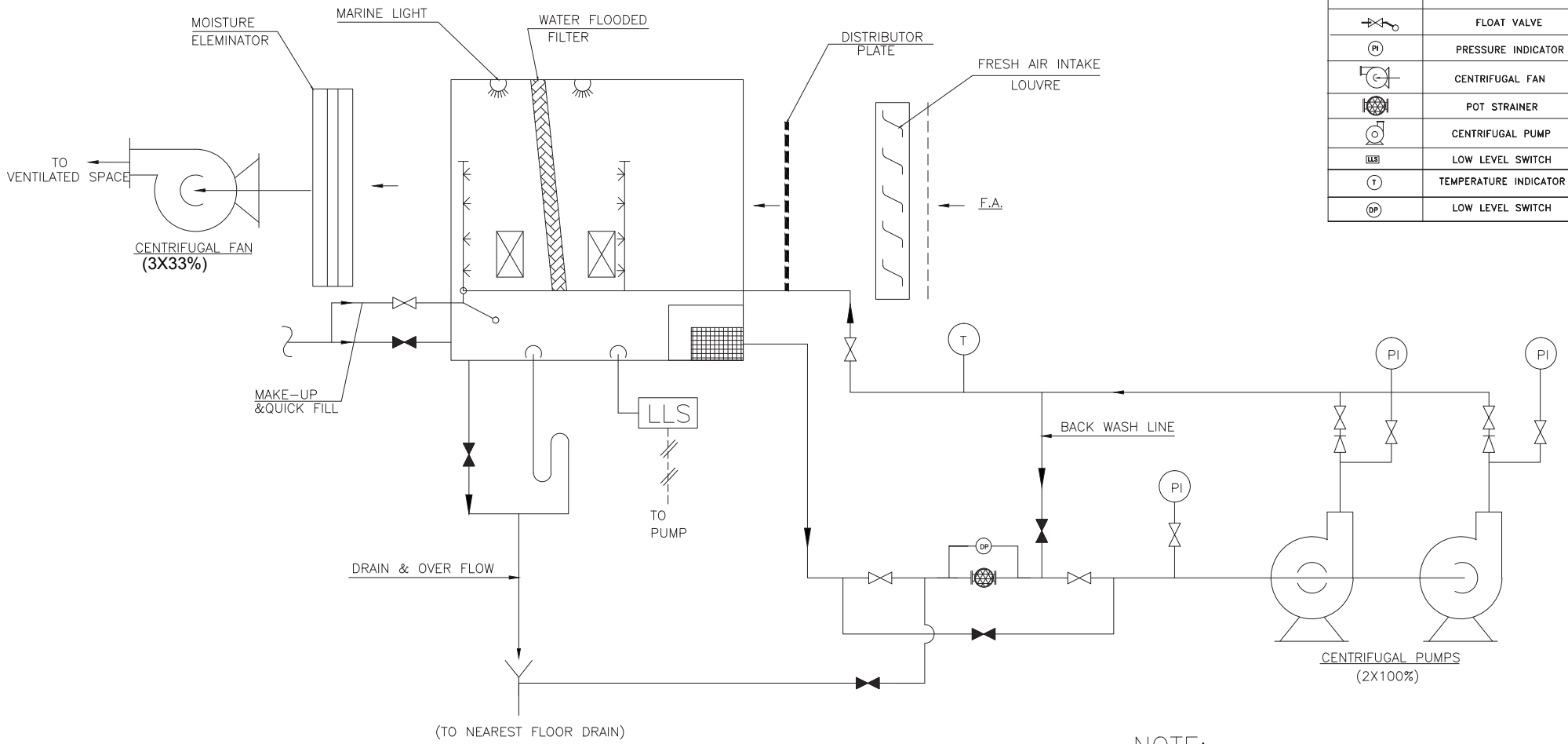


LEGEND:

	GATE VALVE
	NONRETURN VALVE
	FLOAT VALVE
PI	PRESSURE INDICATOR
	CENTRIFUGAL FAN
	POT STRAINER
	CENTRIFUGAL PUMP
LLS	LOW LEVEL SWITCH
T	TEMPERATURE INDICATOR
DP	LOW LEVEL SWITCH

NOTE:

1. THIS DRG. SHALL BE CONSIDERED AS MINIMUM TENDER REQUIREMENT . FINAL DRAWING SHALL BE AS PER CUSTOMER APPROVAL.
2. THE EQUIPMENT/ INSTRUMENTS MAY CHANGE DURING DETAIL ENGINERING.

NOTE:

1. THIS SCHEME IS FOR ONE (1) NO. AIR WASHER. IT SHALL BE TYPICAL FOR OTHER AIR WASHER.

Anshul S A Khan Praveen Kishore

FOR BID PURPOSE ONLY

REFERENCE DRAWINGS.	NOTES	NOTICE
	1. DO NOT SCALE, ASK WHEN IN DOUBT. 2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE. 3. INSTRUMENTS/ANALYZERS INDICATED IN FLOW DIAGRAM ARE MINIMUM HOWEVER ANY ADDITIONAL REQUIREMENTS REGARDING QUANTITIES & TYPE OF INSTRUMENTS SHALL BE FINALIZED BY OWNER DURING DETAILED ENGINEERING AS PER PROCESS & REDUNDANCY REQUIREMENTS AS STIPULATED IN THE SPECIFICATION.	THIS DRAWING IS THE PROPERTY OF DESEIN PRIVATE LIMITED, NEW DELHI, AND IS LENT SUBJECT TO THE CONDITION THAT IT SHALL NOT BE REPRODUCED, COPIED, LENT OR OTHERWISE DISPOSED OF, DIRECTLY OR INDIRECTLY. IT SHALL NOT BE USED TO FURNISH ANY INFORMATION FOR THE MAKING OF DRAWINGS, APPARATUS, OR PARTS THEREOF EXCEPT FOR THE PROJECT SPECIFICALLY PROVIDED FOR BY CONTRACT AGREEMENT WITH DESEIN.

SR. No. PARTY — PRINT DISTRIBUTION

ZONE	MARK	PARTICULARS	DATE
	0	FOR BID PURPOSE ONLY	04.05.13

REVISIONS

CIVIL	MECH.	ELEC.	C&I	H.O.D.

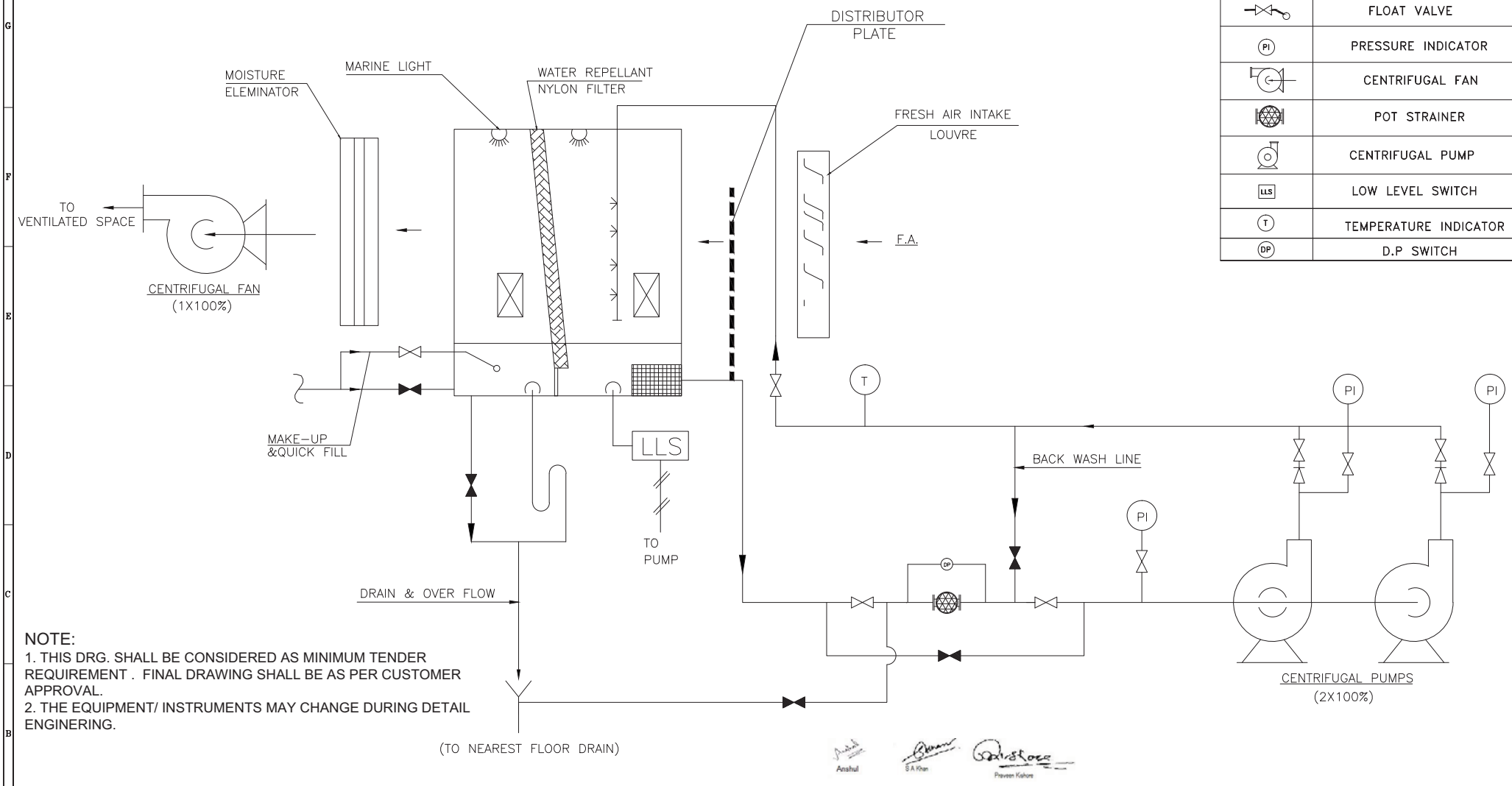
APPROVED

DESEIN
CONSULTING ENGINEERS
NEW DELHI – INDIA

CLIENT: TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION
PROJECT: 2x660 MW ENNORE SEZ SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI
TITLE :- FLOW DIAGRAM AIR WASHER UNIT

	NAME	SIGN.	DATE
CAD/DRAWN	BHARAT		04.05.13
DESIGNED	DEEPAK		04.05.13
CHECKED	EV.ANAND		04.05.13
SCALE	N.T.S		

JOB. No. D-4027
DWG.No. 111-15-6204 REV. 0
Sheet No. of



LEGEND:

	GATE VALVE
	NONRETURN VALVE
	FLOAT VALVE
PI	PRESSURE INDICATOR
	CENTRIFUGAL FAN
	POT STRAINER
	CENTRIFUGAL PUMP
LLS	LOW LEVEL SWITCH
T	TEMPERATURE INDICATOR
DP	D.P SWITCH

NOTE:

1. THIS DRG. SHALL BE CONSIDERED AS MINIMUM TENDER REQUIREMENT . FINAL DRAWING SHALL BE AS PER CUSTOMER APPROVAL.
2. THE EQUIPMENT/ INSTRUMENTS MAY CHANGE DURING DETAIL ENGINERING.

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	PRINT DISTRIBUTION

REFERENCE DRAWINGS.

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2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. INSTRUMENTS/ANALYZERS INDICATED IN FLOW DIAGRAM ARE MINIMUM HOWEVER ANY ADDITIONAL REQUIREMENTS REGARDING QUANTITIES & TYPE OF INSTRUMENTS SHALL BE FINALIZED BY OWNER DURING DETAILED ENGINEERING AS PER PROCESS & REDUNDANCY REQUIREMENTS AS STIPULATED IN THE SPECIFICATION.

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ZONE	MARK	PARTICULARS	DATE
	0	FOR BID PURPOSE ONLY	04.05.13

REVISIONS

DATE	CIVIL	MECH.	ELEC.	C&I	H.O.D.

APPROVED

DESEIN
CONSULTING ENGINEERS
NEW DELHI – INDIA

CLIENT: TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION

PROJECT: 2x660 MW ENNORE SEZ SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI

TITLE :– FLOW DIAGRAM
UNITARY AIR FILTRATION UNIT (UAF) FOR ESP CONTROL ROOM

	NAME	SIGN.	DATE
CAD/DRAWN	BHARAT		04.05.13
DESIGNED	DEEPAK		04.05.13
CHECKED	EV.ANAND		04.05.13
SCALE	N.T.S		

JOB. No. D–4027

DWG.No. 111–15–6203 Sheet No. of REV. 0

PLANT WATER SYSTEM: 98 M3/hr

HVAC MAKE-UP (Clarified water) FOR HVAC MAKE-UP DISTRIBUTION AT VARIOUS PLACES AND TERMINAL POINT AS SHOWN IN DRG.

AC-VENDOR

9 m^3/hr HVAC-1 → For AC SYSTEM , NEAR MAKE-UP WATER TANK NEAR AC SYSTEM COOLING TOWER AT 33 M LEVEL ROOF.

PEM MSE/MPL

LOCATION : (AT ROOF POWER HOUSE BUILDING IN D-F BAY BET.COL. NO. 13-15 AT 33 M.

AC-VENDOR

9 m^3/hr HVAC-2 → For AC SYSTEM, NEAR MAKE-UP WATER TANK NEAR AC SYSTEM COOLING TOWER AT ROOF.

PEM MSE/MPL

LOCATION : (AT ROOF/TERRACE OF SERVICE BUILDING)

AC-VENDOR

3 m^3/hr HVAC-3 → For AC SYSTEM, NEAR MAKE-UP WATER TANK NEAR AC SYSTEM COOLING TOWER AT ROOF.

PEM MSE/MPL

LOCATION : (AT ROOF/TERRACE OF ADMIN BUILDING)

VENTILATION SYSTEM VENDOR

17 m^3/hr HVAC-4 → FOR AIR WASHER ROOM-1 MAKE-UP

PEM MSE/MPL

LOCATION: (OUTSIDE A ROY BET. COL. NO. 10-12 AT 0 M level). NEAR AIR-WASHER ROOM-1.

VENTILATION SYSTEM VENDOR

17 m^3/hr HVAC-5 → FOR AIR WASHER ROOM-2 MAKE-UP

PEM MSE/MPL

LOCATION: (OUTSIDE A ROY BET. COL. NO. 21-23 AT 0 M level). NEAR AIR-WASHER ROOM-2.

VENTILATION SYSTEM VENDOR

17 m^3/hr HVAC-6 → TO AIR WASHER ROOM-3 MAKE-UP

PEM MSE/MPL

LOCATION: (IN BC BAY BET. COL. NO. 2-5 AT 24 M level. NEAR AIR-WASHER ROOM-3.

VENTILATION SYSTEM VENDOR

17 m^3/hr HVAC-7 → TO AIR WASHER ROOM-4 MAKE-UP

PEM MSE/MPL

LOCATION: (IN CD-BAY BET. COL. NO. 13-16 AT 33 M level. NEAR AIR-WASHER ROOM-4.

APPLICABLE FOR VENTILATION SYSTEM

AC-VENDOR

1.5m^3/hr HVAC-8 → For AC SYSTEM, NEAR MAKE-UP WATER TANK NEAR AC SYSTEM COOLING TOWER AT ROOF.

PEM MSE/MPL

LOCATION: (IN ESP BUILDING - 1 ROOF LEVEL)

VENTILATION SYSTEM VENDOR

3m ^{3}/hr HVAC-9 → FOR UAF OF ESP - 1 BUILDING

PEM MSE/MPL

LOCATION: (IN ESP BUILDING - 1 ROOF LEVEL) NEAR UAF

AC-VENDOR

1.5m^3/hr HVAC-10 → For AC SYSTEM, NEAR MAKE-UP WATER TANK NEAR AC SYSTEM COOLING TOWER AT ROOF.

PEM MSE/MPL

LOCATION: (IN ESP BUILDING - 2 ROOF LEVEL)

VENTILATION SYSTEM VENDOR

3m ^{3}/hr HVAC-11 → FOR UAF OF ESP - 2 BUILDING

PEM MSE/MPL

LOCATION: (IN ESP BUILDING- 2 ROOF LEVEL) NEAR UAF

NOTE:-

1. MPL TO PROVIDE HVAC MAKE-UP WATER PIPING/FITTINGS UP TO THE TERMINAL POINT AS SHOWN IN DRG.
2. HVAC MAKE-UP WATER PIPING INCLUDING FITTINGS SHALL BE TERMINATED WITHIN THE RANGE OF 5 METER DISTANCE FROM MAKE-UP WATER TANK / AIR-WASHER BY MPL (LP PIPING VENDOR'S SCOPE) FURTHER PIPING SHALL BE DONE BY RESPECTIVE PLANT SUPPLIER AS MARKED IN THIS DRG.
3. THE HVAC MAKE-UP WATER ISOLATING VALVES AS PER VALVE SCHEDULE SHALL BE ARRANGED BY MPL (VALVE GROUP) AS PER THE SCHEME AS MARKED IN TGHE DRG.
4. HVAC MAKE-UP WATER PRESSURE at EACH TERMINAL POINT SHALL BE MAINTAINED 0.5 kg/cm2.
5. AC - SYSTEM MAKE-UP WATER PIPING FROM TERMINAL POINT TO MAKE-UP WATER TANK, COOLING TOWER, EXPANSION TANK & FAN HUMIDIFIER SHALL BE IN BIDDER'S SCOPE.
6. MAKE-UP WATER REQUIREMENT IS CONTINUOUS.

Anshul

S A Khan

Praveen Kishore

| | | |

DRAWING NO. PE-DG-412-100-M001

FIRST ANGLE PROJECTION — ALL DIMENSIONS ARE IN MM

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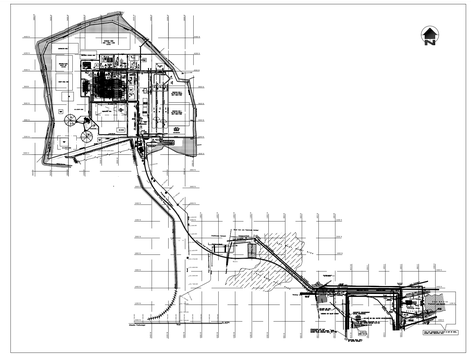
ELECTRONIC FILE NAME: 412_100_M001_R1.DWG

NORTH

KEY PLAN



LEGEND:	
	GREEN BELT
	COMPOUND WALL
	BURIED PIPING
	PLANT ROADS
	PIPE RACK
	WATCH TOWERS
	COAL CONVEYOR
	INTERNAL COMPOUND WALL
	GATES
Tower	High Tension Line

IDENTIFICATION NUMBER	DESCRIPTION
1	TG BUILDING
2	SWITCH GEAR ROOM, CONTROL ROOM, AC PLANT ROOM
3	STEAM GENERATOR
4	ESP
5	CHIMNEY
6	SPACE FOR FGD PLANT
7	TRANSFORMER YARD
8	400KV GIS SWITCHYARD
9a	DG SET
9b	COMPRESSOR HOUSE
10	VACUUM PUMP HOUSE (UNIT–1) & COMPRESSOR HOUSE
11	BOTTOM ASH SLURRY PUMP HOUSE
12	ASH WATER PUMP HOUSE
13	BUFFER HOPPER TOWER
14	FLY ASH SILOS
15	HFO/LDO UNLOADING AREA
16	HFO/LDO STORAGE TANK DYKE AREA
17	HFO/LDO FORWARDING PUMP HOUSE
18	ELECTRO CHLORINATION BUILDING
19	SEA WATER INTAKE PUMP HOUSE (OUTSIDE PLANT BOUNDARY)
20	FILTERED WATER AND FIRE WATER STORAGE TANK AND PUMP HOUSE
21	MILL REJECT SILO
22	RO–DM CUM DESALINATION PLANT
23	DM STORAGE TANKS & PUMP HOUSE
24	STORAGE YARD (WITH COMPOUND WALL, COVERED STORES & OFFICE)
25	ETP
26	CENTRAL MONITORING BASIN
27	GUARD POND
28	BULK CHEMICAL AREA
29	CPU REGENERATION BUILDING
30	NEUTRALISING PIT
31	WORKSHOP
32	SWITCH YARD CONTROL ROOM
33	CONVEYOR
34	ADMINISTRATION BUILDING
35	CANTEEN
36	NDCT
37	COOLING WATER PUMP HOUSE
38	STACKER CUM RECLAIMER
39	CRUSHER HOUSE
40	CHP CONTROL ROOM
41	DISPENSARY AND FIRST AID CENTER
42	ADDITIONAL CANTEEN
43	SERVICE BUILDING
44	DORMITORY
45	ESP CONTROL ROOMS
46	CONDENSATE STORAGE TANK
47	FIRE STATION
48	ROAD WEIGH BRIDGE BUILDING
49	MAIN GATE & TIME OFFICE CUM SECURITY COMPLEX
50	DOZER SHED & REPAIR SHOP
51	COAL PILE RUN OFF PIT
52	COAL STOCK PILE
53	AIR WASHER ROOM
54	BHEL SITE OFFICE
55	WATCH TOWERS
56	FIRE WATER BOOSTER PUMP HOUSE
57	EMERGENCY RECLAIM HOPPER
58	DELETED
59	33KV CONSTRUCTION TERMINAL POINT
60	WEIGH BRIDGE BUILDING ASH SILO AREA
61	H_2 PLANT
62	RAIN WATER HARVESTING POND
63	CLARIFIER
64	CLARIFIED WATER STORAGE TANK
65	SLUDGE SUMP
66	FIELD MAINTENANCE BUILDINGS
67	VACUUM PUMP HOUSE (UNIT–2)
68	FA SLURRY PUMP HOUSE
69	SILO UTILITY BUILDING
70	STP
71	AUX. BOILER
72	SERVICE WATER OVERHEAD TANK
73	CUSTOMER'S SITE OFFICE

NOTES:

1. PLANT FINISHED GRADED LEVEL (FGL) SHALL BE RL (+)9.50M.
   POWER HOUSE (TG BUILDING) FINISHED GROUND FLOOR LEVEL IS EL(+)0.00M, WHICH CORR. TO RL(+)10.0M.
   BOILER PAVED LEVEL IS EL(–)0.20M & TRANSFORMER YARD PAVED LEVEL IS EL(–)0.10M.
2. ALL DIMENSIONS ARE IN MM & LEVELS ARE IN METER UNLESS OTHERWISE STATED.
3. THE FACILITIES/ BUILDINGS SHOWN IN THE TABLE ABOVE ARE TENTATIVE & SHALL BE PROVIDED AS PER CONTRACT. DIMENSIONS AND LOCATION SHOWN ARE ALSO TENTATIVE & SHALL BE FINALIZED DURING DETAILED ENGINEERING.
4. CO–ORDINATES GIVEN IN THE PLOT PLAN ARE WITH RESPECT TO PILLAR No. 25 AND PILLAR No. 26. CO–ORDINATES OF P–25 (PLANT CO–ORDINATE W:1900.000M., N:3200.107M.) AND P–26 (PLANT CO–ORDINATE W:1900.000M., N:3400.000M.) ARE MARKED IN THE PLOT PLAN DRAWING.

REV.	DATE	ALTD	CHD	APPD
01	20.02.15	SD	SK	JJ

01 DRAWING GENERALLY REVISED BASED ON CUSTOMER'S COMMENTS.

JOB NO.	412
STATUS	CONTRACT
DISTRIBUTION	
TO	
No. OF	

PROJECT	2x660MW ENNORE SEZ SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI
OWNER	TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED
OWNER'S CONSULTANT:-	DESEIN PRIVATE LIMITED DESEIN HOUSE, NEW DELHI
EPC CONTRACTOR:-	BHARAT HEAVY ELECTRICALS LTD.

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

DEPT CODE		NAME	SIGN	DATE
M	DRN	SD	sd/–	29.10.2014
	DESN	SD	sd/–	29.10.2014
	CHD	SK	sd/–	29.10.2014
	APPD	JJ	sd/–	29.10.2014

TITLE: PLOT PLAN

DEPT. | SCALE: 1:2500 | SIGN | DATE

DRAWING NO. PE–DG–412–100–M001

SHEET 1 OF 1 | REV. 01

FORMAT SIZE A0

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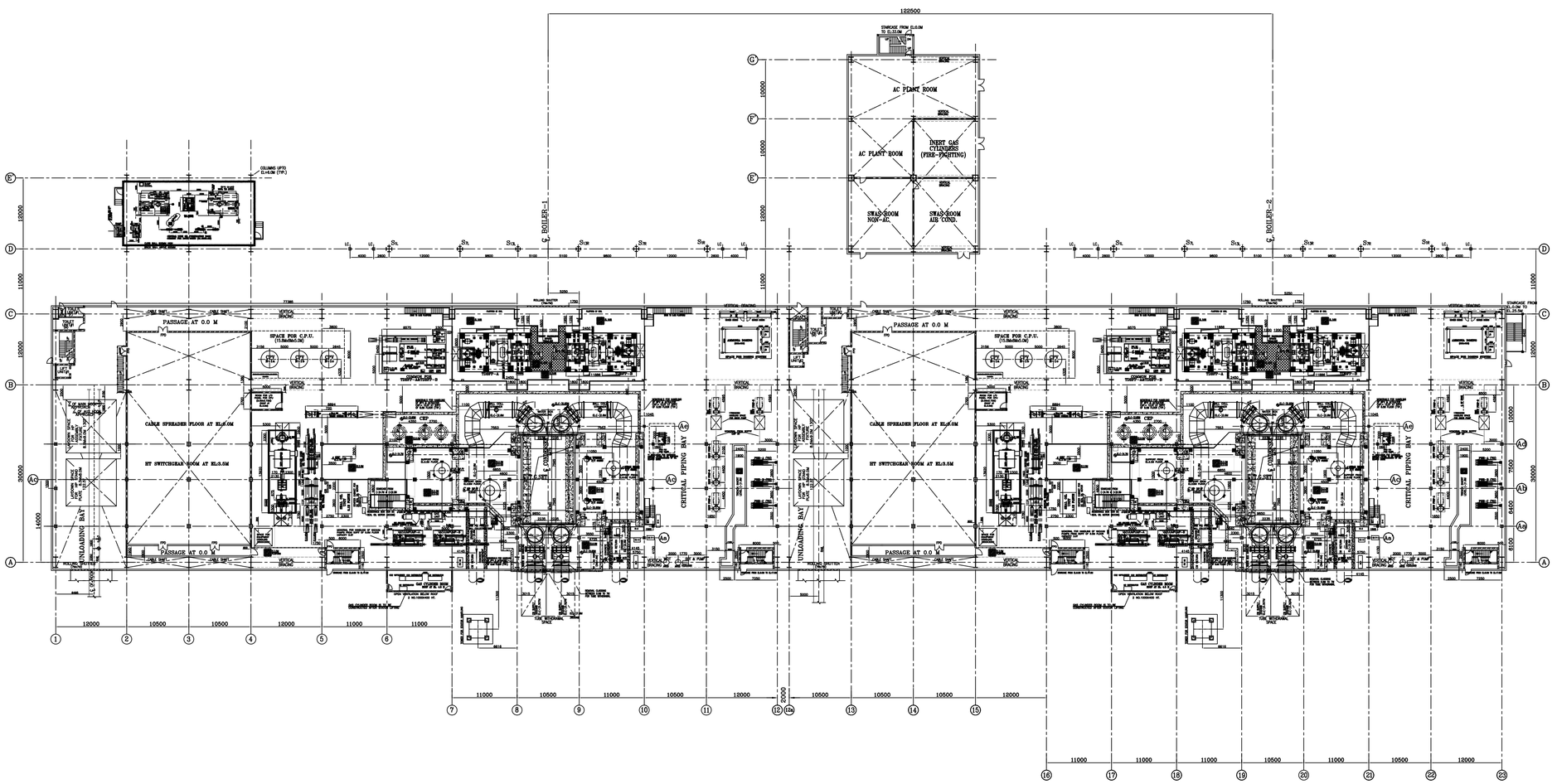
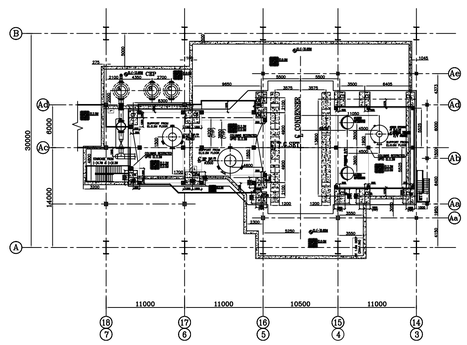
ELECTRONIC FILE NAME:412_100_M003_RO.DWG

DRAWING NO. PE-DG-412-100-M003

FIRST ANGLE PROJECTION

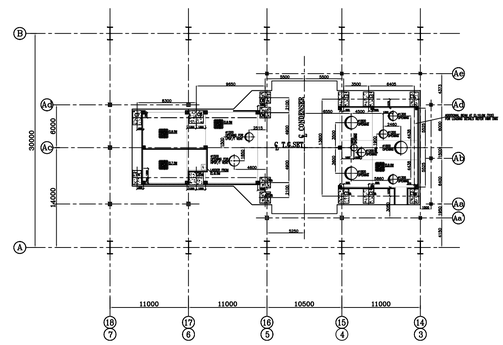
ALL DIMENSIONS ARE IN MM





PLATFORM AT EL:0.0M & EL:2.2M LEVEL

*=PLATFORM BEAMS/TIE BEAMS TO BE RESTRICTED TO DEPTH OF 300MM)



PLATFORM AT EL:7.5M/EL:8.0M/EL:8.5M LEVEL

*=PLATFORM BEAMS/TIE BEAMS TO BE RESTRICTED TO DEPTH OF 300MM)

NOTES:--

1. ALL DIMENSIONS ARE IN MM'S AND LEVELS ARE IN METRES.
2. ALL ELEVATIONS INDICATED IN THE DRG. ARE W.R.T. POWER HOUSE GROUND FLOOR ELEVATION AS 0.00M, WHICH CORRESPONDS TO R.L(+)10.0M.
3. EQUIPMENT SIZES SHOWN IN THIS DRAWING ARE INDICATIVE ONLY, THE SAME SHALL BE FINALIZED DURING DETAILED ENGINEERING.

LEGEND:

- CHEQUERED PLATE FLOORING
- REMOVABLE CHEQUERED PLATE
- GRATED FLOORING
- REMOVABLE GRATING
- CONCRETE BLOCK
- HAND RAILING
- PARAPET WALL
- GLASS PARTITION
- CUT OUTS
- BRICK WALL

REFERENCE DRAWINGS:

1.	EQUIPMENT PLAN AT 9.5M	PE-DG-412-100-M004
2.	EQUIPMENT PLAN AT 17.0M	PE-DG-412-100-M005
3.	EQUIPMENT PLAN AT 24.0M/25.5M	PE-DG-412-100-M006
4.	CROSS SECTION OF MAIN PLANT	PE-DG-412-100-M007
5.	CONDENSER ASSEMBLY (U.A.)	01601070070C208 (HWH)
6.	TG FOUNDATION ARRANGEMENT	--- (HWH)
7.	GLAND STEAM CONDENSER	--- (HWH)
8.	FOUNDATION DETAILS OF GEN. AUXILIARY EQUIPMENTS	--- (HWH)
9.	FOUNDATION ARRANGEMENT OF CEP	--- (HYD)
10.	GENERAL ARRANGEMENT OF DRAIN COOLER	--- (HYD)
11.	FOUNDATION DETAILS OF HPSU (HPBP VALVE)	--- (TRY)
12.	VACUUM PUMP	--- (HWH)
13.	GA OF DOT & PUMP	--- (HWH)
14.	GA OF WOT	--- (HWH)
15.	PLOT PLAN OF TDBFP	--- (HYD)
16.	GA OF HP DRAIN F/T	--- (BPL)
17.	GA OF LP DRAIN F/T	--- (BPL)
18.	GA OF STEAM DRAIN F/T	--- (BPL)
19.	GA OF UNIT F/T	--- (BPL)
20.	GA OF CLEAN OIL TANK	--- (BPL)
21.	GA OF DIRTY OIL TANK	--- (BPL)
22.	ARRNGT. & ASSY. OF OIL UNLOADING VESSEL	--- (BPL)
23.	CPU SYSTEM	--- (PEM)
24.	GA OF CENTRAL OIL PURIFIER	--- (HWH)
25.	GA OF DOSING SKID	--- (PEM)
26.	PLOT PLAN OF MDBFP	--- (HYD)
27.	GA OF CCLTCS	--- (PEM)
28.	GA OF PHEs	--- (PEM)
29.	GA OF EMCW PUMPS	--- (PEM)
30.	TURBINE JB LIST & LAYOUT	--- (HWH)

Anshul

S A Khan

Praveen Kishore

REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD

JOB NO. 412
STATUS CONTRACT
DISTRIBUTION
TO
No. OF

PROJECT
2x660 MW ENNORE SEZ COAL BASED STPP
AT ASH DYKE OF NCTPS, CHENNAI

CUSTOMER: TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)

CONSULTANT: DESEIN PRIVATE LIMITED
DESEIN HOUSE, GREATER KAILASH-II, NEW DELHI

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI

DEPT CODE		NAME	SIGN	DATE
M	DRN	SD	sd/–	06.12.2014
	DESN	SD	sd/–	06.12.2014
	CHD	SK	sd/–	06.12.2014
	APPD	JJ	sd/–	06.12.2014

TITLE
T.G. EQUIPMENT LAYOUT PLAN AT EL. 0.0M

DEPT. | SCALE: 1:300 | DRAWING NO. PE-DG-412-100-M003
SIGN
DATE
SHEET 1 OF 1 | REV. R0

FORMAT SIZE A0

DRAWING NO. PE-DG-412-100-M004

FIRST ANGLE PROJECTION | ALL DIMENSIONS ARE IN MM

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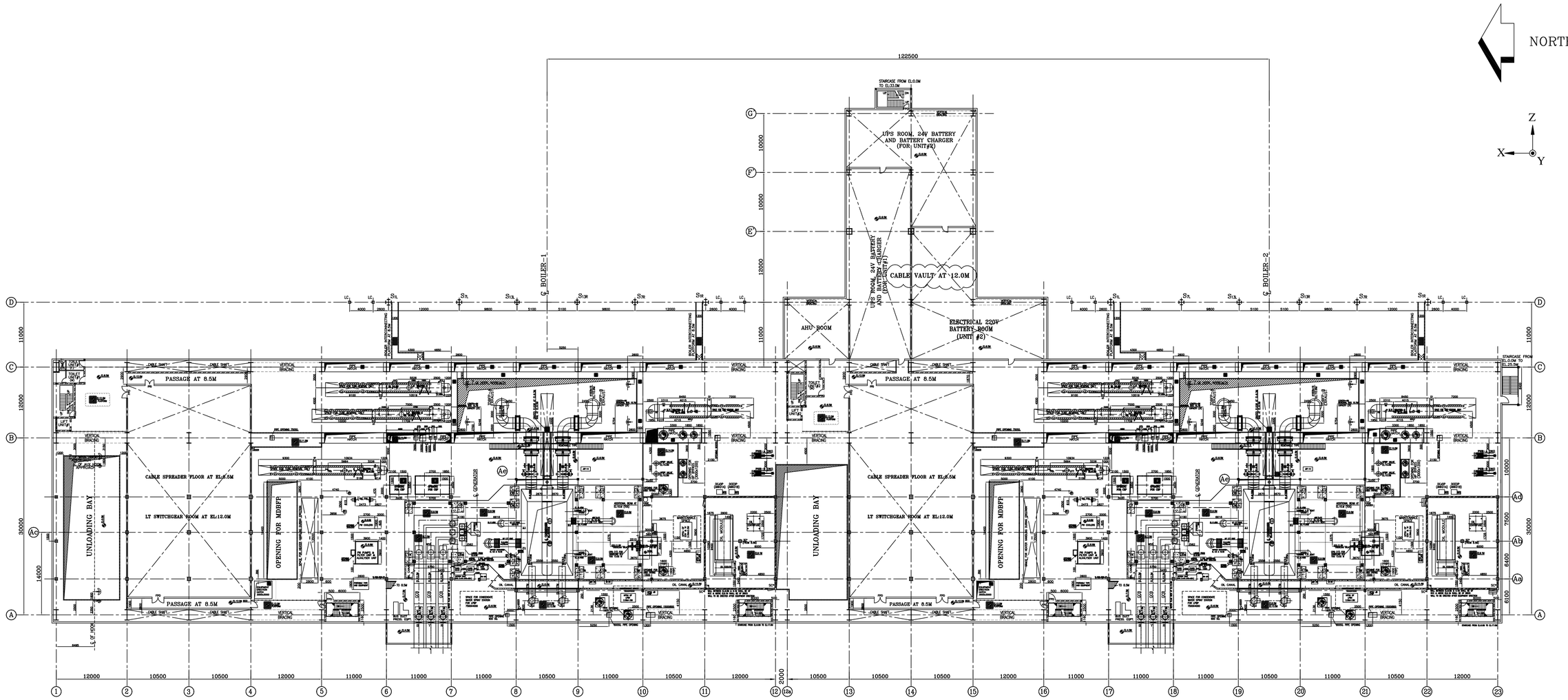

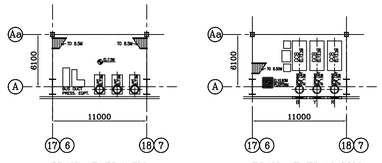

LEGEND:

- CHEQUERED PLATE FLOORING
- REMOVABLE CHEQUERED PLATE
- GRATED FLOORING
- REMOVABLE GRATING
- CONCRETE BLOCK
- HAND RAILING
- PARAPET WALL
- GLASS PARTITION
- CUT OUTS
- BRICK WALL

NOTES:-

1. ALL DIMENSIONS ARE IN MM'S AND LEVELS ARE IN METRES.
2. ALL ELEVATIONS INDICATED IN THE DRG. ARE W.R.T. POWER HOUSE GROUND FLOOR ELEVATION AS 0.00M, WHICH CORRESPONDS TO RL:(+)10.0M.
3. EQUIPMENT SIZES SHOWN IN THIS DRAWING ARE INDICATIVE ONLY, THE SAME SHALL BE FINALIZED DURING DETAILED ENGINEERING.

REFERENCE DRAWINGS:

1.	EQUIPMENT PLAN AT 0.0M	PE-DG-412-100-M003
2.	EQUIPMENT PLAN AT 17.0M	PE-DG-412-100-M005
3.	EQUIPMENT PLAN AT 24.0M/25.5M	PE-DG-412-100-M006
4.	CROSS SECTION OF MAIN PLANT	PE-DG-412-100-M007
5.	CONDENSER ASSEMBLY (G.A.)	01601070070C208 (HMR)
6	GENERATOR OUTLINE	-- (HMR)
7.	OIL ROOM ARRANGEMENT	-- (HMR)
8.	FOUNDATION DETAILS OF GEN. AUXILIARY EQUIPMENTS	-- (HMR)
9.	LP BYPASS VALVE ARRANGEMENT	-- (HMR)
10.	GENERAL ARRANGEMENT OF LP HEATER No.-1	-- (HMR)

Anshul
S A Khan
Praveen Kishore

REV.	DATE	ALTD	CHD	APPD

REV.	DATE	ALTD	CHD	APPD

PROJECT: 2x660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI

CUSTOMER: TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)

CONSULTANT: DESEIN PRIVATE LIMITED, DESEIN HOUSE, GREATER KAILASH-II, NEW DELHI

JOB NO. 412
STATUS CONTRACT
DISTRIBUTION
TO
No. OF

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI

DEPT CODE		NAME	SIGN	DATE
M	DRN	SD	sd/-	06.12.2014
	DES	SD	sd/-	06.12.2014
	CHD	SK	sd/-	06.12.2014
	APPD	JJ	sd/-	06.12.2014

TITLE: T.G. EQUIPMENT LAYOUT PLAN AT EL. 8.50M

DEPT. | SCALE: 1:250 | DRAWING NO. PE-DG-412-100-M004
SIGN
DATE
SHEET 1 OF 1 | REV. R0
FORMAT SIZE A0

ELECTRONIC FILE NAME: 412_100_M004_R0.DWG

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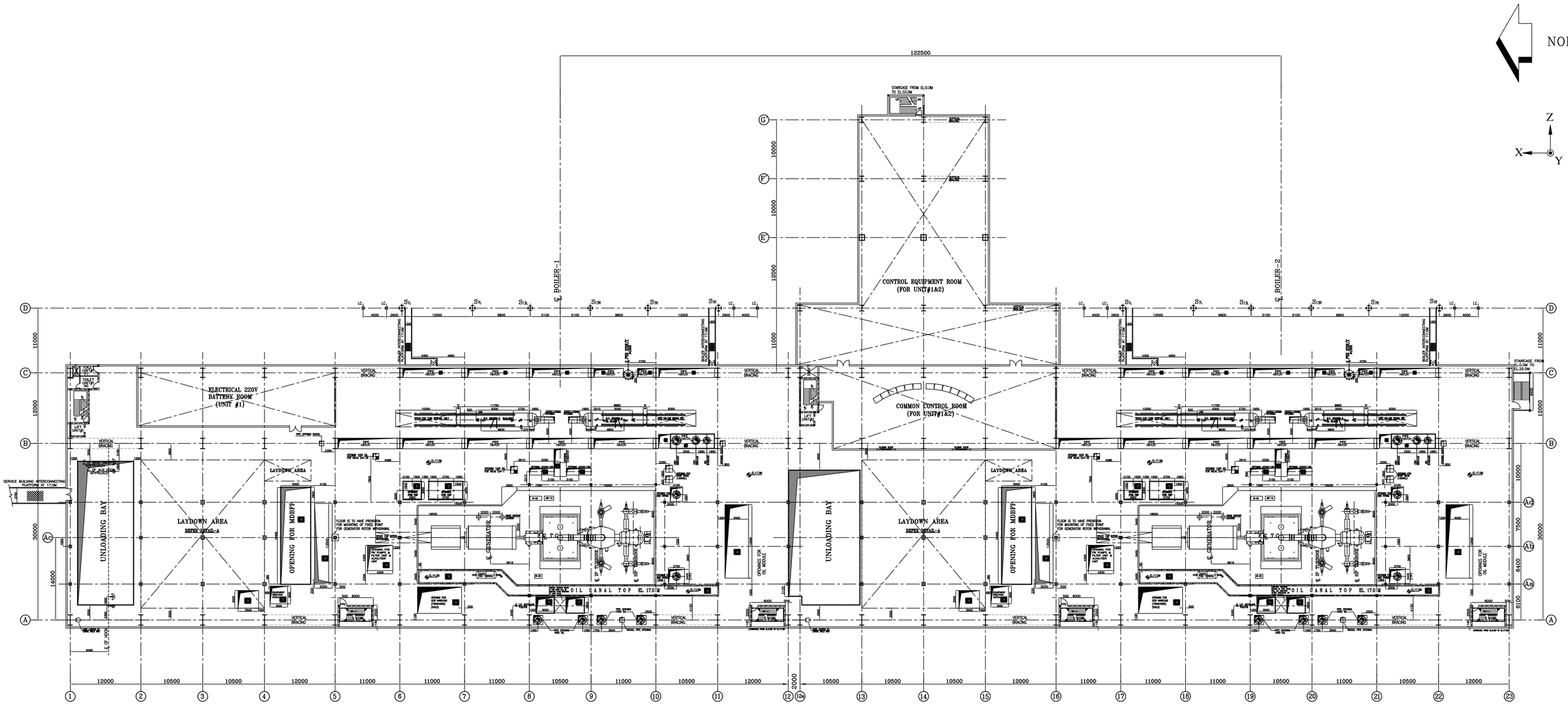
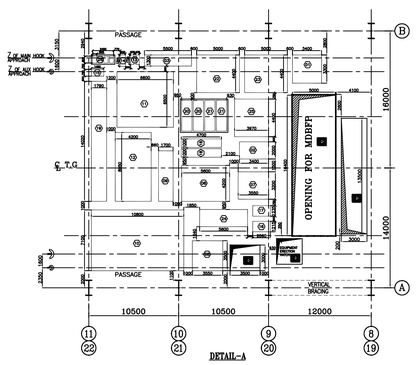
DRAWING NO. PE-DG-412-100-M005

FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN MM





DETAIL-A
LAY-DOWN SPACE FOR TG COMPONENTS

DETAIL OF LAY-DOWN SPACE FOR TG COMPONENTS.

S.No	DESCRIPTION	WEIGHT (Kg.)	AREA (SQM)
(1)	HP OUTER CASING (EXHAUST PART)	35000	3.4 X 5.3
(2)	HP INNER CASING UPPER HALF	17000	3.4 X 2.0
(3)	HP SHAFT	20000	5.5 X 1.3
(4)	HP STAND PLATE (LOCATED AT 0.0M FLOOR)	112000	8.0 X 8.5
(5)	HP ASSEMBLY FIXTURE (LOCATED AT 0.0M FLOOR)	130000	8.0 X 8.5
(6)	IPT OUTER CASING UPPER HALF	35000	5.8 X 4.2
(7)	IPT INNER CASING UPPER HALF	30000	3.35 X 3.3
(8)	IPT INNER CASING LOWER HALF	35000	3.35 X 3.5
(9)	IP SHAFT	32000	5.9 X 1.7
(10)	LP OUTER CASING UPPER HALF	480000	10.8 X 7.1
(11)	LP INNER CASING UPPER HALF	98000	6.6 X 6.5
(12)	LP SHAFT	120000	8.05 x 4.2
(13)	LP SHAFT SEAL CASING (VE & GE)	900 x 2	0.405 x 1.12
(14)	PEDESTAL COVER-HP(BEARING CASING HP FRONT)	900	1.344 x 0.82
(15)	PEDESTAL COVER HP-IP(BEARING CASING HP REAR)	1000	1.45 x 0.79
(16)	PEDESTAL COVER IP-LP(BEARING CASING IP REAR)	2300	2.08 x 1.215
(17)	PEDESTAL COVER LP-GEN(BEARING CASING LP REAR)	2500	2.08 x 1.235
(18)	STAGE BLADE CARRIER ASSEMBLY OF STAGE 2-7 (UPPER HALF, LEFT & RIGHT)	7000 x 2	4.7 x 1.0
(19)	GENERATOR ROTOR WITH SHAFT FRAME	850000	14.050 x 1.79
(20)	END SHIELD UPPER & LOWER HALF (EX)	8000 x 2	1.2 x 3.6
(21)	END SHIELD UPPER & LOWER HALF (TE)	8000 x 2	1.2 x 3.6
(22)	HYDROGEN COOLER (2 NOS. TWIN TYPE)	10000 x 2	2.5 x 1.5 (LP) 2.55 x 1.5 (HP)
(23)	HYDROGEN COOLERS HOUSING	10000	5.0 x 4.4
(24)	EXCITER	35000	5.6 x 3.01
(25)	EXCITER HOUSING	3500	4.4 x 2.87
(26)	BEARING SHELLS (TG&CS-UPPER & LOWER HALF)	500 x 4	0.5 x 0.8

NOTES:–

1. ALL DIMENSIONS ARE IN MM'S AND LEVELS ARE IN METRES.
2. ALL ELEVATIONS INDICATED IN THE DRG. ARE W.R.T. POWER HOUSE GROUND FLOOR ELEVATION AS 0.00M, WHICH CORRESPONDS TO RL(+)10.0M.
3. EQUIPMENT SIZES SHOWN IN THIS DRAWING ARE INDICATIVE ONLY, THE SAME SHALL BE FINALIZED DURING DETAILED ENGINEERING.

LEGEND:

- CHEQUERED PLATE FLOORING
- REMOVABLE CHEQUERED PLATE
- GRATED FLOORING
- REMOVABLE GRATING
- CONCRETE BLOCK
- HAND RAILING
- PARAPET WALL
- GLASS PARTITION
- CUT OUTS
- BRICK WALL

REFERENCE DRAWINGS:

1.	EQUIPMENT PLAN AT 0.0M	PE-DG-412-100-M003
2.	EQUIPMENT PLAN AT 8.5M	PE-DG-412-100-M004
3.	EQUIPMENT PLAN AT 24.0M/25.5M	PE-DG-412-100-M006
4.	CROSS SECTION OF MAIN PLANT	PE-DG-412-100-M007
5.	GENERAL ARRANGEMENT OF HP HEATER NO.–7	–– (HYG)
6	GENERAL ARRANGEMENT OF HP HEATER NO.–8	–– (HYD)
7.	TG FOUNDATION PLAN	–– (HMR)
8	GA OF FWSVD F/T	–– (BPL)
9.	OIL CANAL DETAIL	–– (HMR)
10.	LAYDOWN SPACE FOR GENERATOR COMPONENTS	–– (HMR)
11.	LAYDOWN SPACE FOR STEAM TURBINE COMPONENTS	–– (HMR)
12.	OIL ROOM ARRANGEMENT	–– (HMR)
13.	LP BYPASS ARRANGEMENT	–– (HMR)
14.	CCR/ CER ROOM LAYOUT	–– (PEM)

Anshul

S A Khan

Praveen Kishore

REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD

PROJECT: 2x660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI

CUSTOMER: TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)

CONSULTANT: DESEIN PRIVATE LIMITED, DESEIN HOUSE, GREATER KAILASH–II, NEW DELHI

JOB NO. 412

STATUS CONTRACT

DISTRIBUTION

TO

No. OF

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI

DEPT CODE		NAME	SIGN	DATE
M	DRN	SD	sd/–	06.12.2014
	DESN	SD	sd/–	06.12.2014
	CHD	SK	sd/–	06.12.2014
	APPD	JJ	sd/–	06.12.2014

TITLE: T.G. EQUIPMENT LAYOUT PLAN AT EL. 17.0M

DEPT. | SCALE: 1:250 | DRAWING NO. PE–DG–412–100–M005

SIGN

DATE

SHEET 1 OF 1 | REV. R0

FORMAT SIZE A0

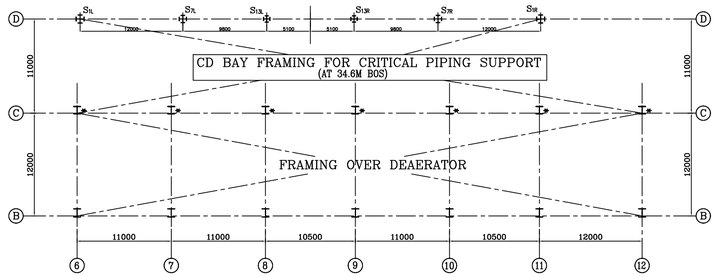
ELECTRONIC FILE NAME:412_100_M005_R0.DWG

DRAWING NO. PE-DG-412-100-M006

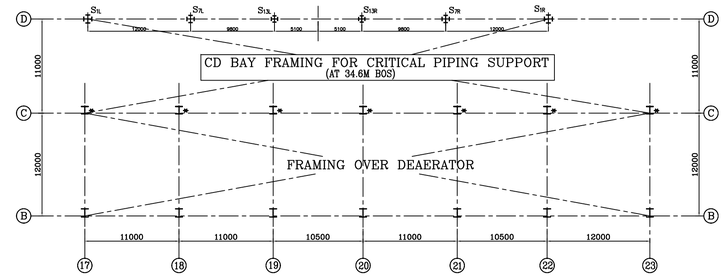
FIRST ANGLE PROJECTION | ALL DIMENSIONS ARE IN MM

NORTH

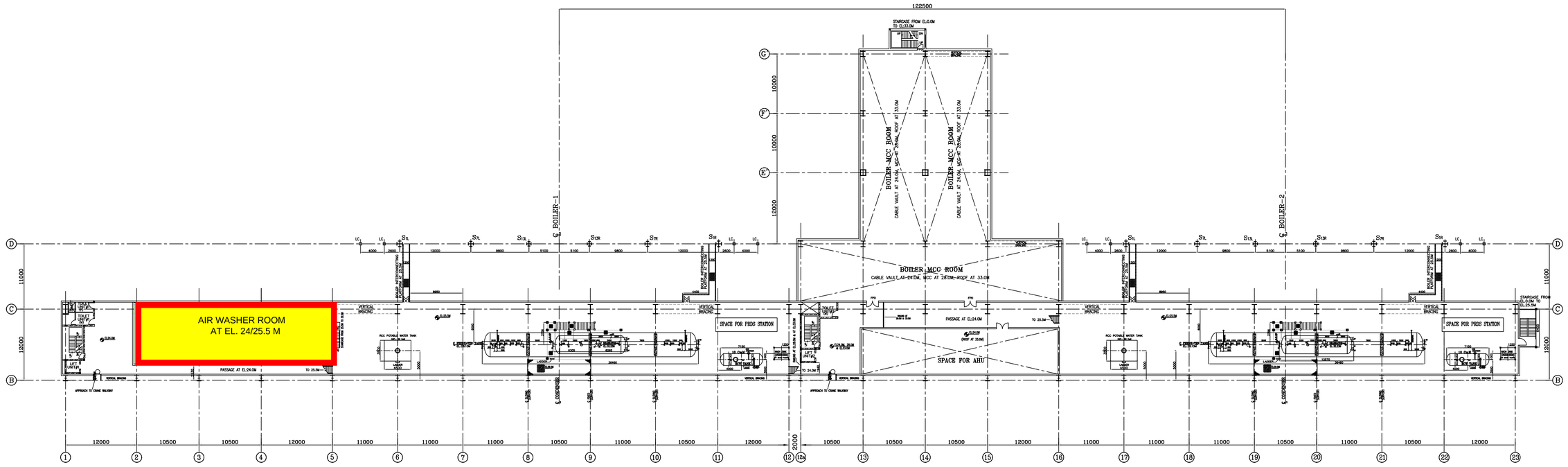
Z
X Y



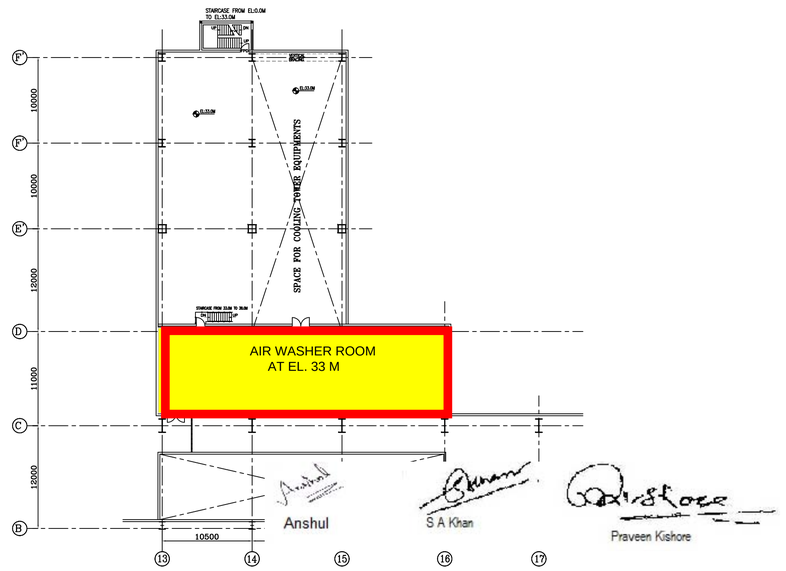
PLAN AT EL:37.5M (TOS)



PLAN AT EL:37.5M (TOS)



PLAN AT EL:24.0M/25.5M



PLAN AT EL+33.0M

NOTES:-

1. ALL DIMENSIONS ARE IN MM'S AND LEVELS ARE IN METRES.
2. ALL ELEVATIONS INDICATED IN THE DRG. ARE W.R.T. POWER HOUSE GROUND FLOOR ELEVATION AS 0.00M, WHICH CORRESPONDS TO RL(+)10.0M.
3. EQUIPMENT SIZES SHOWN IN THIS DRAWING ARE INDICATIVE ONLY, THE SAME SHALL BE FINALIZED DURING DETAILED ENGINEERING.

LEGEND:

- CHEQUERED PLATE FLOORING
- REMOVABLE CHEQUERED PLATE
- GRATED FLOORING
- REMOVABLE GRATING
- CONCRETE BLOCK
- HAND RAILING
- PARAPET WALL
- GLASS PARTITION
- CUT OUTS
- BRICK WALL

REFERENCE DRAWINGS:

1.	EQUIPMENT PLAN AT 0.0M	PE-DG-412-100-M003
2.	EQUIPMENT PLAN AT 8.5M	PE-DG-412-100-M004
3.	EQUIPMENT PLAN AT 17.0M	PE-DG-412-100-M005
4.	CROSS SECTION OF MAIN PLANT	PE-DG-412-100-M007
5.	GA OF DEAERATOR	-- (HYD)
6	DEAERATOR PLATFORM ASSEMBLY	-- (HYD)
7.	GA OF DMCW TANK	-- (BPL)
8	GA OF NAOH DOSING TANK	-- (PEM)
9	GA OF POTABLE WATER TANK	-- (PEM)

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ELECTRONIC FILE NAME: 412_100_M006_BOILING

PROJECT: 2x660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI

CUSTOMER: TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)

CONSULTANT: DESEIN PRIVATE LIMITED, DESEIN HOUSE, GREATER KAILASH-II, NEW DELHI

JOB NO. 412
STATUS CONTRACT
DISTRIBUTION
TO
No. OF

REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI

DEPT CODE		NAME	SIGN	DATE
M	DRN	SD	sd/–	06.12.2014
	DESN	SD	sd/–	06.12.2014
	CHD	SK	sd/–	06.12.2014
	APPD	JJ	sd/–	06.12.2014

TITLE: T.G. EQUIPMENT LAYOUT PLAN AT EL. 24.0M/ 25.5M

DEPT. | SCALE: 1:250 | SIGN | DATE

DRAWING NO. PE-DG-412-100-M006

SHEET 1 OF 1 | REV. R0 | FORMAT SIZE A0

DRAWING NO. PE-DG-412-100-M007

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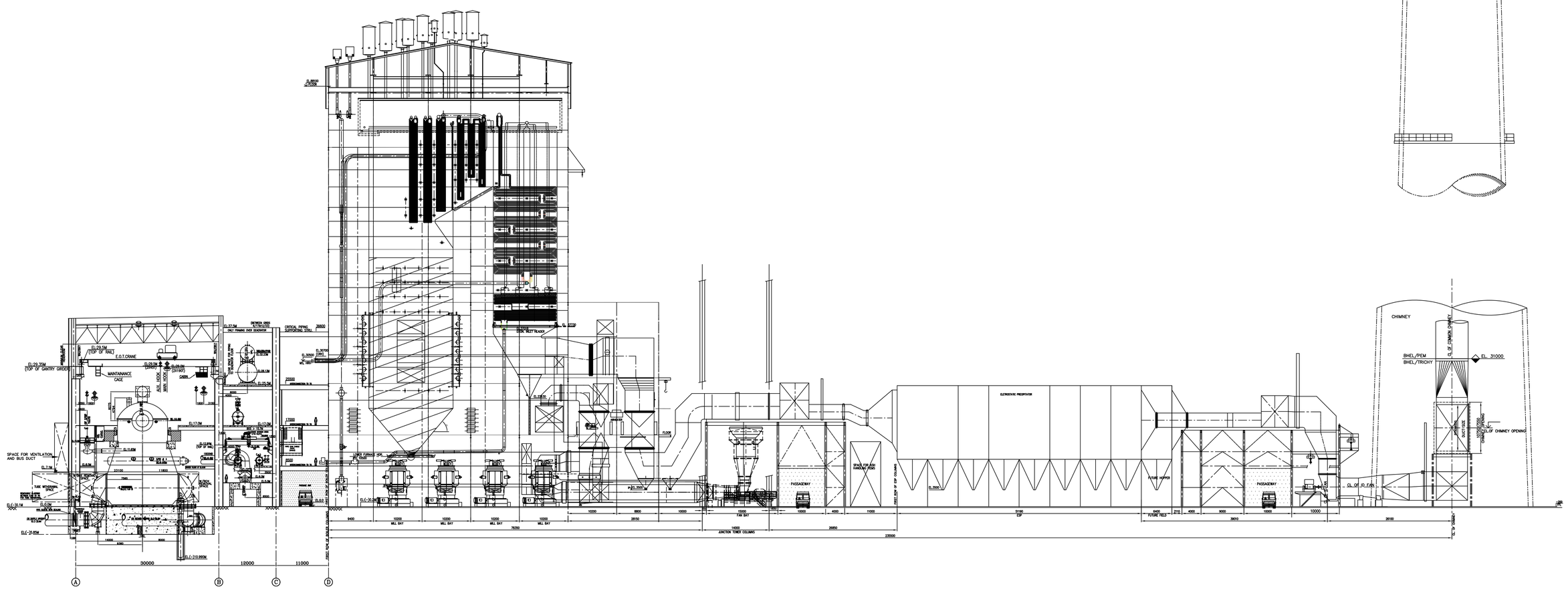
FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN MM



DRAWING NO. PE-DG-412-100-E008

FIRST ANGLE PROJECTION | ALL DIMENSIONS ARE IN MM

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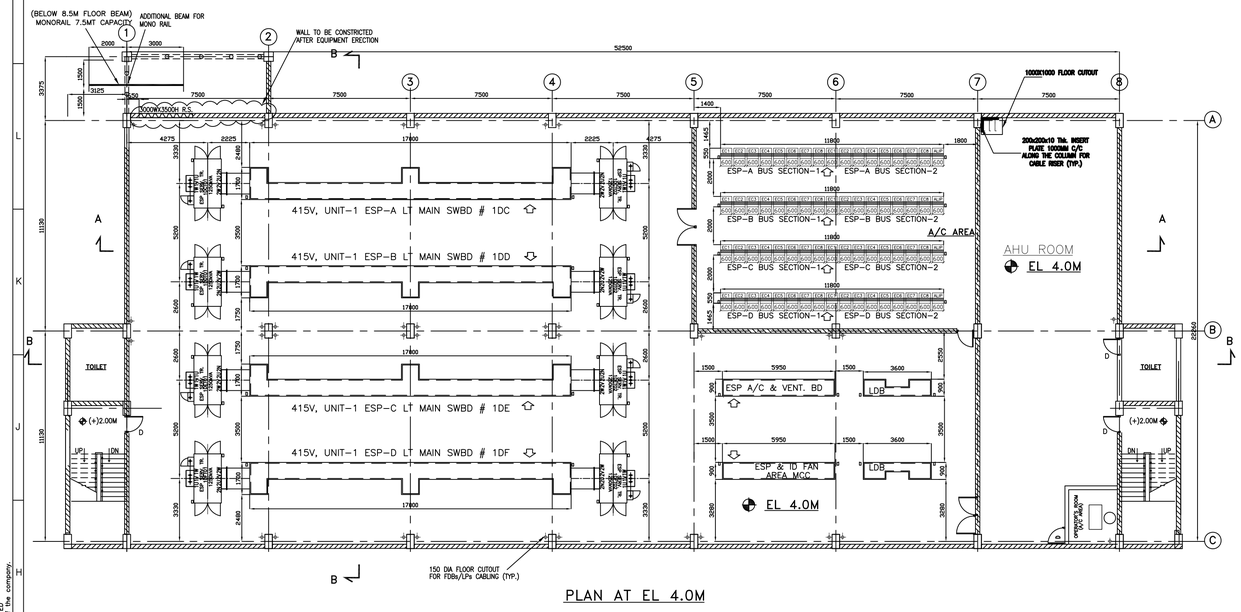
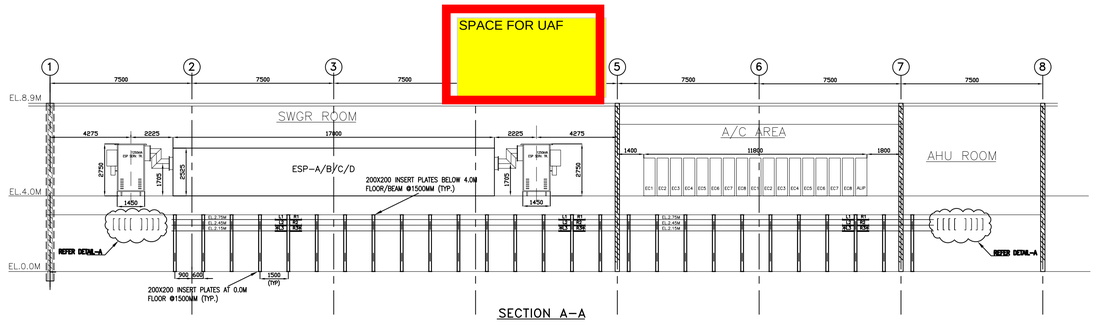
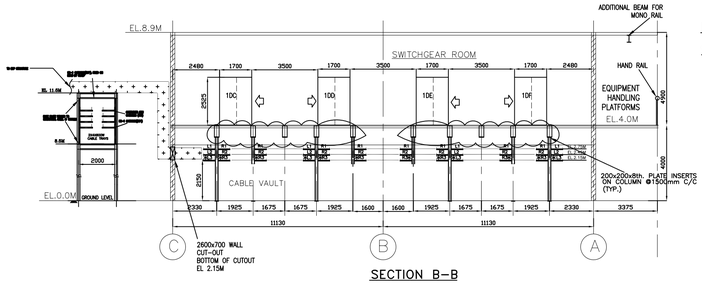
It must not be used directly or indirectly in any way.



PLAN AT EL 4.0M

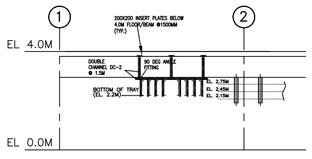


SECTION A-A

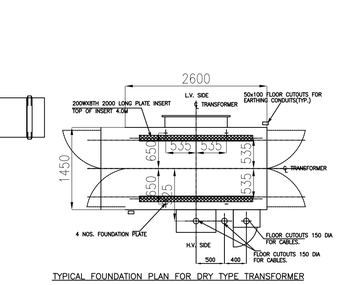


SECTION B-B

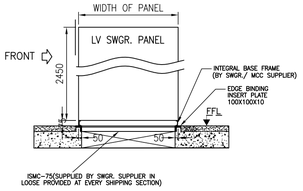
PLAN AT EL 0.0M



DETAIL-A



TYPICAL FOUNDATION PLAN FOR DRY TYPE TRANSFORMER



TYPICAL FIXING ARRGT. FOR BREAKER/MCC PANEL (FLOOR CUTOUT)

REFERENCE DRAWINGS :

S. NO.	TITLE	DRAWING NO.	SOURCE AGENCY
1.	PLOT PLAN	PE-DG-412-100-M001	PEM/ MPL
2.	MAIN PLANT EQUIPMENT LAYOUT PLAN	PE-DG-412-100-M002	PEM/ MPL
3	CROSS SECTION OF MAIN PLANT	PE-DG-412-100-M007	PEM/ MPL
4.	RECOMMENDED CONTROL ROOM LAYOUT FOR ESP	2-00-114-29869	BHEL/ RANIPET
5.	ELECTRICAL SINGLE LINE DIAGRAM	PE-DG-412-565-E001	PEM/ ELECT
6.	CABLE ERECTION PHILOSOPHY	PE-DG-412-507-E004	BHEL/ ELECT
7.	TYPICAL DETAILS OF CABLE TRAYS & ACCESSORIES	PE-DG-412-507-E005	BHEL/ ELECT
8.	INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM	PE-DG-412-507-E006	BHEL/ ELECT
9.	DESIGN PHILOSOPHY FOR ELECTRICAL EQUIPMENTS LAYOUT	PE-DC-412-507-E101	BHEL/ ELECT

NOTES :

1. ALL ELEVATIONS MARKED ARE W.R.T. T.G. HALL FINISHED FLOOR ELEVATION OF 0.0 M. WHICH CORRESPONDS TO RL +10.0M.
2. ALL DIMENSIONS ARE IN MM AND ELEVATIONS IN METRES UNLESS STATED OTHERWISE.
3. THE PANEL DIMENSIONS INDICATED IN DRAWING ARE TENTATIVE AND ARE SHOWN FOR DEVELOPING CONCEPTUAL LAYOUT.
4. SEPARATE DRAWING IS SUBMITTED FOR UNIT-2 ESP CONTROL ROOM.
5. THIS DRAWING IS TO BE REFERRED FOR DETAILS OF ELECTRICAL EQUIPMENT AND CABLING LAYOUT ONLY. LAYOUT SHOWN FOR FACILITIES SUCH AS AC & VENTILATION SYSTEM IS INDICATIVE & FOR INTERFACE PURPOSE. FOR EXACT LAYOUT OF OTHER SYSTEMS, RELEVANT DISCIPLINE DRAWINGS SHALL BE REFERRED.
6. ALL AREAS SHOWN IN THIS DRAWING ARE NON A/C UNLESS STATED OTHERWISE.
7. CABLE TRAYS & SUPPORTS INSTALLATION SHALL BE DONE AS PER REF. DRG. NO. 6, 7 & 8.
8. BOTTOM MOST/OUTERMOST TRAY OF ALL RUNS SHALL BE PERFORATED TYPE.

TABLE-I

S.NO.	EQUIPMENT	SOURCE
1	ESP SG	BHEL/RANIPET
2	EC	BHEL/RANIPET
3	DT TRANSFORMERS	BHEL/JHANSI.
4	NSP BUSDUCT	BHEL/CBU
5	ESP & ID FAN AREA MCCs	BHEL/CBU
6	AC & VENT MCC	BHEL/CBU
7	LDB	PEM/ELECT.

LEGEND

- OPERATING FRONT OF THE PANEL
- BRICK WALL
- CABLE TRAYS
- CABLE TRAYS
- DOUBLE LEAF DOOR WITH TRANSOM ARRANGEMENT
- D — SINGLE LEAF DOOR (1000Wx2100H)
- FPD — FIRE PROOF DOOR
- PERFORATED TYPE CABLE TRAY

Anshul — S A Khan — Praveen Kishore

CUSTOMER	TANGEDCO	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
CONSULTANT	DESEIN	DESEIN PRIVATE LIMITED, DESEIN HOUSE, GREATER KAILASH-II, NEW DELHI

JOB NO. 412 | STATUS CONTRACT | DRG./REF. NO. (INTERNAL) | PRINT SCALE IN METRE

2x660 MW ENNORE SEZ COAL BASED STPP
AT ASH DYKE OF NCTPS, CHENNAI

BHARAT HEAVY ELECTRICALS LTD.
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

REV.	DATE	ALTD	CHD	APPD

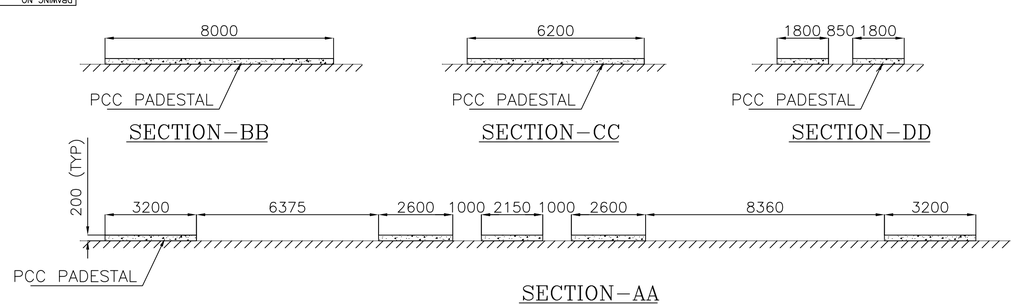
DEPT CODE		NAME	SIGN	DATE
DSN	AA			05.03.2015
DRN	AA			05.03.2015
CHD	SM/ SL			05.03.2015
APPD	RS			05.03.2015

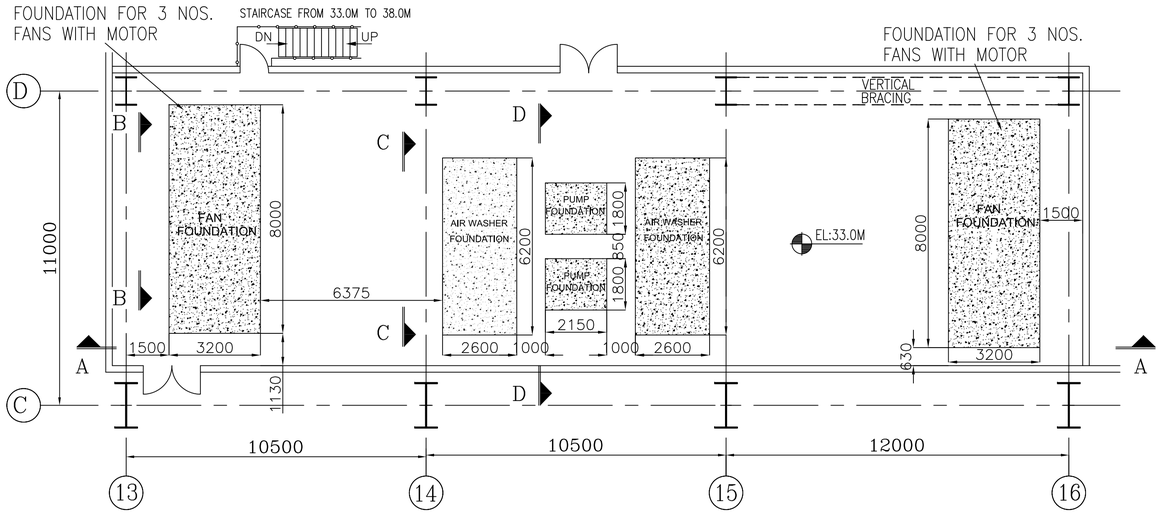
TITLE: ELECTRICAL EQUIPMENT & CABLING LAYOUT IN ESP CONTROL BUILDING (UNIT-1)

SCALE 1:100 | DRAWING No. PE-DG-412-100-E008 | SHEET 1 OF 1 | REV 0

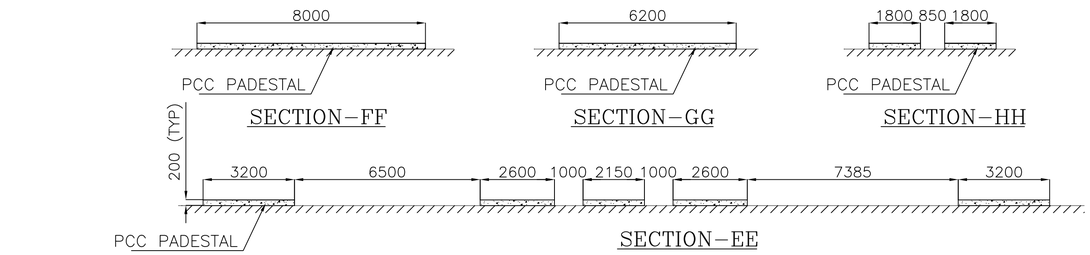
FORMAT SIZE A0

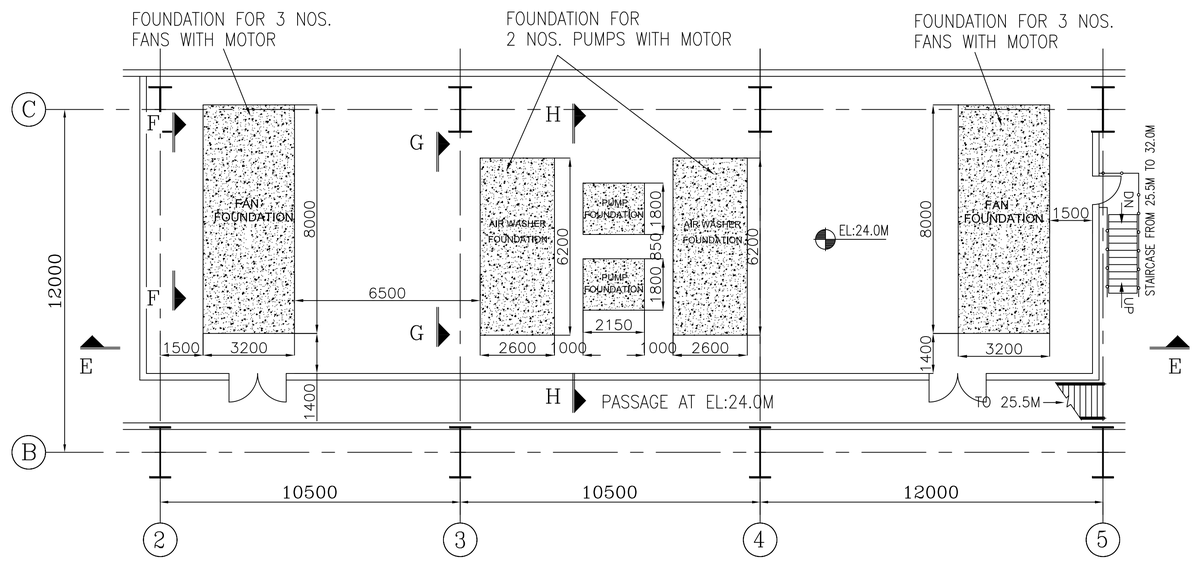
PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT
FIRST ANGLE PRJECTION
ALL DIMENSIONS ARE IN MM
DRAWING NO. PE-DG-412-554-A003



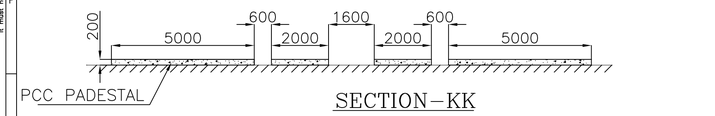


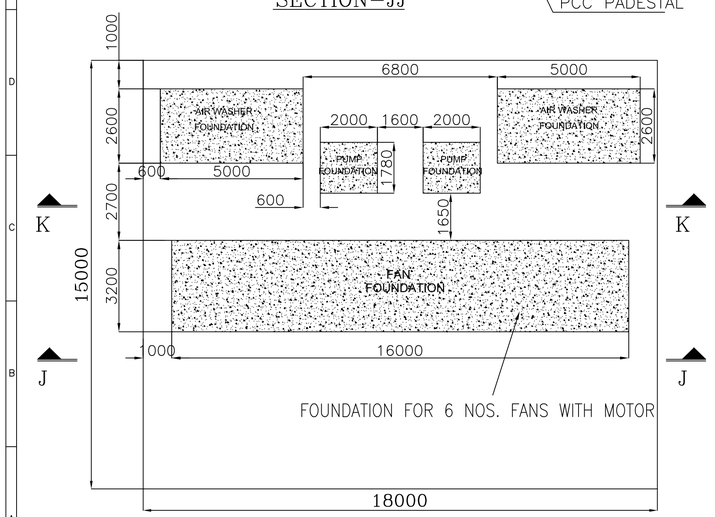
AIR WASHER ROOM AT EL+33.0M



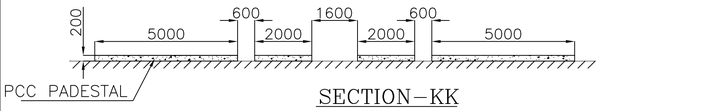


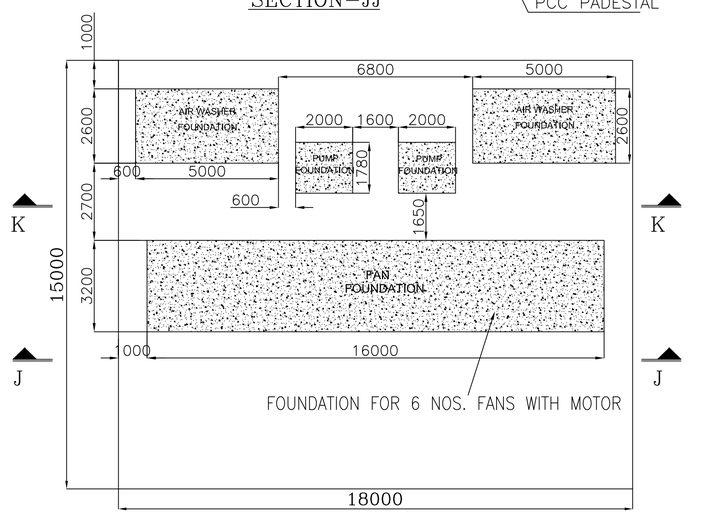
AIR WASHER ROOM AT EL+24.0M





AIR WASHER ROOM –1
OUT SIDE A ROW AT EL +0.0M





AIR WASHER ROOM –2
OUT SIDE A ROW AT EL +0.0M

GENERAL:–

1. FOUNDATION DIMENSIONS SHOWN IN DRAWING ARE TENTATIVE AND MAY CHANGE DURING DETAIL ENGINEERING.

NOTE:–

1. FLAT, PLATFORM TYPE RCC / PCC FOUNDATION SHALL BE PROVIDED FOR INSTALLING AIR WASHERS/FANS / PUMPS ETC.
2. BIDDER SHALL FIX THE EQUIPMENT USING PROPER ANCHOR FASTENER TO SECURE THE EQUIPMENT AND OBTAIN PARAMETER RELATED TO VIBRATION AND NOISE.

Anshul

S A Khan

Praveen Kishore

FOR TENDER ONLY

REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD

JOB NO. 412
STATUS CONTRACT
DISTRIBUTION
TO
No. OF

PROJECT: 2x660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI

CUSTOMER: TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)

CONSULTANT: DESEIN PRIVATE LIMITED
DESEIN HOUSE, GREATER KAILASH–II, NEW DELHI

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI

DEPT CODE		NAME	SIGN	DATE
M	DRN	AG	sd/–	29.04.2015
	DESN	AG	sd/–	29.04.2015
	CHD	SAK	sd/–	29.04.2015
	APPD	PK	sd/–	29.04.2015

TITLE: FOUNDATION DETAIL FOR VENTILATION EQUIPMENT

DEPT. | SCALE: 1:75 | DRAWING NO. PE–DG–412–554–A003
SIGN
DATE
SHEET 1 OF 1 | REV. R0
FORMAT: SIZE A0

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