TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LTD.

2X660 MW ENNORE Supercritical Thermal Power Project

VOLUME – II – B

TECHNICAL SPECIFICATION FOR

AIR CONDITIONING SYSTEM

SPECIFICATION NO.: PE-TS-412-553-A001 Rev 0

BHARAT HEAVY ELECTRICALS LIMITED

POWER SECTOR

PROJECT ENGINEERING MANAGEMENT

NOIDA, INDIA

Anshul S A Khan Praveen Kishore

VOLUME – IIB

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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 **AIR CONDITIONING 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 **AIR CONDITIONING SYSTEM.**

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

1.4 The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing. Similarly, the extent of supply also includes all tems 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: C 1

SPECIFIC TECHNICAL REQUIREMENT

1. FUNCTION

The purpose of the system is to provide air-conditioning system for different areas of 2 x 660 MW, Ennore STPP under the scope of BHEL.

2. SYSTEM DESCRIPTION

2.1 MAIN POWER HOUSE BUILDING- UNIT 1 & 2 (AC PLANT-1)

a) A Central Chilled water type air conditioning plant shall be provided to cater to the air conditioning requirements of the following areas.

- Central Control Room.
- EER Room
- Computer Room
- UPS Room
- SWAS Room (Dry panel)
- Shift in-charge room
- Office area, conference room etc.
- Any other area

b) The air conditioning plant shall comprise of 2 x 100% Screw Chilling machines. The condenser cooling water shall be circulated through these units by means of 2 x 100% horizontal split casing centrifugal pump sets and 2 x 100% FRP cooling towers. The chilled water produced by the chilling units shall be circulated to the air handling units by means horizontal centrifugal pump sets. These AHU shall be located in AHU rooms located adjacent to air-conditioned areas in Power House Building (AHU room shall contain multiple AHUs with 100% standby capacity. The conditioned air from AHUs shall be distributed to the air-conditioned areas by galvanised sheet steel ducting and extruded Aluminium grilles / diffusers with volume control dampers and supporting frames. The return air shall be led back to the AHU Room in ducts for air conditioned areas at 17.0M level in control tower. For balance areas, i.e air conditioned areas at 8.5M level in control tower for unit-1 & 2, the return air shall be collected above the false ceiling and led back to the AHU rooms which acts as mixing plenum for return and fresh air.

c) FCU shall be provided for SWAS room for Unit-1 & Unit-2 & AC Plant control Room.

d) Controls for the AC plant shall be PLC based.

2.2 ESP CONTROL ROOM FOR UNIT-1 (AC PLANT-2)

The air conditioning plant shall comprise of (2 x 100%) water Cooled direct expansion AC plant to air-condition areas in ESP Control Room. The conditioned air from water Cooled direct expansion type AC plant is distributed to the air-conditioned areas by galvanized sheet steel ducting and extruded Aluminum grilles / diffusers. The return air is collected above the false ceiling and led back to the AHU room which acts as mixing plenum for return and fresh air.

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2.3 ESP CONTROL ROOM FOR UNIT-2I (AC PLANT-3)

Same as AC Plant-2.

2.4 SERVICE BUILDING (AC PLANT-4)

Multiple Water cooled type Package AC shall be provided for each floor of service building. The conditioned air from these P.U shall be distributed to the air-conditioned areas by galvanized sheet steel ducting and extruded Aluminum grilles / diffusers. The return air shall be collected above the false ceiling and led back to the P.U room which acts as mixing plenum for return and fresh air

2.5 ADMINISTRATION BUILDING (AC PLANT-5)

Same as AC Plant-4

2.6 SPLIT TYPE AIR CONDITIONERS

Split type air conditioners (air cooled) shall be provided to cater to the air conditioning requirements of Compressor house control room areas having workstation for auxiliary plant. For areas requiring multiple working split ACs, One (1) No. standby (of same capacity) shall be provided. (Only those aux. control rooms which are under scope of BHEL). Local isolator / MCB shall be provided with split units.

Local Distribution Boards containing Switch / MCB shall be provided for Split Air Conditioners, and FCUs. Each split unit shall also be provided with suitable rating stabiliser.

Single phase electrical feeders of following ratings shall be provided for split units. Bidder to ensure the suitability as per these feeder requirement.

Capacity of Split AC	Single phase feeder
1.5 TR	2.2 KW
2TR	3.0 KW

3. DESIGN CRITERIA

3.1 SYSTEM DESIGN CRITERIA

For design parameters refer to clause 19.3 of section C-2A, customer specifications.

4. SYSTEM CAPACITY AND CONFIGURATION:

A) FOR AC PLANT 1:

2 x 300 TR Actual capacity water cooled screw chillers (1 working + 1 standby) shall be provided.

B) FOR AC PLANT 2:

2 x 30 TR Actual capacity water cooled screw type condensing units (1 working + 1 standby) shall be provided.

C) FOR AC PLANT 3:

Same as AC plant 2.

D) FOR AC PLANT 4 AND 5:

Multiple water cooled type Package AC shall be provided for each floor of service building.

5. LAYOUT CONSIDERATIONS:

A) AC PLANT-1

i. The central chilled water plant, condenser water & chilled water pumps for AC plant shall be housed in AC Plant Room at 0.0 M level between E - G Bay Power House Building.

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

1. AHU Room at 8.5 M level of Power House Building in C-D Bay for AC areas at 8.5 m level.
2. AHU Room at 24.0 M level of Power House Building in B-C Bay col 13-16 for AC areas at 17 m level.

iii. The Cooling Towers, Make-up water Storage Tank, Expansion Tank, shall be located at 33.0 M level in B-C Bay.

iv. 3 T electric hoist with monorail for AC plant shall be provided for the AC Plant room only for maintenance purpose by BHEL.

V. One no. of 2 T capacity chain pulley block shall be provided for each AHU room by BHEL. Bidder to develop the layout for provision of erecting of chain pulley block.

B) AC PLANT-2

i. Water Cooled direct expansion type AC units shall be housed in AC plant Room at 4.0 M level of ESP Building of Unit-1.

ii. AHUs shall be place inside AHU room at 4.0 M of ESP control room.

iii. The Cooling Towers, Make-up water Storage Tank, Expansion Tank, shall be located at 8.9 M level in B-C Bay

iv. One no. of 2 T capacity chain pulley block shall be provided for AHU room by BHEL. Bidder to develop the layout for provision of erecting of chain pulley block.

C) AC PLANT-3

Same as AC plant -2

D) AC PLANT-4

i. Multiple Water Cooled Package type AC shall be housed in PAC Room at each floor in service building.

ii. The Cooling Towers, Make-up water Storage Tank, Expansion Tank shall be located at roof of service building

E) AC PLANT-5

Same as AC plant -2

Note: The locations given above for different plants are tentative and may change during detail engineering.

6. SPECIAL CONSIDERATION

a) Water flow rate for chilled water pump selection : 0.7 cmh/TR

b) Water flow rate for condenser water pump selection : 1.0 cmh/TR

c) Condenser water pumps, chilled water pumps shall have further 10% margin on their flow capacities.

d) The IKW/TR of screw chillers shall not be more than 0.7 at 100%

e) All equipment shall be of high quality and high efficiency meeting the stipulated power consumption as defined elsewhere in the specifications.

f) Other technical details shall be as per relevant clauses of section C-2A, customer specifications.

7. EQUIPMENT DESCRIPTION

7.1 WATER COOLED SCREW CHILLER/CONDENSING UNIT

a) Refer to clause no. 19.6, 19.8.1 and other relevant clauses of section C-2A, customer specifications.

b) Accessories (valves, pressure gauges, water flow switches, controls and instruments etc. shall be provided with each screw chiller as per customer approved PID.

7.2 CONDENSER & CHILLED WATER PUMPS

a) Refer to clause no. 19.8.4 and other relevant clauses of section C-2A, customer specifications.

b) Accessories (valves, pressure gauges, water flow switches, controls and instruments etc. shall be provided with pump as per customer approved PID

7.3 AIR HANDLING UNIT

a) Refer to clause no. 19.8.2 and other relevant clauses of section C-2A, customer specifications.

b) Efficiencies of filter shall be as per clause no 19.8.5 of section C-2A, customer specification.

c) Motors shall be installed inside the AHU.

d) Accessories (valves, pressure gauges, water flow switches, controls and instruments etc. shall be provided with pump as per customer approved PID

e) Drain piping from the AHUs up to nearest drain point.

f) Serrated rubber pads for vibration isolation

g) Accessories (valves, pressure gauges, water flow switches, controls and instruments etc. shall be provided with AHUs as per customer approved PID

7.4 COOLING TOWER

a) Refer to clause no. 19.8.6 and other relevant clauses of section C-2A, customer specifications.

b) Accessories (valves, pressure gauges, water flow switches, controls and instruments etc. shall be provided with CT as per customer approved PID.

c) The Cooling tower shall be selected for

Design wet bulb: 28^0 C.

Cold water temp: 32^0 C.
Hot water temp: 36^0 C

7.5 AIR DISTRIBUTION SYSTEM

a) Refer to clause no. 19.8.7 and other relevant clauses of section C-2A, customer specifications.

b) For galvanising class refer to clause no. 19.3.23 of section C-2A, customer specification.

c) For fire damper refer to clause 19.8.7, 19.8.11 and other relevant clauses of section C-2A, customer specifications.

d) Motorized fire damper shall be installed at supply and return air duct at suitable locations where duct pass through wall & floors for ease of isolation, maintenance and as well as for emergency operation. Fire damper in the supply and return air duct shall close on receiving fire signal from fire protection system and shall also be possible manually from remote control panel. Necessary arrangement shall be incorporated in the duct for providing duct mounted multi- sensor detectors in the return air duct for all air conditioned areas. Also respective Air Handling Units, Air washers/UAFs shall trip on receiving fire signal from fire protection system.

7.6 INSULATION WORK

a) Refer to clause 19.3.25, and other relevant clauses of section C-2A, customer specifications

7.7 PIPING & VALVES

a) Refer to clause 19.8.8 & 19.8.9 and other relevant clauses of section C-2A, customer specifications

7.8 STRIP HEATING & HUMIDIFICATION PACKAGE

a) One common set of electrical strip heaters package of suitable capacity complete with contactor, airstat, humidistat (room or mounted on strip heater control box), safety thermostat, heater box with insulation etc. for winter heating and monsoon reheat, mounted inside the AC plenum/duct for each AHU Room. Refer to relevant clauses of section C-2A, customer specification.

b) One No. Pan humidification system comprising heater, humidistat, water tank, low level switch over flow, draining, make up connection, float valves etc. for each AHU Room. Other points shall be as per clause no. 19.8.11, and other relevant clauses of section C-2A, customer specifications.

7.9 NON CHEMICAL TYPE SCALE PREVENTER

a) Refer to clause 19.8.6, and other relevant clauses of section C-2A, customer specifications.

7.10 ELECTRICAL ITEMS

a) Refer to relevant clauses of section C-2A, customer specifications and section C-3, electrical portion of specifications.

7.11 FOR OTHER ITEMS REFER TO TO RELEVANT CLAUSES OF SECTION C-2A, CUSTOMER SPECIFICATIONS

8. CONTROL PHILOSOPHY

a) A common PLC based control system shall be provided for control of various equipment of AC plant and Air washers & UAF of ventilation plant. The system shall comply with clause no. 19.8.17 and other relevant clauses of section C-2A, customer specification.

b) The operation of the AC plant shall be done by microprocessor-based panel mounted on the chiller package. Further, overall control of both AC & ventilation system shall be done from common PLC based control panel located in the AC PLANT-1 Room. Control panel shall also be provided with solid –state annunciation, start-stop push buttons, indication lamps & interlocks. The AC Plant compressor can be started only when its associated condenser fan, chilled water pumps are in operation.

c) Chiller Package shall be provided with skid mounted microprocessor based control panel.

d) Stop / trip Annunciation for all the equipment (Fan, Pumps, Chillers and safety interlocks) shall be provided in local control panel.

e) All fire dampers shall be closed on getting signal from the respective fire panels. Necessary cabling required for the purpose shall be covered under bidder's scope. Further the respective AHU motor / PU motor shall stop on closure of fire damper.

8.1 SAFETY CONTROLS

All necessary measuring – control instruments & control system shall be provided. With following compressor & evaporator interlock in the control panel of the Chiller Package.

a) High discharge pressure cut-out (HP)

b) Low suction pressure cut out (LP)

c) Oil pressure cut-out (OP)

d) Chilled water flow switch

e) Anti-freeze thermostat (AFT)

f) Airstat / safety thermostat with heaters of the AHU's

8.2 OPERATING CONTROL

All operating control as necessary shall be provided. However following minimum control shall be provided. Central chilled water system shall have the following controls:

a) Automatic capacity control system.

b) Automatic unloaded starting device

c) Operating Thermostat

d) Unloading solenoid valves (if applicable)

e) 3 way flow control valve at the AHU's

f) Operation / Sequence Interlock of the Air conditioning system shall be as under:

g) Condenser fan is started.

h) The Air Handling Unit is started.

i) Chiller Pump is started

j) Chilling unit is started

8.3 INTERFACE WITH DCS

Following hardwired signals shall be provided in the DCS for monitoring purpose

a) Temperature & Humidity.

b) AC Plant On / Off Status.

c) Pump Run / Trip.

d) AHU Run / Trip.

e) General AC Plant Warning.

f) The operation of the air conditioners shall be done from local start–stop push button. Peripherals serial link shall be provided for the transfer of important signals to DCS in the central control room.

9. SPECIFIC REQUIREMENT

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

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

Sr. no.	Items	Motor rating (Kw)
1.	Screw Chiller	250
2.	Chilled Water Pump	37
3.	Condenser Water Pump	45
4.	AHU for Power House at 24.0Mtr.	45
5.	AHU for Power House at 8.5Mtr.	7.5
6.	Cooling Tower	15
7.	Fresh Air Fan	1.5

8.	Water Cooled PAC 15TR	15
9.	Water Cooled PAC 10TR	10

10. 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) All drawings and documents shall be computer based.

4) All commissioning spares & consumables for trouble free operation shall be provided Vendor to include level gauge & level switch for each tank for alarm & trip of the pumps. Also include one no. Pressure switch for each pump

5) 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.

6) 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.

7) 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.

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

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

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

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

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

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

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

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

16) Instrument for testing shall be calibrated by Air-conditioning plant supplier before taking up testing.

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

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

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

20) 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%.

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

22) 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.

23) For motorized fire damper / 3 Way valve actuators / motorised valves, power supply shall be derived by vendor from respective control panels. BHEL shall not provide any feeder for them. Suitable transformer shall be provided by bidder (if required) to derive the power input. Further distribution through junction box / distribution board shall be in vendor scope and shall have provision for isolation of individual fire damper/ valves.

24) Tender drawings enclosed form the part of specification and the bidder shall check the space requirements for installing the equipment as per the specification and layout requirements given in the specifications.

25) Bidder should suitably group the signals coming from various instruments etc. & 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.

26) 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.

27) 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.

28) 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.

29) 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.

30) Sealing of duct opening, grouting of foundation / foundation bolts etc. including special type of grouting like GPX2 etc. are in the scope of Air-conditioning system vendor.

31) Flat, platform type RCC / PCC foundation shall be provided for installing Chiller/ PUMP, AHU and FAN etc. Vendor shall fix the equipment using anchor fasteners to secure the equipment obtain parameters related to vibration and noise.

32) 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.

33) RCC foundation of cooling tower shall be provided by BHEL. However, steel beam / joist etc as required shall be supplied by air-conditioning plant supplier.

34) Air-conditioning plant supplier to furnish drawings/ documents as per the dwg. / documents distribution as per project requirement.

35) 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.

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

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

38) The bidder shall furnish complete tech. Particulars in data sheet and schedules as specified elsewhere in the specification.

39) Necessary duct mounted Booster fan (if required) to maintain the static pressure for Precision AC shall be provided without any implication.

11. EXCLUSIONS

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

a) Construction of AC plant room, air handling unit room, foundations for AC equipment's.

b) False ceiling, drop ceiling.

c) Slab cut out for running ducts, pipes, cables, grilles/dampers. Underground masonry trenches and masonry risers. However minor civil work like making opening to suit / finishing of opening, sealing of duct opening, grouting of foundation bolts including special type of grouting like GPX2 etc. are in the scope of AC system vendor.

d) Provision of drain traps / points,

e) For Electrical scope, refer Electrical scope matrix sheet.

12. CODES AND STANDARDS

Design, manufacture, inspection and testing of the equipment covered by the specification shall unless otherwise specified conform to the latest edition of the standards and codes including all addenda mentioned below:

IS-659	: Safety code for air-conditioning
IS-660	: Safety code for mechanical refrigeration
ASHRAE-23	: Standard method of testing and rating [67 Standards] air conditioner.
ARI-450-6	: Standards for water cooled refrigerant Condenser.
ASME Sec. VII	: Unfired pressure vessels
IS-4503	: Shell and tube type heat exchanger.
ASHRAE 22-72	: Method of testing for rating water cooled refrigerant condenser.
ASHRAE-15-2007	: Safe Standard for Refrigeration System
ASHRAE-30-1995	: Method of testing liquid chilling packages
ANSI-8-31.5	: Refrigeration piping.
ANSI-8-9.1	: Safety code for mechanical refrigeration.
AR1-410	: Standard for air cooling and air heating coils.
AR1-210	: Standard for unitary air conditioning equipment.
IS-3588	: Specification for electrical axial flow fans.
AMCA-210	: Methods of performance test for fans.
BS-2831	: Methods of test for air filters used in AC and general ventilation.
IS-4671	: Expanded polystyrene for thermal insulation purpose.

IS-702	: Industrial bitumen
IS-1239	: Heavy class Pipes for sizes up to 150 mm dia.
IS-8188	: For Water conditioning
IS-325	: 3 phase induction motors
IS-4029	: Guide line for testing 3 phase induction motor
IS-210	: Specification grey iron casting
IS-2062	: Structural steel
AMCA – Bulletin No. 210 flow fans	: Standard code of testing centrifugal and axial
IS-2825	: Code of practice for welding mild steel
IS-2676 sheets and strips.	: Dimensions for wrought aluminium and aluminium alloy
ASHRAE Code	: For various filter
ASHRAE-62-2004	: Ventilation rates
IS-655	: Specification for metal air ducts

Pump design and testing should correspond to the procedure mentioned in IS-1520

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	

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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.			

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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 : **Bidder :** **Bidder No. :** **System :**			**Stage :**		**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**

Anshul

S A Khan

Praveen Kishore

ANNEXURE-VII

MFGR.'s LOGO	SUPPLIER'S NAME AND ADDRESS	FIELD QUALITY PLAN					PROJECT : PACKAGE : CONTRACT NO. : MAIN-SUPPLIER:				
		ITEM : SUB-SYSTEM :		QP NO.: REV.NO.: DATE: PAGE: …. OF….							
SL. NO	ACTIVITY AND OPERATION	CHARACTERISTICS / INSTRUMENTS	CLASS# OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		REMARKS	
1.	2.	3.	4.	5.	6.	7.	8.	9.	D*	10.	
		LEGEND: * **RECORDS**, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. **LEGEND TO BE USED: CLASS #: A = CRITICAL, B=MAJOR, C=MINOR;**					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**

Anshul

S A Khan

Praveen Kishore

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		

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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		

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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		

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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			

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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**			

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**					

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**					

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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		

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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		

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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			

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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				

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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.		

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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 %

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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				

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** _____

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Amendment to

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

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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)				

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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				

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				

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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 →			

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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

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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)			

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 _____

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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

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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	

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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	

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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	-----	

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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.**

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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 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			

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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		

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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	%		

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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	%		

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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	%		

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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.			

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		

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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		

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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	%		

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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			

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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		

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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		

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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			

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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	%		

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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**			

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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					

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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		

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				

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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				

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	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 _____

SEAL OF THE COMPANY **DESIGNATION** _____

COMPANY _____

DATE _____

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				

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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)				

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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				

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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				

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**		

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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			

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

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 _____

SEAL OF THE COMPANY **DESIGNATION** _____

COMPANY _____

DATE _____

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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.

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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

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(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

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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 :

$$\text{HEAT RATE} = \frac{M1\,(H1-h1) + M2\,(H3-H2) + Mis\,(h1-his) + Mir\,(H3 - hir)}{Pg}$$

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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

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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.	

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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).

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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) ELECTRICAL SYSTEM

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)

TRANSFORMER LOSSES

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

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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

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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

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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.

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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)

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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(%)

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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.

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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).

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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

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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)

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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.

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(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.

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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.

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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

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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)

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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)

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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

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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

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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.

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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

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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.

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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 120^0C, upto 200^0C, 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)

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 Technical requirements shall be as per specifications listed in Clause 4.1, 4.2, 4.3, 4.4 & 4.5. 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 AC 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 Technical specification – Customer specification - Motors
4.3 BHEL standard specification for LT motors : PE-SS-999-506-E101
4.4 Datasheets – A and C
4.5 Quality Plan for motors.
4.6 Load data format (Annexure-II).

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGES : AIR CONDITIONING
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	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.
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.
9	Lighting	BHEL	BHEL	
10	Equipment grounding (including electronic earthing) &	BHEL	BHEL	Refer note no. 4 for electronic earthing

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ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGES : AIR CONDITIONING

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

PROJECT: 2X660 MW ENNORE TPP

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
	lightning protection			
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.

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.

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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.

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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.

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.

SPECIFIC ELECTRICAL REQUIREMENT FOR AIR CONDITIONING 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		80%
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.
BHEL	MOTOR DATA SHEET - C	VOLUME II B SECTION D REV NO. 00 DATE 29/08/2005 SHEET 1 OF 2

S. No.	Description	Data to be filled by successful bidder
A.	**General**	
1	Manufacturer & country of origin	
2	Motor type	
3	Type of starting	
4	Name of the equipment driven by motor & Quantity	
5	Maximum Power requirement of driven equipment	
6	Rated speed of Driven Equipment	
7	Design ambient temperature	
B.	**Design and Performance Data**	
1	Frame size & type designation	
2	Type of duty	
3	Rated Voltage	
4	Permissible variation for	
5	a) Voltage	
6	b) Frequency	
7	c) Combined voltage & frequency	
8	Rated output at design ambient temp (by resistance method)	
9	Synchronous speed & Rated slip	
10	Minimum permissible starting voltage	
11	Starting time in sec with mechanism coupled	
12	a) At rated voltage	
13	b) At min starting voltage	
14	Locked rotor current as percentage of FLC (including IS tolerance)	
15	Torque	
	a) Starting	
	b) Maximum	
16	Permissible temp rise at rated output over ambient temp & method	
17	Noise level at 1.0 m (dB	
18	Amplitude of vibration	
19	Efficiency & P.F. at rated voltage & frequency	
	a) At 100% load	
	c) At 75% load	

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

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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			

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	QUALITY PLAN		CUSTOMER :			PROJECT 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	W	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			

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	QUALITY PLAN		CUSTOMER :			PROJECT 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	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	MFG. DRG. SPEC.	RELEVANT IS	SUPPLIER'S TC	3	-	2	
		3. DIMENSIONS	MA	MEASUREMENT	100%	-DO-	MANUFR'S DRG.	LOG BOOK	3	-	2	
		4.INTERNAL FLAWS	CR	UT	-DO-	ASTM-A388	MANUFR'S SPEC. BHEL SPEC.	-DO-	3	2	1	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		
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	DATE		BIDDER'S/VENDORS COMPANY SEAL

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	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 3 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY 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	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

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	QUALITY PLAN	CUSTOMER :	PROJECT TITLE	SPECIFICATION : NUMBER :
		BIDDER/ VENDOR :	QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03	SPECIFICATION : TITLE
	SHEET 4 OF 9	SYSTEM	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)	SECTION VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY 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	
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	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

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	QUALITY PLAN	CUSTOMER :	PROJECT 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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	SIGNATURE		
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	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 6 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY 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**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

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	QUALITY PLAN	CUSTOMER :	PROJECT TITLE	SPECIFICATION : NUMBER :
		BIDDER/ VENDOR :	QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03	SPECIFICATION : TITLE
	SHEET 7 OF 9	SYSTEM	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)	SECTION VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY 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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	SIGNATURE		
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		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			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	
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	SIGNATURE		
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	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 9 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11

NOTES:

1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED.

2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON.

3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THESE TEST MAY NOT BE REPEATED.

4 WHEREVER CUSTOMER IS INVOLVED IN INSPECTION, AGENCY (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER.

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

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	QUALITY PLAN	CUSTOMER :			PROJECT 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			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	

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	QUALITY PLAN	CUSTOMER :		PROJECT 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	W	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

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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

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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)

भेल BHEL	LOAD DATA (ELECTRICAL)	JOB NO.	412	ORIGINATING AGENCY		PEM (ELECTRICAL)
		PROJECT TITLE	2X660MW ENNORE TPP	NAME		DATA FILLED UP ON
		SYSTEM / S	AIR CONDITIONING SYSTEM	SIGN.		DATA ENTERED ON
		DEPTT. / SECTION		SHEET 1 OF 1	REV. 00	DE'S SIGN. & DATE

SECTION: C-4
TECHNICAL SPECIFICATION (C&I PORTION)

C&I SPECIFICATION
FOR
AIR CONDITIONING SYSTEM
FOR
2X660 MW ENNORE SEZ STPP

DESIGN	AC
CHECKED	SK/SCS
APPROVED	SCS
REV- 00	DATE 23.03.15
JOB NO.	412

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A.GENERAL

&

SPECIFIC

TECHINICAL

REQUIREMENT

FOR

AC 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):

The control of Air Conditioning System Plant shall be through PLC based control system having hot redundant Central Processing Unit. The control of Ventilation system shall also be through above PLC based system. The operation and control philosophy of Air Conditioning System has been elaborated in separate section in the specification. The PLC shall be common for both units, and shall be located in AC Plant Control Room. One no. OWS with 24" LED monitor with anti-glare coating, one no. Operating cum engineering station with redundant hot standby processor with one no. A4 size B/W Laser jet printer & A3 sized Dot Matrix Printer shall be provided by the bidder for operation & monitoring of the Air Conditioning System and Ventilation system. In addition to OWS operation, Back up control desk with colored Process mimics, Hardwired annunciation system , required Push Button arrangements in Back Panel for complete operation of the systems, ammeters, process parameters indicators, LED based indication lamps etc. shall also be provided. The Complete PLC based control system with OWS, Laptop, Remote I/Os, Printer, UPS (for PLC, OWS, Remote I/Os, Printer etc.), desk along with furniture for Air Conditioning System and Ventilation system shall be in Bidder's scope. PC for OWS shall be of workstation grade. Additional laptop shall be provided with the AC system individually.

1. Bidder to consider I/Os for ventilation system in offered PLC. Same shall be finalized during detail engg.

2. Bidder to keep the provision for accepting fire signals from Fire Alarm & Protection System and the closure of relevant fire dampers in Air Conditioning and Ventilation System.

3. The communication between PLC and Main plant DCS shall be OPC compliant (Data Access 2.0) TCP/IP on Fibre Optic link. The communication link between PLC and Main plant DCS shall be redundant. The necessary hardware/software including LIU (Light Interface unit) at PLC end shall be in Bidder's scope. Repeaters if required for interfacing shall also be provided by the bidder. For communication between main plant DCS and PLC, the PLC end shall be considered as server and DCS shall be considered as client.

4. PLC control system shall be time synchronized with the Master clock system of the main plant to ensure uniform time indication

throughout the Plant. The required provision (IRIG-B) shall be made by the bidder at the PLC end to achieve the same.

5. The software and hardware for offered PLC system shall be of latest version and shall be upgradable. Bidder to ensure the availability of spares and service support for the offered PLC system for minimum 15 years after guarantee period.

6. All electrical actuators shall be conventional of integral starter type.

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. 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.

11. Provision for redundant soft interfacing and Hardwired interfacing shall be included for signal exchange between Air conditioning PLC and chiller's Microprocessor based control panel.

12. 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.

13. UPS (Common) for PLC & OWS shall be in bidder's scope with 2X100% configuration. UPS shall have 2X100%, Ni-Cd type battery bank with 60 min back up.

14. Bidder shall provide Customer training on the proper application and maintenance on PLC Hardware & Software at Vendor's work or at Ennore SEZ site. Duration of the training, number of persons & the topics to be covered shall be discussed & mutually agreed during contract finalization stage.

15. Following documents to be furnished by the bidder along with the bid:

- Proposed PLC system configuration drawing with write-up
- Duly stamped and signed copy of Quality Plan.
- Product catalogues and specifications for PLC as well as HMI application.
- Requirement of electronic earthing, if any, for PLC based control system

16. Complete Industrial grade furniture required for placing OWS, 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.

17. 8 Nos. temperature elements/sensors in AC control room shall be provided for monitoring the room temperature. Temperature & humidity monitoring system shall be in bidder's scope.

18. Bidder to comply with codes and standards as mentioned in the specification.

19. Bidder shall provide the necessary hardware & software required for connecting the PLC system to Bidder's remote service centre, through which the diagnostics & fault analysis of the PLC system can be carried out. The method of connection shall be as per Bidder's standard practice. However, it is preferred to have the connection through a single point in the PLC system.

20. Bidder shall provide an unlimited warranty on all equipment and software 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.

21. PLC network shall have Intrusion Detection System (IDS) and Intrusion Prevention System (IPS) with following features:

In order to inspect all inbound and outbound network activity and identify suspicious patterns that may indicate a network or system attack from someone attempting to break into or compromise a system on the Station LAN Network, the recommended IDS/IPS should contain the following combined features. Any feature can be selected depending on whether it is to be configured as IPS or IDS.

i. Able to analyze, detect and report on security related events.
ii. Able to inspect traffic and to drop malicious traffic based on the configuration of security policy.
iii. Able to inspect the content of network packets for unique sequences/signatures.
iv. Able to detect and prevent known types of attacks such as worm or Trojan infections and hacks.
v. Able to prevent denial of service (DOS) and Distributed Denial of Service attacks.
vi. Able to prevent abnormal behaviors by monitoring and learning normal network behaviors.
vii. Keeps up-to-date on new threats and vulnerabilities.
viii. Should provide user friendly interface to queries and reports on threats and event data so that security administrators can gain a better understanding of their ability to protect their network.
ix. Should provide detailed activity logs for auditing.
x. Able to detect known threats via deep-packet inspection.
xi. Able to defect unknown threats via anomaly scanning.
xii. Able to detect unknown threats via behavior pattern to protect from zero day.

22. All local gauges , transmitters and switches shall be mounted on suitable enclosures, racks subject to owner's approval. All transmitters shall be HART compatible.

23. Bidder to delegate /depute their persons/experts as per owner/consultants' requirement.

24. Bidder must offer general tools and tackles and special calibration instruments required during start-up, trial run, operation and maintenance of the system.

25. The above given scope is indicative & minimum. Any item/ equipment not indicated above however required for the completeness of the system is to be supplied by bidder without any technical, commercial and delivery implication to BHEL.

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GENERAL

1. The specification hereunder provides a general guideline for Control & Instrumentations to be provided for the Plant auxiliary systems and Off Site Plants. Bidder shall provide functionally independent & geographically distributed PLC (Programmable Logic Control) based control & Instrumentation system with all control equipment, instruments, accessories, cables and erection hardware for safe, efficient and reliable operation of the plant.

2. Each of the Plant Auxiliaries & off site systems shall be provided with annunciation system. It shall be an integral part of the control system. All the field contact for this purpose shall be acquired through control system. The annunciation sequence/logic shall conform to ISA sequence ISA-2A. The window lamps for the system shall be driven through output modules of the control system.

3. Remote Terminal Units (RTUs) have been envisaged for data acquisition function. Bidder shall provide necessary RTUs comprising of Input / Output modules, Processor etc., signal cable for interface with PLC panel, communication cables, and erection hardware's and other software & hardware for complete functioning of the off - site plants.

4. The instrumentation to be provided for each of the plant auxiliary & Off Site Plant systems shall be as per the technical specification document / drawings wherever provided for the respective systems as a minimum requirement for bidding purpose. However, for completeness of each of the plant auxiliary & Off Site system and its associated equipment, Bidder shall also provide all the necessary instruments to the process requirement even if it is not specifically indicated in the given technical Specfication document / drawings.

5. The instrumentation, operation and control philosophy proposed is specific to the plant design. Any improvement over the proposed typical Control & Instrumentation scheme shall be accepted so long as it does not deviate from the basic intent and general philosophy enumerated herein and elsewhere in this specification.

6. Plant auxiliaries / Off Site Plants shall be operated from their respective local control panels or Operating work stations located in the local area control rooms. Some of the auxiliaries will have operational facility from central control room as well as from local panels. All the PLC's of Ash Handling, DM-RO plant, Service water pump house, Compressor Plant, Condensate polishing unit, Fire Water Pump house etc., shall have digital data communication connectivity with DDCMIS already detailed/discussed in chapter 4. The control system for each of the Plant auxiliaries, Off Site Plant and their Man machine interface requirement and DDC MIS interfaces in the central control room shall be as follows:

   i. Considering the high ambient noise and electromagnetic interference prevailing in power plant, it is recommended that all links between off-site controls and plant DDC MIS shall be based on Dual Optical Fiber Communication (OFC) medium. Necessary ports / converters shall be provided at both ends.

   ii. PLC and RTU shall be designed for operating in a non air-conditioned harsh environment also. Communication media shall be optical fiber cable with MODBUS / OPC protocol between DDCMIS and PLC as per requirements. Optical cable, PLC end Modem/Converter and DDCMIS end Modem/Converter shall be supplied by bidder at both end. Optical cables shall be routed through GI conduit pipes. Communication protocol between the Modems shall be RS485/Modbus and the maximum communication time for receipt of signal at DDCMIS end should not exceed 2 seconds. The Communication links shall be as per chapter 4.

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iii. In addition Hard wired signal interfacing shall also be provided for any signal required for interlock, control & protection. Similarly cable for hard ware signal transfer between DDCMIS and PLC/relay based control system shall be supplied, laid terminated by the bidder including preparation of cable schedule. Quantum of hard wired signals for linking each PLC based system and DDCMIS shall be decided during detailed engineering,.

7. Bidder will provide necessary separate industrial grade parallel redundant UPS power supply with 60 minutes battery backup for each PLC, Operating station & printer etc. Bidder shall provide necessary separate industrial grade parallel redundant 24 volts DC charger with 60 minutes battery backup for each PLC without Operating station . Bidder shall have to provide necessary cabling for redundant power supply to UPS / charger.

8. Whenever control system is PLC based, annunciation system shall be driven by PLC via Digital output. Mimic LED shall also be driven from PLC digital output. For other relay based control systems, solid-state annunciation system shall be provided. Mimic acrylic sheet thickness shall be min 6-7 mm.

9. For each PLC system, without OEWS (Operating Engineering Work Station), Laptop along with software shall be provided for engineering (Laptop shall be separate for each PLC with out OWES).

10. PLC system without OEWS (Operating & Engineering Work Station) shall have panel mounted push buttons, lamps, H.W. annunciation, indicators, Ammeters and MIMIC etc for operation & control purpose except specifically requirements of control desk mentioned for any package listed above.

11. All the PLC control system shall be of same make, model & same family and shall be supplied directly from manufacturer/vendors. PLC system supplied /engineered by system houses shall not be acceptable. It is preferred to have same family of Plant DDCMIS .

12. All remote I/O cards shall be with IP-65 protection class and should withstand upto 70 deg.C temperature.

13. All cables terminated in the terminal block, power distribution scheme instruments shall be ferruled. Ferruling shall be double cross ferruling (i.e.) source and destination addresses shall be marked on both sides of the tube ferruling.

14. Any Package not listed above shall be PLC (redundant hot standby controllers) controlled with one no. OWS, one no. OEWS (Operating & Engineering Work Station) and one no. A4 B/W LJP.

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15. Bidder shall provide local panel for local start/ stop monitoring of auxiliaries and equipment as per requirement .The requirement shall be decided during detailed engineering. All local panel shall be NEMA 4X with canopy.

16. Bidder shall provide ammeters, voltmeters, PB indicating lamp, mimic, electrical scheme, indicators, chartless recorders and HW annunciations on the desk/ panels as requirement and shall be decided in detailed engineering.

17. PLC supplier shall prepare graphic for the complete plant with proper tag nos. for drives, binary inputs, analogue inputs, status of drives etc for the soft link for DDCMIS as per format of DDCMIS.

18. Each PLC/Microprocessor based system/electrical system shall be time synchronized with master clock system. Redundant Time synchronisation signals shall be provided for each control system, wherever redundant controllers/processors are provided.

19. Each subsystem PLC shall be provided with HW interfacing with main system PLC for signals used for command, interlocks, protections and other importants process parameters.

20. Control, operation & monitoring of electrical distribution system, namely PCC, Bus coupler, Incomer, breakers etc. for respective plant BOP package shall be controlled & operated from its respective PLC operating station/ backup control desk as well as from respective switchgear unit. Control system for the same shall be implemented in the respective PLC envisaged in the local control room. Bidder shall consider all transducers for monitoring of voltage, current, Kwh, power factor at respective PLC operating station and backup control desk. All signals shall be hardwired only.

21. The technical particulars & requirements of PLC, OWS, Printers, LVS and all other related hardwares/softwares shall be as per Vol. V, Chapter 4.

22. The technical particulars & requirements of UPS & 24 V DC systems shall be as per Vol. V, Chapter 7.

(Refer PLC System Configuration Drawings, # 114-01-0000, 0101, 0105, 0107, 0111, 0113, 0114 & 0116, In case any ambiguity between System Configuration Drawings & above Annexure A, Annexure A shall prevail for finalizing the PLC configuration).

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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.

B.C&I DELIVERABLES

FOR

AC SYSTEM

LIST OF DELIVERABLES OF PEM - C&I DEPARTMENT FOR AC 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-V9-412-553-I901	INSTRUMENT DATA SHEETS	A	-	VENDOR	C&I	
2	PE-V9-412-553-I902	INSTRUMENT SCHEDULE	I	-	VENDOR	C&I	
3	PE-V9-412-553-I903	INSTRUMENT INSTALLATION/ HOOK UP DIAGRAMS	A	-	VENDOR	C&I	
4	PE-V9-412-553-I904	FIELD JB TERMINATIONS /GROUPING DOCUMENT	I	-	VENDOR	C&I	
5	PE-V9-412-553-I905	QUALITY PLANS (CV,FE, Tx and Analyser)	A	-	VENDOR	C&I	
PLC PANEL							
1	PE-V9-412-553-I906	PLC CONFIGURATION DRAWING	A	A	VENDOR	C&I	
2	PE-V9-412-553-I907	PLC PANEL GA (INTERNAL & EXTERNAL) DRAWING	A	-	VENDOR	C&I	
3	PE-V9-412-553-I908	CONTROL SCHEMES (BLOCK LOGIC)	A	-	VENDOR	C&I	
4	PE-V9-412-553-I909	PLC INPUT / OUTPUT SIGNAL LIST	I	-	VENDOR	C&I	
5	PE-V9-412-553-I910	UPS BATTERY CHARGER/ BATTERY DATASHEET & SLD	I	$$	VENDOR	C&I	
6	PE-V9-412-553-I911	UPS SIZING CALCULATIONS	I	-	VENDOR	C&I	
7	PE-V9-412-553-I912	BATTERY SIZING CALCULATIONS	I	-	VENDOR	C&I	
8	PE-V9-412-553-I913	CONTROL DESK LAYOUT / GA DRAWING	A	-	VENDOR	C&I	
9	PE-V9-412-553-I914	PLC-OWS/PRINTER FURNITURE BOM	A	-	VENDOR	C&I	
10	PE-V9-412-553-I915	PLC CONTROL ROOM LAYOUT DRAWING	A	-	VENDOR	C&I	
11	PE-V9-412-553-I916	PLC CATALOGUE	I	-	VENDOR	C&I	
12	PE-V9-412-553-I917	PLC QUALITY PLAN & FAT PROCEDURE	A	-	VENDOR	C&I	
13	PE-V9-412-553-I918	LIST OF SIGNAL EXCHANGE WITH DDCMIS (BOTH HARDWIRED & SERIAL INTERFACE IN BHEL FORMAT)	A	`	VENDOR	C&I	
14	PE-V9-412-553-I919	PROCESS GRAPHIC MANUSCRIPTS PLC	I	-	VENDOR	C&I	
15	PE-V9-412-553-I920	PROCESS GRAPHIC MANUSCRIPTS FOR DDCMIS	I	-	VENDOR	C&I	
16	PE-V9-412-553-I921	CABLE SCHEDULE (IN BHEL EXCEL FORMAT) & CABLE INTERCONNECTION DETAILS	I	-	VENDOR	C&I	
17	PE-V9-412-553-I923	PANEL & ELECTRONIC EARTHING REQUIREMENT	I	-	VENDOR	C&I	
18	PE-V9-412-553-I924	PANEL HEAT DISSIPATION DATA	I	-	VENDOR	C&I	
19	PE-V9-412-553-I925	MANDATORY SPARES BILL OF MATERIAL	A	A	VENDOR	C&I	
20	PE-V9-412-553-I926	PLC O & M MANUAL	I	-	VENDOR	C&I	
21	PE-V9-412-553-I927	PLC EARTHING SCHEME	I	-	VENDOR	C&I	
	Notes:	412 - Project No.					
		553 -SI No of MAX Package (AC SYSTEM)					
		$$ -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.

Anshul

S A Khan

Praveen Kishore

C.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

D.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 ± 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.

3.03.42 **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	:	$\pm$ 1 percent (class 1)
Indication	:	Pointer with scale
Magnetic Shield	:	Shielded Case
Quantities	:	For all HT Motors & LT motor with rating $\geq$ 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	:	$\pm$ < 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

E.SPECIFICATION

FOR

PLC

4.02.00 Control System Basic Features/Design Requirements

4.02.01 Design Requirements

1. The instrumentation and controls shall be designed for maximum availability, reliability, operability and maintainability.

   All components shall function in a satisfactory manner within their rated capacity under the specified conditions during the continuous service life of the plant.

2. All like instrumentation, control hardware, control and protective system should be of same make and model no. in order to achieve the goal of consistent control philosophy and to minimize the diversity of I&C equipment & spares.

3. Control system shall comply with following general failure criteria :

   a. No single fault can cause the complete failure of the control system.
   b. No single fault can cause the boiler or turbine/generator protection system to malfunction or become inoperative.

c. The grouping of control functions into system blocks shall be arranged such that failure of any one block will only partly degrade the control of the overall system. Such degradation shall always be manageable by operator intervention.

d. The control system shall be structured to reflect the redundancy provisions of the plant so that no single fault within the control system can cause the failure of the duty equipment or make the standby equipment unavailable. Start command or stop command/trip command towards safety of process or process equipment shall be hardwired parallel from the **two different DO cards.**

e. As a result of a control system fault, a plant item or control function shall always respond to its controls at the actuator level (i.e., remote manual control). That item or control function shall be required to be isolated from automatic control system.

f. No single random fault in the entire automation and control system will cause a load loss, forced outage or unit trip.

g No two simultaneous faults shall lead to or potentially cause damage to plant

h Safety related instrumentation and control shall be designed with a fail-safe mode.

i No single fault shall jeopardise the functioning of the entire system.

j The control and automation system and the field instruments and actuators as well as it's support systems, power supplies and data networks shall be immune to the electromagnetic interference and shall conform to the internationally accepted standards.

k To meet the operational and safety requirements, the control system hardware and software shall conform to a modular, hierarchical architecture.

l When more than one device utilizes the same measurement or control signal, the transmitter and other components shall be fully equipped to provide all signal requirements without overloading and with proper isolation. Transmitters required to serve multiple receivers shall be arranged so that disconnecting, shorting or grounding of one receiver device shall not have any perceptible influence on any other consumer point of the same signal nor shall change the transmitter calibration.

4. Distributed control equipment shall employ modern distributed microprocessor based technology, as required to comply with the project specification and the DDCMIS system should not be more than 5 year old. A truly integrated DCS is envisaged with all the self sustaining subsystems communicating with each other over the bus network and thus ensuring that the system has a truly global data base.

5. The active control system including the plant protection system is the heart of the DCS system and therefore most stringent safety, availability and reliability

requirements have to be fulfilled by this subsystem. The bidder must bring out very clearly in his proposal how he intends to satisfy these requirements.

6. The control system shall be functionally distributed, (For Boiler, TG and BOP and similarly the control for 2 similar equipments like ID Fan A, B and C should be in different controllers & I/O cards) highly modular and arranged to reflect the functional grouping plant equipment and systems to be controlled. This functional group control strategy shall also form the basis for the partitioning of the controller to enhance the system reliability and flexibility. In case of redundant Analogue and Binary Signals, these will be connected to different input modules and different CPU. Similarly whenever inputs are more than one and needs temperature and pressure correction, the same shall be carried out in different CPU.

   In case of redundant/multi Pumps/Drives for same service, all related Inputs & outputs of main pump/drive shall be in separate I/O cards and similarly all related Inputs & outputs of respective standby pump/drive shall be in separate I/O cards. Inputs/outputs of any two same services pumps/drives shall not be mixed in one common I/O card.

7. To meet the above failure criteria at sr. no. 3, the I&C system shall incorporate self-checking facilities so that internal faults can be detected within the system itself prior to any resulting disturbance to the process. In addition, the protection and safety systems shall incorporate channel redundancy or diversity of measurement as well as self-checking and adequate test facilities. For some important systems, “on line” test shall be employed with no effect to the proper functioning of the protection system.

8. In order to make sure that the DDCMIS is an extremely user friendly system a centralized engineering subsystem is envisaged. An integrated subsystem has to be provided which takes over the complete task of planning, I/O allocation, generation of function schemes and wiring documentation (in design stage) and finally the automatic linking and loading of the planned functions in the target hardware.

   The complete engineering of all the automation and data acquisition functions should be possible from this central tool. This shall included all modulating and sequence control functions as far as the automation is concerned, generation of plant graphics, logs and other MMI functions. In addition the central engineering system must support all service, maintenance and commissioning assistance functions.

9. For protection applications, multi-channel measurements shall be provided incorporating 2 out of 3 trip action. Facilities for the on-line testing of each independent channel shall be provided without loss of protection. Each measurement channel shall include discrete transmitters and instrument loops, i.e. multi channel measurement of the same process variable shall not be derived from common instrument. As per NFPA, Triple supply viz.240VAC UPS, 24 V DC and 220 V DC shall be ensured for critical Boiler and Turbine protection.
   Both redundancy and diversity of trip criteria shall be considered to achieve sufficient guarantee against non operability or unnecessary operation of the

protection system. The principle of de energized to trip (Fail safe logic) shall be adopted.

10. Individual control elements shall be equipped with permissive to prevent the in-appropriate operation of the item and “active interlocks” to trip the item in case of dangerous operation conditions.

11. Each of the multifunction controller together with its I/O and drive level control modules is to be understood as a self sustaining automation island, which executes the function allocated to it independently and is not affected by a disturbance in the adjacent island. For the purpose of lateral communication between the automation islands, a high speed redundant bus (the so-called control bus) should be provided which should be solely responsible for the automation (control) signal exchanges.

12. Alarms shall be provided for all abnormal conditions over which the operator has control in the control room, plus those abnormal conditions which are of interest to the operator because they may affect plant operation or security.

13. The following colors shall be selected for equipment status indicating lights:
- Red----energized, running, valve open
- Green----de-energized, stopped, valve closed
- Light yellow ----abnormal, discrepancy
- White----control power available

14. The functions of DDCMIS System are achieved through bus communication units, bus interfaces, process controllers, I/O modules and computers. The system shall be versatile and provide the user, the flexibility to freely choose configuration and redundancy. The system shall ensure very high reliability and safety through complete distribution and decentralization which goes right down to the individual I/O level.

15. Interposing relays with suitable contact rating shall be provided between DCS/PLC and MCC/Swgr in Interposing relay panels for giving command signals ON/OFF or OPEN/CLOSE. Interposing relays shall have minimum 2 NO and 2 NC contacts.

16. All parameters on which protection is achieved through pressure/ temperature/ flow switches; the measurement shall also be made available through transmitters. “**Provision of transmitter/remote sensor will be applicable for 70% of total protection signals for such important services which will be decided during detailed engineering”**

17. Also the system shall have the flexibility to easily reconfigure any controller at any time, without requiring additional hardware or system wiring changes and without disabling the devices from their normal operating mode.

18. The system shall execute all control functions with the help of a set of pre-programmed functions resident in controllers.

The offered system shall have provision for open system architecture to establish communication to any other system using open system standards such as UNIX, WINDOWS NT, WINDOW XP/7, TCP/IP, OSF, MOTIF, SQL Access etc.

19. The system shall be provided with extensive diagnostic features so that a system failure can be diagnosed down to the module level giving location and nature of fault. Ease of maintenance and trouble-shooting shall be a primary consideration in equipment selection.

20. The system shall provide inherent safe operation under all plant disturbances and component failures so that under no circumstance safety of the plant personnel or equipment is jeopardized.

21. The design of the control system and related equipment shall adhere to the principle of “fail safe” operation at all system levels and provide reliable and efficient operation of the plant under dynamic conditions and attainment of maximum station availability.

22. The DDCMIS shall be fully capable to operate plant in all regimes of plant operating conditions, including emergency operation/trip conditions, black out conditions etc. without resorting to manual control. The DDCMIS shall be capable of bringing the plant to safety state automatically without operator interventions.

23. All process input/output cards shall have built in galvanic/optical/electronic isolation for each input and output channel.

24. The failure of controller module and each I/O module shall be indicated on control cubicles and all operator stations.

25. For all the trip signals (very high/very low) employed for the boiler/Turbine Control System, **the alarms (High/Low) shall appear for correcting the process by the operators**.

26. For measurement of boiler metal temperature flue gas temperature, air pre-heater grid temperature etc., The bidder shall provide permanent/removable duplex type mineral insulated thermo-couples terminated in junction boxes at boiler platforms. Remote I/O unit has been envisaged for these inputs. The remote I/O panel shall be provided with I/O cards, redundant power supply unit and redundant communication modules etc. These parameters are brought to DDCMIS via DDCMIS I/O bus or via redundant soft link (either TCP/IP on OPC or MODBUS with RS485) to have real time data. This remote I/O panel shall be powered from UPS or 24V DC source of respective unit. The unit enclosure shall be of weather proof, dust tight and water proof. Bidder shall provide necessary air conditioning unit, if require for the system. This panel shall also be accommodate able for 4-20 mA and RTD signals of monitoring parameter and not for control parameters. The quantities **of remote I/O panels** shall be decided during detailed Engineering.

27. For measurement of turbine metal temperature turbine casing temperatures, stator winding temperature, Generator seal oil system, Turbine bearing temperature, Turbine oil temperature, Turbine bearing drain oil temperature, BFP turbine measurement parameters, MDBFP measurement parameters etc., The

bidder shall provide permanent/ removable duplex type mineral insulated thermocouple/ RTD terminated in junction boxes at respective turbine side floors. Remote I/O unit has been envisaged for these inputs. The remote I/O panel shall be provided with I/O cards, redundant power supply unit and redundant communication modules etc. These parameters are brought to DDCMIS via DDCMIS I/O bus or via redundant soft link (either TCP/IP on OPC or MODBUS with RS485) to have real time data. This remote I/O panel shall be powered from UPS or 24V DC source of respective unit. The unit enclosure shall be of weather proof, dust tight and water proof. Bidder shall provide necessary air conditioning unit, if require for the system. This panel shall also be accommodate able for 4-20 mA and RTD signals of monitoring parameter and not for control parameters. The quantities **of remote I/O panels** shall be decided during detailed Engineering.

28. **8 Nos. temperature elements/sensors in each units control room** shall be provided for monitoring the room temperature.

29. On unit tripping, about hundred Engineers shall be informed through SMS automatically from DDCMIS. Incase of tripping of major fans/pumps/HT drive the concerned Engineer configured in such a way shall get the SMS information.

    To achieve the automatic SMS facility, GSM (global system for mobile Communication) with redundant Ethernet connectivity shall be provided by bidder for SMS facility. Same shall be connected with DDCMIS/OPC server/MIS server as decided during detailed engineering.

30. For Auto generation of trip message of unit & major fans/pumps/HT drive thru Email, Email facility in DDCMIS/OPC server shall be provided by bidder.

31. All the 4 nos. 40” LED TV monitors per unit and 2 nos. 40” LED TV monitors for common system at CCR shall be erected at the false roof top of central control room.

4.02.02 CONTROL SYSTEM PHILOSOPHY

4.02.02.1 In order to minimise the burden on the unit operator, all control functions within the operational load range shall be fully automated. The control system shall be structured in accordance with a well-defined control hierarchy to permit operator intervention at appropriate levels during abnormal modes of operation.

4.02.02.2 The automation shall meet the following objectives as minimum:

(a) Consistent start-up, shut down and running of the plant under all operational condition

(b) Achieve minimum run-up and loading time

(c) Maximize fuel economy during start-up, shut down and normal on load operation cycle

(d) Maximize plant life expectancy

(e) Contribute to power grid during normal and disturbance condition

(f) To meet the operational and safety requirements, the control system hardware and software shall conform to a modular, hierarchical architecture. The system hierarchy shall be at four levels.

4.02.03 Different Level of Controls

4.02.03.1 Drive Level

4.02.03.1.1 The first and lowest level shall cover all the modulating, sequence and protection control functions directly associated with all remotely controlled plant items. It shall also incorporate all necessary interlocks, initiations and trip functions for starting and stopping a main drive motor.

4.02.03.1.2 Control at this level shall either be initiated directly from the remote manual control interface or automatically by the next hierarchical level.

4.02.03.2 Subgroup Level

4.02.03.2.1 The second level shall coordinate the control of all first level drives, both closed loop and open loop, associated with a particular functional subgroup. In the case of a pump subgroup, for instance, the permissive checks, the coordination of the operation of the suction and discharge valves, the main drive initiations and the basic modulating control loops shall be executed at this control level. The major monitoring functions (e.g. turbine supervisory measurements) shall also be identified with this level.

4.02.03.2.2 Typical control functions associated with this level are:

i. Auto- Start and stop initiation or set point guidance from the next higher control level
ii. Start-stop- Normal initiation of the auxiliary start and stop sequence.
iii. Auto Standby-Start initiation in the event of duty item failure.

4.02.03.2.3 A functional group consists of different units, which individually represent and control a part of the complete plant and can be divided into two or more groups. Every sub group is controlled by an independent sub group control, which controls the operation of various drives. Once a start signal issued by a functional group, the sub group control brings the sub group from one state into another operating condition by issuing command signals in a programmed sequence. It brings the sub group from a shut down state into a working condition and vice-versa. The functional group instrumentation and control system co-ordinates the entire sub group controls belonging to one functional group.

4.02.03.2.4 Group Level

4.02.03.2.4.1 The third and penultimate level shall coordinate the individual subgroup control function (both modulating and sequence controls) within the main functional groups of the system.

4.02.03.2.4.2 The group co-ordinate the sub group of a functional group. Its main function is to

deliver start-up or shutdown command signals to the sub-group and change over from a faulty subgroup to the reserve sub group, the group co-ordination control supervises. the actual and the required position of the switchgear in the sub group and then decides whether the sub group shall be switched “ON” or “OFF”..

4.02.03.2.4.3 The aforesaid concept of functional group control is independent of the control techniques-freely programmable.

4.02.03.2.5 Unit Co-Ordination Level

4.02.03.2.5.1 The fourth level, which stands at the apex of the hierarchical triangle, shall perform the overall unit coordination. It shall incorporate, for example, the master load control function which should regulate the load generated by the generator to the demand set point value. In general for automatic start-up and shutdown control, the sequential initiations of the functional group sequences should be generated at this level.

4.02.03.2.5.2 The typical sequence control functions to be implemented at this level would include:

i. The sequential initiation of the subordinate functional group sequences for automatic start up and shutdown.

ii. The sequential initiation of the subordinate functional group sequences for automatic start up and shutdown of a part/full.

iii. The sequential transition to the various combination of subordinate functional Groups.

4.02.03.2.5.3 The modulating control functions to be implemented at this level would include the following:

i. Unit load control with frequency regulation incorporating load balancing (remote set point adjustment from the CCR /LCR shall be provided).
ii. Station load demand and demand rate limiting

4.02.03.2.5.4 In general the operator shall have direct access to all four control levels where these are identified, through the operator control interface located in the CCR.

4.02.03.2.5.5 Communication links shall be provided between the various control systems to allow for access to the system from any of the operator’s interface stations.

4.02.04 CONTROL SYSTEM - LEVEL OF AUTOMATION

4.02.04.1 The unit control and monitoring shall be performed from control room by means of OWS/KB operation interface mounted on unit control desk, through a microprocessor based distributed Digital control monitoring and information system.

4.02.04.2 The unit shall be remotely controlled, but a fully automatic system of the plant shall be provided, i.e. all valves, motors, final control elements and other equipment that have to be operated during start up, operation and shut down, belonging to the Main Systems, shall be remotely controllable from unit control room by the operator through Distributed digital control monitoring and Information system.

4.02.04.3 Subordinated drives belonging to one main aggregate shall be managed by means by sub group control systems. Automatic open/closed loop controls shall be installed wherever it is possible to lighten the work of the operation.

4.02.05 CLOSED LOOP CONTROL SYSTEM (CLCS)

4.02.05.1 The CLCS shall control the process variables automatically both under steady state and dynamic conditions with in the limits specified under guarantee clauses over the entire operational range of the equipment/system.

4.02.05.2 The CLCS shall have the following features:

(a) Provision of predictive and/or adaptive controls in addition to PID controls as required by the system. Availability of **advance control techniques/Algorithms** ensuring process optimization.

(b) Set point adjustments and indication from operating work stations/ KBs for process variables which need to be changed during load changes, start-up, shutdown, normal or under any other emergency conditions.

(c) Fixed set point at the software level/hardware level (only changeable by the maintenance engineer) and indication for those process variables which need not be changed with respect to load or otherwise.

(d) Bias adjustment with indication where a single controller is controlling more than one final control element (control valve, control damper, speed drive etc.) to maintain the same process variable.

(e) Auto and manual control facility shall be transferable in both directions without bump of the value of the process variable to control the parameter during manual operation. Both master Auto Manual station and Auto / Manual station for individual control element shall be provided in OWS. Auto tuning facility shall be an inherent feature of the DDCMIS. Availability of control loop of process parameters in auto for different loads. If required, the system shall have the feasibility of **auto changing of PID constants (K constants)** in micro-processor/controller for different loads so as to avoid hunting of control valve.

(f) Characterization of final control element to suit the various applications with respect to load or otherwise as dictated by the process.

(g) Function generator to provide necessary characterization or variation of set points with respect to load, speed or any other requirement.

(h) Soft Auto /Manual station interlocks to drive the final control elements to a suitable position for safe plant operation in the event of process/equipment abnormal conditions.

(i) Blocking/Interlocking function as dictated by process/equipment.

(j) Monitoring of loop failures or any hardware failure in the loops.

(k) Fail safe operation of final control elements in case of failure of motive power or

Signal.

(l) Redundancy criteria of sensors for CLCS shall be dictated as per NIT, Vol. V, Cl. No. 2.05.05.

(m) Redundancy criteria of I/O cards and Wiring for redundant or non redundant signals from field to control system (I/O cards & controllers) shall be dictated as per NIT, Vol. V, Cl. No. 4.02.08.02 and 4.02.08.02.1 respectively.

4.02.06 OPEN LOOP CONTROL SYSTEM (OLCS)

4.02.06.1 Protection, interlock and sequence controls constitute OLCS. This system shall enable the operator for safe start up and shutdown and carryout normal operation both from control room and local areas. Protection and Interlock shall be provided for all the equipment and system to safeguard the equipment against abnormal conditions which may result in the failure and less utility of the equipment and protect the operating personnel. Controls shall be provided to start/shutdown various systems and/or any equipment with associated auxiliaries and to operate the Unit on line with optimum number of operations and higher safety.

4.02.06.2 The OLCS shall have the following features as a minimum:

Features-General Requirements

(a) The logic and sequence control shall be Digital distributed microprocessor based and programmable.

(b) Enable the operator to start/stop various unidirectional motors, to open/close various valves and dampers and carry out inching operation of bypass valves or any other similar equipment both from control room and local areas.

(c) The system shall be designed based on the philosophy of command to energise a relay or solenoid valve.

(d) Where there is more than one pump or fan for the same service (say 2 pumps), auto standby features shall be provided to select the standby unit and this standby unit shall start automatically on failure of running pump or on applicable process criteria (say low discharge pressure) with an annunciation.

(e) All the contacts of the sensors used in protection circuit shall be monitored.

(f) Triple redundant sensors shall be provided when used in protection circuits for major critical equipment and 2 out of 3 logic shall be derived for further use in protection circuit

4.02.06.3 Features-Interlock Requirements

(a) Permissive conditions for a equipment start shall be provided. The permissive conditions within the equipment are bearing temperature normal, winding temperature normal, adequate suction pressure, bearing vibrations normal, bearing lubrication oil pressure normal, switchgear in service, switchgear not in test, no protection trip command persisting (as applicable) etc.

(b) The permissive conditions from a process system related equipment are

establishment of free path for the flowing medium under all start-up, emergency and shutdown conditions, closure of discharge valve for the starting of first of the identical pumps/fans and then opening the valve after the operating condition is established etc.

(c) Selection of standby equipment and starting the equipment automatically on the tripping of running equipment and/or desired process parameter conditions (say loss of discharge pressure or low level in the discharge tank etc.)

(d) Isolation of the tripped equipment from the main process.

(e) Any other conditions for safe starting and shutting down the equipment.

4.02.06.4 Features-Sequence Control Requirements

Sequence control shall be provided to start and stop the equipment and the associated auxiliaries. The sequence control shall have the following features:

(a) Once the start-up or shutdown of an equipment is initiated either manually or automatically from the system, the control of associated auxiliaries shall be automatic with facility for manual operation at each stage (step).

(b) Criteria check up for each stage of operation with monitoring and displaying.

(c) Bypass facility for each criteria when only the feedback signal/display is incorrect but the actual condition is fulfilled. This activity shall be logged and annunciated in control system (DCS / PLC).

(d) Adequate time delay between the steps as dictated by the process to establish an operating parameter or healthiness of an equipment.

(e) Normally, the auxiliaries of the standby equipment should be running (as applicable) so that the standby equipment is started without loss of time.

4.02.06.5 Features-Protection Control Requirements

The following minimum protection shall be provided for the various equipment/system as applicable to trip the equipment.

(a) Any condition which endangers the safety of the plant personnel

(b) Any of the permissive conditions becoming abnormal thereby producing a dangerous condition in operating the equipment.

(c) The conditions from process such as dry flow conditions, flashing conditions or any other conditions that may create cavitation.

4.02.06.6 Redundancy criteria of sensors for OLCS shall be dictated as per NIT, Vol. V, Cl. No. 2.05.05.

4.02.06.7 Redundancy criteria of I/O cards and Wiring for redundant or non redundant signals from field to control system (I/O cards & controllers) shall be dictated as per NIT, Vol. V, Cl. No. 4.02.08.02 and 4.02.08.02.1 respectively.

4.02.07 System Architecture for Main Plant Control System (unit wise)

Following Operating work stations & Engineering work stations per unit except wherever specifically asked for both unit, are envisaged for control & operation of main power plant from Unified Distributed Digital Control, Monitoring and Information System (DDCMIS) (Refer System Configuration Drawing, # 114-01-0100).

4.02.07.01 Option 1 – For Unified DDCMIS

4.02.07.01.01 Operating Work stations:-

i. 6 nos of Operating Stations (one no. of boiler control system like MFT, two nos., for BMS (FSSS), Boiler auxiliaries, two nos. for Turbine auxiliaries and one no. for electrical system & BOP) shall be connected directly on Proprietary/ preferably Industrial Data Highway/higher level network of DDCMIS with 2 LJP A4 B/W and 1 LJP A4 Color.

ii. 2 nos. of Operating Stations for Turbine Control System (governing system), like DEHGC, ATRS, ATT, ETS from the respective system shall be connected directly on Proprietary/ preferably Industrial Data Highway/higher level network of DDCMIS with 1 LJP A4 B/W & 1 LJP A4 Color.

iii. 1 no. of Operating Station for TSE for Unit incharge (shift supervisor) with 1 LJP A4 Color (if this is not integral of DDCMIS, TSE shall be connected with DDC MIS through redundant OPC connection).

iv. 1 no. of Operating Station for Unit incharge (shift supervisor) - Printer not required

v. 1 no. of Operating Station for Station incharge (in the cadre of Executive Engineer) with 1 LJP A4 B/W.

vi. 1 no of Operating Station for performance calculations & optimization for Unit incharge (shift supervisor) shall be provided with 1 LJP A4 B/W.

vii 1 no. of Operating Station for performance calculations & optimization at the Office of Executive Engineer/Efficiency shall be provided with 1 LJP A3 B/W.

viii. 1 no. of Operating Station for water chemistry parameters connected with performance calculations & optimization at the SWAS / Chemical Express lab shall be provided with 1 LJP A4 B/W.

ix. 1 no. common Operating Stations at Factory manager, and 1 no. common Operating Stations at Electrical System incharge room shall be provided for both units, operation/ command shall not be executed from these three consoles to start/stop the equipments. Software and hardware security lock shall be provided not to use these controls for any operations. 1 LJP A4 Color with each Operating station shall be provided.

x. 2 nos. of common Operating Stations for both units at common DDCMIS network in CCR with A3 sized color LJP.

4.02.07.01.02 Engineering Work stations & Servers:-

i. 2 nos. of Engineering Stations for system maintenance Engineer for unit DDC MIS system with 2 LJP A4 Color, 1 No. A3 sized Scanner, copier cum printer, 1 LJP Heavy Duty Industrial grade A3 Color.

ii. 1 no. Engineering Station for system maintenance Engineer for Turbine Control System with 1 LJP Heavy Duty Industrial grade A3 Color.

iii. 1 no Engineering Station for Turbine Stress Evaluation with 1 LJP A4 Color (if this is not integral of DDCMIS, TSE shall be connected with DDC MIS through redundant OPC connection).

iv. 1 no. of Engineering Station for Sequential Event Recording with 1 no. A3 sized DMP

v. Redundant Historian server (Historical Data Storage & Retrieval system) with Work station and 2 no. A3 sized DMP.

vi. 1 no. redundant server system for performance calculation & optimization (PADO) with Engineering work Station and Heavy Duty Industrial grade A3 Color printer.

vii. Redundant OPC server for OPC connections with DDCMIS from other systems with Work station & 1 LJP A4 B/W.

viii. Redundant MIS server with one no. MIS work station, and 1 no. LJP A4 B/W.

ix. Common Redundant OPC server for OPC connections with both units DDCMIS from other common systems with Work station & 1 LJP A4 B/W.

4.02.07.01.03 “The local operating stations 6 nos. per unit namely at locations like ESP, Zero M Elev. Turbine building, Boiler - A Elevation, HT Switchgear room, SWAS / Chemical Express lab room & CWPH (with 1 no. A4 sized B/W LJP) and 1 nos. namely at common locations like FOPH shall be provided with 24” LED color screen/OWS, with minimum configuration connected to DDCMIS on redundant connection to show the status/ conditions of various process parameters/equipments in process mimics, trends, logs etc with real time data.

Operation/command shall not be executed from these local operators’ consoles to start/stop the equipments. Software and Hardware security lock shall be provided for not using these consoles for any control/operations. Specification of these local stations shall be same as specified at cl. no. 4.03.03.04 respectively.

All the locations/rooms availing the operating stations namely FOPH, CWPH, Boiler A elevation, Turbine 0 meter, ESP, Ash handling Control room, HT Switchgear room, 400 KV switchyard control room and SWAS / Chemical Express lab, DM Plant are to be air conditioned.

4.02.07.01.04 All operating stations connected on redundant data highway shall be interchangeable and operation of the plant shall be possible from Engg. station after security check. All operator stations shall have full access to the entire plant data base and shall have identical functionalities. The system shall have full data base redundancy. The data base shall be independent and shall reside separate from the operator stations.

4.02.07.02 Option – 2

i. Separate DCS based control system is provided for Turbine integral control and DEHGC, ATT, same shall be provided with complete configuration (OWS & EWS with printers) as specified above at cl. No. 4.02.07.01.01 (ii) & 4.02.07.01.02 (ii) and TSE's work stations & TSE's Engineering stations with printers & TSI work station with printers as specified else where in the specification.

ii. Separate DCS based control system is provided for Turbine protection (ETS – Emergency trip system), same shall be provided with one no. operating station and one no. operating cum engineering station and one no. A4 sized B/W LJP.

iii. Separate DCS based control system is provided for MFT & Boiler protection controls, same shall be provided with one no. operating station, one no. operating cum engineering station and one no. A4 sized B/W LJP and one no. A4 sized color LJP.

iv. For option 2, Qunatities of OWS & EWS shall remain same with DDCMIS as specified above at cl. No. 4.02.07.01.01 (i & iv to viii), 4.02.07.01.02 (i & iv to vii) & 4.02.07.01.03 irrespective of separate control systems (DCS) for Boiler integral controls and Turbine integral control respectively.

v. In case bidder provide separate Turbine control system & Boiler control system from DDCMIS. Then configuration of LVS shall be 4 no. LVS with Display controller as part of DDCMIS package, 1 no. LVS with display controller as part of Turbine control system and 1 no. LVS with display controller as part of Boiler MFT control system.

4.02.07.03 Option – 3

i. Separate DCS based control system is provided for DEHGC, TSC, ATT & Turbine protection (ETS – Emergency trip system), same shall be provided with complete configuration (OWS & EWS with printers) as specified above at cl. No. 4.02.07.01.01 (ii) & 4.02.07.01.02 (ii), one no. OWS for ETS/Turbine protection, and TSE's work stations & TSE's Engineering stations with printers & TSI work station with printers as specified else where in the specification.

ii. MFT & Boiler protection controls shall be part of DDCMIS.

iii. For option 3, Qunatities of OWS & EWS shall remain same with DDCMIS as specified above at cl. No. 4.02.07.01.01 (i & iv to viii), 4.02.07.01.02 (i & iv to vii) & 4.02.07.01.03, irrespective of separate control systems (DCS) for Turbine integral control system.

iv. In case bidder provide separate Turbine control system from DDCMIS. Then configuration of LVS shall be 5 no. LVS with Display controller as part of DDCMIS package and 1 no. LVS with display controller as part of Turbine control system.

4.02.07.04 Total 6 No. 80/84" diagonal sized LVS per unit shall also be provided for monitoring, operation and control of power plant as per details specified elsewhere in the specification.

2 no. common 80/84" diagonal sized **LVS** with their own display controller connected to both unit DDCMIS on common redundant OPC network to show the status/ conditions of various process parameters/equipments in process mimics, trends, logs etc of common BOP/Offsite packages with real time data shall be provided by bidder. These two nos, LVS are common to both 2 X 660 MW units and shall be located in CCR. Operation/command shall not be executed from these LVS to start/stop the equipments. Software and Hardware security lock shall be provided for not using these local LVS for any control/operations.

4.02.07.05 Modulating Controls (CLCS) and Discrete Open Loop Control (OLCS) shall be designed to eliminate the necessity of operator action except manual / auto selection, set point changes, biasing and similar actions during normal operation. Bumpless and balance less transfers between automatic and manual operation modes and vice-versa shall be provided automatically without need of operator action. Complete backup shall also be provided for safe shutdown operation of plant.

The system shall have built in redundancies for all system functions both at the processor and device level. No failure of any single device or processor shall lead to any system function being lost. It shall have redundant data highway on a "master less" principle.

Redundant equipment wherever provided shall be powered from redundant power supply units in order to improve system availability and reliability.

The system shall have the capability and facility for expansion through addition of station/drops, controllers, processors, process I/O cards etc., while the existing system is fully operational. The system shall have the capability to add any new control loop in CLCS and new group, sub group, drive functions in OLCS while existing system is fully operational. Intelligent I/O cards will be preferred.

All the basic systems shall be connected through redundant data high way/bus system. The local bus system with associated bus couplers shall be provided for communication between different I/O modules and processors. The communication system shall be designed keeping in view the integrity & security aspects for the control system. In case the system employs master communication controllers, facility for 100% hot back up controllers with automatic switch over shall be provided and it shall be ensured that no loss of data takes place during failure of communication controller.

The DDCMIS shall be fully capable to operate plant in all regimes of plant operating conditions, including emergency operation/trip conditions, black out conditions etc. without resorting to manual control. The DDCMIS shall be capable of bringing the plant to safety state automatically without operator interventions.

The application programmes for the functional controllers shall reside in EPROMS or in non volatile RAMS. The application programme shall be alterable by access through programmer's console. Parts replacement or parts removal shall not be required for accomplishing changes in application programmes including control loop tuning. Each controller shall be equipped with the amount of functional capacity required to perform its specified functions and still have an overall spare capacity of 40%.

4.02.08 Redundancy & Availability Requirements

The CPU / Controllers, communication modules, data highway, power supply modules, etc for all DDCMIS/DCS/PLC shall be 100% hot standby redundant. I/O cards redundancy shall be as per cl. No. 4.02.08.02.

4.02.08.01 Controller Redundancy

All functional controllers for sequence control, functional controllers for closed loop control and functional controller for DAS & monitoring shall be provided with hundred percent hot standby controllers. However controller redundancy is not mandatory, where controller is purely executing data acquisition & monitoring functions. DAS function can also be integrated within CLCS/OLCS controller. All processors for modulating controls shall have self-tuning facility.

All the 100% hot back up controllers shall be identical in hardware and software to their corresponding main controllers. Further, each of the 100% hot back up controller shall be able to perform all the tasks of their corresponding main controller. The 100% hot back up controller shall continuously track/update its data corresponding to its main controller. There shall be an automatic and bumpless switchover from the main controller to its corresponding back-up controller in case of main controller failure and vice versa. The changeover shall take place within 50 msec. Engineered solution for redundancy in CPU are not acceptable. Dual redundant controllers shall be placed separately and shall not share the same motherboard or shall not have any other common sharing point.

Any switchover from main controller to 100% hot back up controller and vice versa, whether automatic or manual shall not result in any process upset or any change in control status. The transfer from main controller to the back-up & vice-versa shall be indicated as alarm on all operator station OSs.

In case of switchover from main controller to back up controller, the back-up controller shall be designated as the main controller.

All the input variables shall be available to the main controller as well as its 100% hot back up controller so that any failure within the main controller shall not degrade the input data being used by the 100% hot back-up controller and vice-versa.

Each controller shall have 40% spare functional capacity to implement additional function blocks, over and above implemented logic/ loops under worst load conditions. Each controller shall have battery backup or EEPROM/NVRAM for program memory.

Parts replacement or parts removal shall not be required for accomplishing changes in application programmes including control loop tuning.

Each of the corresponding communication controllers shall also have same spare capacity as that of controller.

For controller, the worst loading condition shall include the following tasks:

(a) All process inputs scanning and processing is in progress and all the data is transmitted over the main data bus every one (1) second.
(b) All closed loop controls in operation
(c) All open loop controls in operation
(d) All output devices are in operation with rated performance/speed.
(e) Control/information request is initiated on all control Operating stations.
(f) In burst mode operation (in case of major equipment trip), 100 digital alarms are generated per second for a period of 10 seconds.

4.02.08.02 Redundancy in Input/output Modules

Hot standby 100% redundancy shall be provided for all input/output cards where inputs/outputs are used for CLCS and OLCS. All input/output of SCADA from/ to breaker & isolators shall be redundant. No redundancy at I/O card level is required which are executing purely data acquisition/monitoring functions. I/O card shall have 16 channels per AI/RTD/TC/AO card and 32 channels for DI/DO card. No. of channels per I/O card indicated are maximum, which may also further reduced to meet the I/O cards features specified elsewhere in specification.

Wherever redundant I/O modules/cards are used as per specification requirement, both (1:1 redundant) input or output modules shall execute the designated functions parallely. The offered system shall have facility to enable final output from any of redundant input/output module, in case both modules are healthy. In case one of redundant card/module is unhealthy, the system shall detect the same and the output to and from system shall be given from the healthier card. I/O card redundancy shall not be achieved through relays, diodes or any other additional hardware or software, Engineered solution for redundancy in I/O cards are not acceptable.

Wherever redundant sensors are employed each sensor shall be wired to both input modules of redundant modules so that even if one input module fails, the both signals will be available from the other input module. This arrangement is necessary to avoid loss of both input signals due to failure of one input module where both the signals are connected.

In addition to above, 20% fully wired input/output spare channel should be provided for each I/O modules.

Bidder to note that all type of hardwares & electronic modules like controllers, I/O cards, communication modules and interface modules etc used in DDCMIS/DCS/PLC shall be sourced/supplied from their Principal's works.

4.02.08.02.1 Wiring Scheme for inputs/outputs to/from control system shall be as follows:

i. Each of the triple redundant binary & analog inputs shall be wired to separate input modules. In addition, for functions employing 2V3 controllers (eg. Turbine protection, MFT, Boiler protection, DEHGC etc.), each of the triple redundant binary & analog signals shall be wired to separate input modules associated with each controller, so that even if one input module fails, the signal will be available from the other input module.

In case of dual redundant binary & analog inputs, each of the signal shall be wired to both input modules of redundant modules, so that even if one input module fails, the both signals will be available from the other input module. These redundant modules shall be placed in different racks, which will have separately fused power supply distribution. Implementation of multiple measurement schemes of these inputs will be performed in the redundant hardware. Loss of one input module shall not affect the signal to other modules. Other channels of these modules can be used by other inputs of the same functional group.

ii. The single (i.e. non-redundant) binary & analog signal required for control purposes shall be wired as follows:

All single analog & binary inputs (used for OLCS & CLCS) including the limit switches of valves/dampers MCC/SWGR check-backs of all drives, SOE & information related signals shall be wired to redundant input modules.

The binary and analog outputs from one subsystem of the Control System to other which are required in these systems for control & protection purposes, shall be made available from triple/dual redundant binary and analog output modules. Other binary & analog outputs used for DAS shall be non-redundant only. Failure of any single module shall not affect operation of more than one single drive.

4.02.09 DDCMIS/DCS Controller Grouping/Partitioning

All controllers shall be dual redundant except Triple modular redundant controllers for Turbine DEHC, Turbine protection & Boiler MFT/protection. Following tentative segregation for controls (OLCS, CLCS) & DAS is proposed, however final segregation shall be subject to Owner's approval during detailed engineering:-

a) Coordinated master controls, FTP, Oil System, Misc. Drives, Burner Tilt
b) IDF A, FDF A, Air flow and excess air correction, PA fan –A/AH – A/SCAPH-A/PA header Pr. Control.
c) IDF B, FDF B, Furnace draft, PA fan –B/AH – B/SCAPH-B
d) Mill related controls such as air flow/feeder rate/outlet temperature, Mill Lube oil controls; Two mills per redundant processor
   i. AB
   ii. CD
   iii. EF
   iv. GH
   v. JK
   vi. MN

e) Feed water/BFP Scoop control/CBD

f) TDBFP - A integral controls per redundant processor
   i. ATRS 1 SGC & Turbine Protection
   ii. ATRS 2 SGC, TSI & CLCS
   iii. DEHC (Digital Electro Hydraulic Governing System)

g) TDBFP - B integral controls per redundant processor
   i. ATRS 1 SGC & Turbine Protection
   ii. ATRS 2 SGC, TSI & CLCS
   iii. DEHC (Digital Electro Hydraulic Governing System)

h) MDBFP – C & Aux and Boiler fill up Pumps

i) Deaerator (three element controls), CEP, hot well, & Hot well makeup Pumps.

j) HP heaters 5, 6, 7 & 8.

k) LP Heaters 1, 2, & 3.

l) SH steam temperature control (multi variable control) & RH steam temperature control (multi variable control), Metal Temp.

m) DMCW Pumps & DMCW system for SG & TG and CPU* (* CPU incase DDCMIS controlled) .

n) COLTCS, HP & LP Dosing System and Cooling Tower & Aux.

o) Electrical system 1

p) Electrical system 2

q) Electrical system 3

r) **Remote I/O panel** with redundant processor from DDCMIS family is to be implemented with following grouping for CW & ACW system

   i. CW Pump – A, CW Pump – C, ACW Pump A & CW lines to/from unit # 1 Condenser/Hotwell.
   ii. CW Pump – B, ACW Pump B, CW makeup system & CW lines to/from unit # 2 Condenser/Hotwell.

s) Turbine integral controls per redundant processor

   i. ATRS SGC Oil Supply, Turbine & Drains
   ii. ATRS SGC Condensate & Evacuation System
   iii. GSPC (Gland Steam Pressure Control), LP Bypass
   iv. GAMP (Generator Aux. Monitoring)
   v. TSC (Turbine Stress Evaluation Control System) & TSI
   vi. ATT (Automatic Turbine Tester)

t) SG integral controls per redundant processor

   i. Oil A B & Oil CD
   ii. Oil E F & Oil G H
   iii. Oil J K & Oil M N
   iv. Coal A B
   v. Coal C D
   vi. Coal E F
   vii. Coal GH
   viii. Coal JK
   ix. Coal MN

x. SADC & APRDS
xi. SBC controls, SBC PR & Drain Temp. controls.
xii. HPBP

u) Steam Turbine controls like DEHGC (TMR – Triple modular Redundant philosophy) and Turbine Protection (TMR – Triple modular redundant philosophy) with fail safe design cards can be Integral or separate stand-alone.

v) Triple Modular Redundant (TMR) processors for MFT & Boiler protection with fail safe design cards can be Integral or separate stand-alone.

All controllers at "sr. no. a to t shall be dual redundant (92 Nos. total)" and at "sr. no. u to v shall be triple redundant (9 Nos)" for each unit. Hence, altogether minimum 101 processors are envisaged for each unit. During detailed engineering, processor task allocation will be done amongst these processors (and shall be subject to owner's approval) taking into consideration the turbine control, boiler control and the station C&I portion altogether. In addition, loading of signal interfacing from other BOP packages, Aux. & control/monitoring system shall be considered for finalization of quantity of controllers.

For common system between two units, following redundant controller grouping shall be provided with unit 1 DDCMIS, which shall also be interfaced with unit - 2 DDCMIS for control & operation. **Remote I/O panel** with processor from DDCMIS family is to be implemented because of the long distance. Controllers shall be 1 no. dual redundant (2 Nos. total).

i) BTG (FOPH) Fuel Oil System

Above quantity of controllers is minimum, indicative and tentative only. However final quantities of processors in addition to above quantities shall be finalized depending upon I/O handling capacity of the processor and design parameters like response time, communication bus speeds etc. Overcrowding of control loops in controllers shall be avoided.

Each group has sufficient spare capacity of at least 25% to meet modification/extension of the system. Multi-function processors can incorporate the corresponding interlocks (open loop control tasks of the system). Interlock and modulating controls are to be so assigned to the processors in such a way that failure of any processor does not lead to shut down of the entire unit. In no case CPU loading should exceed 60% of its capacity. Bidder to submit calculation of CPU loading along with his bid.

4.02.10 Response Times

The system shall have adequate speed of response through all regimes of system loadings. The minimum criteria to be ensured are as follows:-

a) Key board command to field equipment shall be executed and its confirmation shall be displayed on the screen within1 second.

b) The response for operator requested display (time between pressing of last key and appearance of last character on screen) shall be of the order of one to two seconds under all loading conditions.

c) Dynamic parameters in the OS displays shall be updated in one second interval.

d) The cycle time for open loop and closed loop controls shall be as follows:-

i) For critical closed loops like Steam Separator level control, main steam temp. control, feed water flow control, HRH steam temp. control, HP/LP bypass control, furnace draft control & combustion control, the loop cycle time shall be max. 100 milli seconds preferably 50 milli seconds.

ii) For non-critical closed loops it shall be max. 250 milli seconds (preferably 150 milli seconds).

iii) For all open loops, sequential interlocks & protection it shall be max. 100 milli seconds.

(The loop cycle time is defined as the time taken from change at input module to change in output module for command).

e) All analog inputs to CLCS shall be acquired and data base updated within an interval of 50 milli seconds. Data for critical loops shall be acquired & data base updated at a faster rate to suit the requirements of (d) above.

f) The digital inputs for SOE shall be monitored at 1 milli second resolution.

g) The system shall acquire & check all inputs at the input scan rate. If the input is in alarm state (i.e. the input is in an off normal condition) the alarm status shall be annunciated, printed out and displayed within 1 second after the input is scanned.

4.02.11 Established Reliability

i) All components and systems offered by the Bidder shall be of established reliability. The minimum target reliability of each component shall be established by the Bidder, considering its failure rate/meantime between failures (MTBF) & meantime to repair (MTTR), such that the availability of the complete system is assured for 8700 hours / year (99.7%) or better.

ii) In order to ensure the target reliability the bidder shall perform necessary availability tests and burn in tests for major systems. Surge protection for electronic control systems, annunciation system and other solid state systems conforming to SWC test per ANSI C 37.90a (IEEE standard 472) and selection of proper materials, manufacturing processes, quality controlled components and parts, adequate derating of electronic components and parts shall be ensured by the Bidder to meet the reliability and life expectancy goals.

iii) Continuous self checking features shall be incorporated in system design with automatic transfer to healthy/redundant circuits to enhance the reliability of the complete system.

iv) In general, failure of equipment used for alarm purpose will cause switching to the alarm state.

4.03.03.04 Specifications for Operator Station, Engineering Work Stations

Each operating station & Engineering work stations and any other work stations/PC envisaged in plant shall meet following minimum requirements & as per latest trends at the time of supply:

- On board Intel – Xeon quad core, 3.46 GHz processor with 1066 MHz bus with Hyper threading or higher.
- 4GB DDR3 RAM (min.)
- 1 x 1000 GB IDE Hard Disc Drive of 7200 RPM or higher
- 1024 MB Graphic Accelerator
- System chipset: Intel Express
- 2 x RS – 232 ports
- 1 x parallel port
- 4 nos. USB ports. (2 nos. on front side)
- 1 x 52X DVD/CD Read Drive
- 16 X DVD R/W Drive
- 2 x Ethernet (10 / 100 / 1000MB) cards (Industrial Grade)
- UXGA graphics and monitor 1920 X 1080, 256 colours with MRPII compliant, viewing angle 178° vertical & Horizontal and fastest response time.
- 1 x windows XP/7 Professional or latest & proven version of Windows OS professional with Multimedia
- Ethernet adapter
- Third party operating system, graphical users interface and software, if required.
- 2 nos. graphic output crads minimum

- Optical mouse
- Sound card
- Internal speakers
- Wireless internet & Blue tooth Interface
- Redundant power supply (In built)
- General MS Windows latest, MS-Office Professional, Adobe Acrobat, anti-virus McAfee or equivalent, AutoCAD etc.
- Application engineering & HMI software - to suit project Specific requirement
- All OWS shall be interchangeable

Preferred makes of OWS/EWS/PC's are DELL, HPCOMPAQ, NEC & IBM.

4.03.03.04.01 Peripherals for Operator Station, Engineering Work Stations & Server System

4.03.03.04.02 Full flat Monitors with LED back lighting

The bidder shall furnish OWS/EWS/Servers/PC with coloured **Full flat Monitors with LED back lighting**. OWS/EWS/Servers/PC with **Monitors** shall have a fast cursor control device like a track ball/optical mouse. All **Monitors** shall be of high resolution colour graphics type and with not less than 32 colours. The picture frequency shall not exceed 85 Hz. The resolution required is 1920 X 1080 pixel or better. The picture shall be stable and completely free of any flickering. The screen illumination shall be enough to give good readability. The screen dimensions shall not be less than 24" screen diagonal.

Antiglare hard coating shall be provided. High reliability and long life 24" (Industrial type) or better size monitors shall be supplied by the bidder. **Monitors** shall be equipped with all adjusting elements accessible on the front plate. Monitors with 3D capabilities for graphics shall be provided by bidder.

Monitors along with keyboard & optical mouse shall be mounted on supervisory control console specified elsewhere in the specification.

4.03.03.04.03 Key Board:

Functional key boards for plant operator station shall be of special type adopted to operation tasks and monitor functions. It shall contain all keys necessary for plant operation arranged in an ergonomically manner. Multi function keys shall be provided with automatic display for modified functions. Freely programmable keys (Minimum 101) shall be available for special user application.

Key Board shall be integrated into supervisors control consoles horizontal part.

Provision of functional keyboard shall be in addition to facility for operator control through mouse/track ball.

Membrane type keyboard shall be provided for operator interface with process for plant control and display functions to access plant data in conjunction with control OPERATING STATIONs. Membrane keypad shall be assignable with LED alarms, dedicated display selection keys with spare provision, hardware locking facility to set OPERATING STATION in engineer, supervisor or operator mode. The keyboard

shall have a minimum of 101 configurable keys for assigning most frequently used displays. A minimum of forty of those keys shall have two independently lit LED's used for event-specific alarm annunciation.

Keyboard shall be provided to enable the shift supervisor to develop graphic displays, control system software and system configuration for the DDCMIS. It shall be possible to perform operating interface functions from engineering OPERATING STATION. Assignable function keys shall be provided for execution of command, program etc. Hardware facility shall be provided to set OPERATING STATION in engineer or operator mode. QWERTY type keyboard shall be provided for engineer's functions. QWETRY type Key Board may be offered alternatively for OWS.

4.03.03.04.04 PRINTERS

Line Impact Heavy Duty Dot Matrix Printers

All printers shall be low noise (less than 60dB) type with a minimum of 136 columns. Printing speed shall be a minimum of 300 characters per second. Since the control room printers are high-speed printers, the system shall output to these printers at the rate of 1000 lines of printout per minute as a minimum. This rate shall be independent of the number of printers in simultaneous operation. Style of printing available shall be indicated by the Bidder. The printers shall have graphic capability and any OPERATING STATION display may be printed on the printer. The printing shall be bi-directional and in two colours black and red for sequence of event recording. Paper input capacity shall be with continuous paper feed.

Printers shall accept and print all ASCII characters via an E.I.A. RS-232 C or twenty milliamp current loop interface. Parity checking shall be utilized.

All printers mounted shall be provided with a separate printer enclosure each. The enclosures shall be designed to permit full enclosure of the printers at a convenient level. Plexiglas windows shall be used to provide visual inspection of the printers and ease of reading.

Printer enclosures shall be designed to protect the printers from accidental external contact and each should be removable from hinges at the back and shall be provided with a lock at the front.

If one of the printers fails to operate, it's functions shall automatically be transferred to the other printer. Failure of the printer shall be indicated on all OPERATING STATION's. Printer shall be offered and supplied from reputed manufacturer with latest proven technology. 5 Rims of papers shall be provided by bidder for each printer provided with subject plant.

Coloured Laser Jet printer

Printing Speed	20 ppm (min.)
Resolution	1200 X 600 dpi
Memory	128 MB (min.)
External Port	1 no. USB 2.0 port, and TCP/IP 10/100 Ethernet, Blue tooth interface

Duty Cycle	40,000 pages per month
Pages size	A3, A4, and Transparency etc. with automatic duplex printing facility.

Laser Jet printer (B & W)

Printing Speed	30 ppm (min.)
Resolution	1200 X 1200 dpi
Memory	128 MB (min.)
External Port	1 no. USB 2.0 port, and TCP/IP 10/100 Ethernet, Blue tooth interface
Duty Cycle	15,000 pages per month
Pages size	A4, A3, and Transparency etc. with automatic duplex printing facility. Paper tray - 2

Ink Jet Printers (Coloured)

Printing Speed	30 ppm (min.)
Resolution	1200 X 1200 dpi
Memory	64 MB (min.)
External Port	1 no. USB 2.0 port, and TCP/IP 10/100 Ethernet, Blue tooth interface
Duty Cycle	5,000 pages per month
Pages size	A4, Transparency etc.
Duplex printing	Automatic

Five sets of print cartridges and Five rims of papers shall be provided with each printer provided anywhere in the plant by bidder with each DDCMIS, DCS & PLC system and any other system specified elsewhere in specification.

Preferred makes of printers are HP, Canon, Fuji Xerox, & Epson.

4.03.03.04.05 External DAT Drive

The DAT drive is a serial back-up device. The DAT drive shall have read/write capability and shall be provided with all required hardware interface including error detection and correction facilities in each control room. The tape (total 10 nos.) of Sony make shall have the capacity of 12/24 GB min. The tape drive shall be specified as follows:-

- DC drive
- Tape format - QIC-80
- Data Transfer Rate – 5MB/minute.
- Seek time – 22 milli second

4.03.03.04.06 Hard Copy Facilities

The system shall be capable of copying hard copy of OPERATING STATION graphics through a video colour copier switch able to any OPERATING STATION.

The printer/copier offered shall be capable of copying OPERATING STATION image in 20 seconds.

4.03.03.04.07 USB Port Pen Drive

Twenty Five (25) no. USB Port pen drive per unit having 32 GB memory with read/write facility shall be provided.
Preferred makes of USB pen Drive are HP, Sandisk, Kingston, Strontium.

4.03.03.04.08 Scanner, Copier cum Printer (A3 size)

Resolution	:	1200 x600 dpi (optical) (min) for Printer 600 x600 dpi (optical) (min) for Scanner
Colour Depth	:	48 bit
Scaling	:	10 to 2000% in 1% increments
USB interface	:	required.
Memory	:	1 GB
Printing Speed	:	30 ppm (min.) for A4 size 20 ppm (min) for A3 size
Duplex printing		Automatic

4.03.03.04.09 DVD Writer

The DVD writer should be capable to read and write any DVDs as well as CDs. and shall be provided with all required hardware interface including error detection and correction. The DVD writer shall meet following minimum requirements:

- DVD write speed - 16x
- CD write speed - 52x
- Cache / Buffer size - 2MB
- Buffer under protection technology

Five nos of DVD (Re-writeable) shall be provided with each OWS/server provided anywhere in the plant by bidder with each DDCMIS, DCS & PLC system and any other system specified elsewhere in specification.

4.03.03.04.10 Digital B/W Copier cum Printer (A3 size)

01.	Type	:	Laser, tabletop / latest
02.	Printer Memory	:	512 MB (min.)
03.	Speed	:	Monochrome 30 ppm - A4 20 ppm – A3
04.	Resolution	:	600 x 600 DPI
05.	No. of color (Basic)	:	Monochrome
06.	Duty cycle	:	Monochrome more than 75000 pages / month
07.	Power supply	:	240 V, 50 Hz, 1 phase UPS
08.	Ambient temperature	:	0-50° C
09.	Humidity	:	95% non-condensing.
10.	Size of paper	:	Paper weight of 45 to 165 g/M^2

11.	Networking Capability	:	USB / Ethernet
12.	Coping	:	Max Original Size – A3, Continuous Coping (1-999)
13.	Accessories	:	i) Adapters
			ii) Connector Cable
			iii) Duplex Unit. Automatic
			iv) Optional Paper feeder- 2 Nos

4.03.03.05 Lap Top

The LapTop shall meet following minimum requirements:

a) Intel Centrino™ Mobile Technology.
b) Intel Core – i7 Processor with 3.46 GHz, 4 MB L2 cache, 1066MHz FSB.
c) 14" WXGA LED Screen with wide angle viewing.
d) 500 GB 7200 rpm HDD with shock absorber.
e) 4 GB 800 MHz DDR3 SDRAM (slot for 1no. additional RAM slot should be provided)
f) 1 x windows XP Professional or latest & proven version of Windows OS with Multimedia
g) Slim type DVD-RW/DVD ROM combo drive.
h) Internal 10/100/1000Mbps Ethernet card
i) IEEE 802.11B connectivity port
j) IR port
- Optical mouse
k) 2Nos. USB ports & Wireless INTERNET & blue tooth interface
l) External mouse connectivity and optical mouse
m) Minimum 8 hrs battery backup.
n) Recovery software tools.
o) Sound cards
p) Internal speakers
- General MS Windows latest, MS-Office Professional, Microsoft Visual Studio, Adobe Acrobat, anti-virus McAfee or equivalent, etc.
q) Application engineering & HMI software - to suit project specific requirement

Preferred makes of Laptop are DELL, HPCOMPAQ, VAIO (Sony), Lenovo.

4.03.03.06 General Specification of the server:

Enclosure	:	6U Rack Mountable server / Tower type Sever
Processor	:	Intel Xeon Quad (4) Core 64 bit Processor capable 3.6 GHz with 16MB L3 cache memory per processor, Dual independent 1333 MHz system bus (2 way SMF) or better.
Memory	:	64GB ECC DDR – 3, 800 SDRAM

Video	:	Integrated with 64MB SDRAM
Resolution	:	1920 x 1080
Drives	:	HDD – RAID 5 (1000 GB) Ultra 320 SCSI adaptors with internal storage capacity 3.6 TB DVD/CDROM – 24X CD – RW/DVD IDE combo USB – 4 ports DAT – 36 / 72 GB
Peripherals	:	PS/2 keyboard Optical Mouse
Operating system	:	Windows 2008 server version standard / latest Enterprise Edition or latest & proven version of Windows Operating system
Backup & Disaster Recovery	:	VERITAS \ CA \ Tivoli \ any other
Environmental	:	Operating Temp range - 10°C to 35°C Humidity range - 8 to 80% (Non-Condensing) Vibration 0.25 G at 3 to 300 Hz for 15 Minutes.
Software	-	General MS Windows latest, MS-Office Professional, Adobe Acrobat, anti-virus McAfee or equivalent, etc. Application engineering & HMI software - to suit project Specific requirement
Miscellaneous	:	i. 1 Parallel port ii. 1 Serial port iii. 4 – 10/100/1000 MB/1GB network ports iv. Two non-boards and two added v. External SCSI port vi. Dual hot plug power supplies vii. Dual Hot plug fans viii. 2 PCI Express slots (1x4 lane and 1x8 lane) ix. 2 PCI X slots (64bit/100MHz) x. 2 PCI slots (one 32bit/33MHz, 5V & one 64bit/66Mz) xi Redundant Server shall be provided, wherever required. xii. LED based 24” sized Monitors.

Preferred makes of OWS & Servers are DELL, HPCOMPAQ, Lenovo.

4.03.03.07 Industrial grade managed type Ethernet switches

Industrial grade managed type Ethernet switches shall be provided with in built diagnostic features, 20% spare ports & inbuilt redundant 24 V DC power supply features and Integrated Security features (IPS, ACL, Firewall). Industrial grade managed type Ethernet switch shall be rack mounted and comply with the IEC 61850 (3) and IEEE 1613 requirements. Switches shall have 10 GB module support for future upgradeability

4.03.03.08 **The Firewall shall meet following minimum requirements:**

Industrial grade Firewall appliance should facilitate multi-vendor, multi-application environment and should support third-party products on open alliance. It should support Active-Active configuration.

i. The firewall should contain following features:

   (a) Stateful inspection of packets.

   (b) NAT functionality, including dynamic and static NAT translations

   (c) Latest version of SNMP

ii. The firewall must send log information to a separate log server via an encrypted connection. Firewall logging must not impact firewall performance.

iii. Remote network access to the firewall should only be possible through the administration interface.

iv. The firewall administration station must be capable of pushing firewall security policies and configurations to individual or multiple firewalls through a secure, encrypted connection to the firewall administration interfaces.

v. Graphical User Interface (GUI) and a Command Line Interface (CLI) for making changes to the firewall rules set should be provided. (Access to the firewalls via the GUI or the CLI must be through an secure encrypted channel).

vi. Any changes or commands issued by an authenticated user should be logged to a database configured on any of the machines in the LAN. The administration station must allow for a hierarchical architecture for rules set administration and viewing of firewall configurations Management.

vii. The firewall must not support any unencrypted means of access to the firewall.

viii. It should Monitors ALL network traffic-traffic at Firewalls (Internet and external networks), in the DMZ and detect known threat through deep packet inspection.

ix. Detects unknown threats via anomaly scanning.

x. Detect unknown threats via behavior pattern to protect from zero day attacks.

xi. Keeps up-to-date on new threats and vulnerabilities.

4.03.03.09 **Software License**:

The Bidder shall provide software license for all software being used in DDCMIS/PLC/simulator/any other electronic/microprocessor based system. The software licenses shall be provided for the project (e.g. organisation or site license) and shall not be hardware/machine-specific. That is, if any hardware/machine is upgraded or changed, the same license shall hold good and it shall not be necessary for Owner to seek a new license/renew license due to upgradation/change of hardware/machine in

DDCMIS/PLC/simulator/any other electronic/microprocessor based system at site. All licenses shall be valid for the continuous service life of the plant.

In case the s/w license is dependent on no of points, then quantity to be considered is 30% above the finally implemented points.

Software Upgrades

As a customer/owner support, the Bidder shall periodically inform the designated officer of the Owner about the software upgrades/new releases that would be taking place after the each system is commissioned and handing over to owner, so that same can be procured & implemented by bidder at site.

The future updated version of any type of software shall be supplied free of cost as and when such software is upgraded, on request by owner until 5 years from the date of commissioning of the unit.

4.03.03.10 Separate Laptops shall also be provided with all master software loaded and engineering of DDCMIS, DCS, simulator & any other control system individually. Similarly additional Laptops shall be provided with all master software loaded and engineering of PLC system individually.

As explained above, One No. Lap top with necessary master software loaded and engineering of each control System shall **be** supplied individually.

4.03.03.11 **SOFTWARE DOCUMENTATION AND SOFTWARE LISTINGS**

All technical manuals, reference manuals, user's guide etc., in English required for modification/editing/addition/deletion of features in the software of the DDCMIS, DCS & PLC /any other microprocessor based control system/simulator etc shall be furnished. The Bidder shall furnish a comprehensive list of all system/application software documentation after system finalisation for Owner's review and approval.

The software listings shall be submitted by the Bidder for source code of application software and all special-to-project data files.

4.03.04 Programming, Diagnostic and Engineering Work Station

There shall be Two (2) no. work station with 24" sized (Industrial type) LED monitor, associated hard disk 3½", Two color laser jet printer and associated peripherals, as like 52X CD drive, DVD Drive, DVD/CD writer, 1 No. A3 sized Scanner copier cum laserjet printer, and A3 heavy duty industrial grade Coloured LJP with DDCMIS.

For PLC based control system, same shall be provided as listed in Annexure A.

The Engineering stations provided wth DDCMIS, DCS & PLC shall have all the function of programming/ configuration/modification/ reconfiguration and documentation. The features and facilities to be included are as under:-

a) Configuration or re-configuration of a system.
b) Possibility to introduce or modify parameters.
c) Documentation of system configuration.

4.05.00 Design Criteria for BOP packages' Control System

4.05.01 Design Criteria for Programmable Logic Controller (PLC) System

The PLC for BOP packages shall have following features:

i. The PLC system shall fulfill and demands emanating from the domains

- Automation
- Monitoring
- Process control
- Management
- Engineering

ii. Uniform operator machine interface
iii. Reliable user guidance
iv. Comprehensive redundancy concept
v. Modern object oriented software structure
vi. Shall be able to communicate with external system and intelligent field equipment
vii. Simple central project planning and configuration aids
viii. Integrated documentation system
ix. Integrated diagnosis and service
x. Commissioning support
The Control System shall have on-line simulation & testing facility.
xii. The system shall have the flexibility to easily reconfigure any controller at any time without requiring additional hardware or system wiring changes and without disabling other devices from their normal operation mode. Modifications shall not require switching *off* power to any part of the system.
xiii. Fault Diagnostics
Complete software for microprocessor based system including the communication software between systems, MIS system etc., shall be supplied and implemented. The software shall be also included for equipment performance test, life evaluation, equipment capability curve and alarm analysis, Management information system, etc.
xiv General I/O requirements of PLC based system shall be as per cl. No. 4.02.08.02, 4.03.11 and Annexure B.
xv Bidder to note that all PLC system shall be from same manufacturer only. PLC system supplied & engineered through system house shall not be acceptable. It should be supplied & engineered directly from PLC manufacturer only. <u>It is preferred to have each PLC system with hardwares from same family of Plant DDCMIS.</u>
xvi. Design & Functional Requirements as per the cl. No. 4.02.00 detailed for DDCMIS/DCS system shall be applicable for each PLC based control systems.
xvii. PLC shall be provided with necessary redundant ports & complete hardwares for Auto time synchronization from Master clock time by bidder.

4.05.02 Technical specification for PLC

4.05.02.1 The latest proven PLC system shall be provided. PLC should be sourced from original manufacturers; PLC from system house shall not be acceptable. PLC system shall be complete with hot standby redundant CPU of word length of 32bits minimum, Input /

Output modules, dual serial link interface module for connecting Input / Output Modules, dual Communication Processors, dual Memory modules and redundant Power supply units. Power supply unit shall be redundant for each CPU & I/O rack. PLC system will be interfaced with DDCMIS through OPC dual redundant communication interfacing (to be provided at PLC & DDCMIS end) for important process parameters. PLC shall confirm to IEC – 61131.

4.05.02.2 Redundant CPUs in hot standby mode shall operate on fault tolerant mode with continuous self and cross monitoring facility. Redundant CPU/controllers shall be placed separately and shall not share the same motherboard.
Failure of the active CPU shall not adversely affect the operation of the plant in any perceptible way. Failure of the active CPU will lead to transfer of the tasks being performed to the other healthy CPU within fastest possible transfer time (i.e. $\leq$ 50 m sec.) without causing any output to drop during the Transfer period. In the Event of the both the CPU failure, the system shall revert to the Fail-safe mode. The CPUs shall not be loaded over 60% of the Individual capacity even under worst data loading conditions. It shall be possible to switch from the active to the back-up CPU and vice versa from Operating station as well from the CPU front panel. (The worst data condition of PLC means all modules in active mode, printer in operation, OLCS&CLCS logics active and process in running condition). Data bus loading shall not be more than 50%. This configuration shall be applicable for each type of PLC based control system. Engineered solutions for redundancy in CPU & I/O cards are not acceptable.

4.05.02.3 The system shall be of modular construction and expandable by adding hardware modules and incorporating them in the address register. Bidder shall provide at least 20% overall with minimum two no. spare channels as hot-on-rail spares in each configured cards / Modules. In addition to this 10% or minimum one no. extra assigned complete spare cards mounted on rails in sub-racks for each type of I/O modules shall also to be provided. The spare channel and cards shall be fully wired up to termination cabinets. Spare Philosophy as detailed in cl. No. 4.03.11 for DDCMIS/DCS system shall be applicable for each PLC based control systems.

4.05.02.4 The memory unit of the CPU shall be field expandable. The memory capacity shall be sufficient (min. 8 MB per CPU) for system operation and shall have the capability for future expansion at least to the tune of 40%. The application program / sequence logic etc. shall be stored in non-volatile memory (EPROM). However all the dynamic memories shall be provided with battery back up with at least for 96 hours. Lithium or Ni-cd battery shall be used. The quantities of Hot standby redundant CPU/controllers for each PLC system shall be finalized during detailed engineering by owner depending upon CPU/controller's worst data loading conditions and CPU/controller's functional distribution.

4.05.02.5 The max number of Input / Output points per card shall be 32 for digital and 16 for Analog / Thermocouple / RTD. No. of channels may also reduced to meet the I/O cards feature specified in NIT. Individual input channels shall have galvanic isolation. Output points shall also have optical / galvanic isolation. Merely fusing of individual or a group of channels is not acceptable. The I/O cards shall be rack mounted. Failure of Analogue I/O cards, binary cards / modules shall also be displayed on the Engineering cum diagnostic station.

4.05.02.6 The data communication system of the PLC including that of its redundant system bus with hot back up and other allied buses such us I/O bus, local bus etc., shall fulfill the following minimum features. The bidder shall furnish all the calculation details of CPU utilization and Bus loading. Bidder shall also furnish communication protocol used for the offered PLC.

i. Communication links (I/O bus) between CPU and individual Input & Output (I/O) modules rack shall be dual redundant with 10 Mbps speed and 16 bit CRC data protection feature. In no case failure of a link shall affect the control of the plant.

ii. The communication system design shall ensure that any single point failure on the system bus / media shall not disrupt not more than single message and disrupted message shall be automatically retransmitted after the standby communication link takes over control.

iii. Failure of physical removal of any station / modules connected on the system bus shall not lead to any loss of communication.

iv. Diagnostics display both at operating workstation and module front end shall be provided for easy fault detection.

v. Bus change over from active bus to stand by bus, during failure of active bus shall be performed automatically and bumpless. Such event shall be suitably logged or alarmed.

vi. The system communication between PLC controllers and the operators stations shall be conducted at high speed minimum 100 Mbps with Ethernet based open protocol with no collision feature to avoid data jamming / overloading of the system. The communication bus, serial link etc. shall have adequate protection against electrical noise and mechanical damage.

vii. System should have open bus structure and should allow further extension facility and connection with any third party system.

h. PLC Network shall also be provided with external surge protection system and industrial firewall.

4.05.02.7 Man Machine Interface (MMI) shall be industrially ruggedised Operator's station based on latest window based market available software along with its peripherals like LED monitor, printer, mouse. Engineering functions shall normally be carried out from dedicated workstation or operating station as per annexure-A "control system for BOP". In case a dedicated engineering station is provided, EWS shall also be worked as operating station through password / Hardware lock. The monitor refresh time i.e. latency time should be $\leq$ 2 second.

4.05.02.8 The Operator's station shall perform the following minimum requirements.

a. Selection of Auto / Manual, Open / Close operation, sequence auto, start / stop operation etc.
b. Dynamic Mimic display detecting the entire process for control monitoring purpose.

c. Alarm monitoring, report generation, logs, calculations and printing of logs, reports, trends etc.
d. Online / historical trending, historical storage and retrieval of data.

4.05.02.9 Software provided shall be latest, modular, upgradable and industrially proven. It shall have capability for multi tasking, multi programming, multi user operation in real time environment and support for third party system. Bidder shall provide the following minimum requirements:

1. Required software for fulfilling the complete implementation of the control logics, operation displays, logs, data storage, retrieval, diagnostic and other functional requirements as indicated in this specification.
2. Detail documentation on all programming software's and this shall be part of the O & M manual.
3. Supply of Licensed version of all software both in edit and run mode with multi – user license. All the third party softwares should be latest and market available.

4.05.02.10 a. Bidder shall provide and connect suitable communication hardware / software/ cables and other accessories required for connecting all numerical relays as per IEC – 61850 of auxiliary in PLC / SCADA where PLC with OWS.

b. Bidder shall provide firewall (hardware) in various layers to protect PLC from other network as per ISA – SP – 99. Communication to any third party system shall be via industrial grade anti spam, anti virus Firewall only.

c. Bidder shall provide redundant software/hardware link with "online" in Motion Bridge computer and other belt weight system with CHP PLC system to calculate coal flow to indicate following status:

i. Daily and cumulative coal unloaded by track hopper.
ii. Daily and cumulative coal sent to stockpile.
iii. Daily and cumulative coal sent to boiler bunker.
iv. Amount of coal available in stockpile.

d. Remote indication in centralized control room (DDCMIS) for total coal unloaded in 24 hours from ECHS shall be provided.

e. A pneumatic control valve shall be provided at the interconnection line between service air header and instrument air header before air dryer unit. When instrument air header pressure falls below set value, the control valve will start opening and maintain the instrument header pressure at specified level in line with plant requirement. Again when instrument air header pressure goes above specified level in line with plant requirement the control valve will fully close automatically. Complete system shall be in bidder scope.

4.05.02.11 PLC shall specifically meet the following requirements:

(a) PLC shall have extensive self-diagnostic capability. Self diagnostics shall include both module level diagnostics as well as channel level diagnostics

(b) PLC shall have hot standby redundant processors/controllers. This shall mean the fulfillment of the following requirements:

(i) Automatic synchronisation of primary processor/controller of PLC with secondary processor/controller

(ii) Bumpless switchover to secondary processor/controller of PLC when the primary fails.

(c) Automatic program and data equalisation in the event of any on-line program / edit executed in the primary processor/controller of PLC.

(d) Automatic "Forcing Bit" update in the secondary processor/ controller of PLC when any " Forcing is applied in the primary processor/controller of PLC.

4.05.03 **SYSTEM REQUIREMENT & SPECIFICATION**

4.05.03.1 The system shall have high MTBF and shall be hot maintainable. The system hardware shall be designed to be fault avoidant by selecting high grade components of proven quality and properly thermally de-rated design. The system shall have extensive fault monitoring, self surveillance & on-line self diagnostic capability so that failure up to module / card level is immediately detected. Each of the modules shall have its self – diagnostic system. The operator station located at the area control room shall be used for fault data presentation and monitoring purpose.

4.05.03.2 The system shall have capability to automatically check & correct gain & drift for ADCs on-line.

4.05.03.3 All data exchanged in a bus shall be fully monitored & checked for validity.

4.05.03.4 Loop Cycle time in PLC shall be equal to or less than.

a. OLCS : 100 ms or less
b. CLCS : 250ms or less

4.05.03.5 Following operations will be performed on I/Os, as required:

1. Square root extraction
2. Pressure & Temperature compensation
3. Responsibility check of all inputs (analog specially), validate and quality tagging like good, bad, suspects etc
4. Channel wise engineering unit conversion.
5. Contact bounce filtering with adjustable time constant.

4.05.03.6 All controllers shall be freely configurable with respect to requisite control algorithms. An extensive library of macros shall be included for the purpose adequate software capability shall be provided to implement closed loop control functions as follows:

i) P, PI, PD and PID control and their variations.
ii) Open loop (On- Off, sequence control)
iii) Cascade control
iv) Ratio control

4.05.03.7 For open Loop Controls, the system shall have, as a minimum, the following features:

a) Logic functions like AND/OR/NOT gates, timers (on-delay, off-delay), shift registers, counters, latches, flip-flops, mono – shots, tantalizers etc.

b) The automatic sequence control to ensure sequential start up and shut down of auxiliaries / equipment. Sequence control shall be performed in groups initiated by command from operator's console. A sequence shall be made of steps executed in predetermined order according to logic criteria. For each step there shall be a provision for 'waiting time' and 'monitoring time', and it shall output an action on the process. System shall have the capability to by pass one step if desired by the operating personnel by forcing an input or output from the operator's station. Such action however will be registered as an exception or alarm.

c) Increase the reliability and availability of the plant as a whole, for example, by timely and correct switchover to standby drives etc.

d) Basic interlock and protection logic related to safety of individual drive and plant equipment. All inputs required for protection system shall be on high priority basis. In the event of either loss of control power or control signal input to the drive, the drive shall remain in its last position unless specifically required otherwise. The system shall be designed such that no upset occurs either to process or to the drive when the power is restored.

4.05.03.8 Interface of the PLC system with AC Solenoids & DC Solenoids shall be in the form of potential free contacts via interposing relay modules mounted in the interposing relay cabinet. 20% additional interposing relay modules shall be provided as installed spare. For AC solenoids and contactors directly driven from output cards, arc suppressors & MCB shall be provide across the coil.

4.05.03.9 **Displays**

4.05.03.9.1 The operator's station shall be responsible for handling all commands as well as in generating desired displays, logs, reports, alarms and printouts. Security in different levels shall be provided to prevent unauthorized access to the system.

4.05.03.9.2 Programming shall also be permissible by drawing Ladder or Boolean diagram or through any easily understandable language. Single programming instruction / command shall be sufficient to delete a program rung from memory. Similarly, any rung can be inserted into the existing program. The active and the standby CPU programs shall equalize automatically, once the new program is permitted to 'RUN'.

4.05.03.9.3 Updating time and reaction time (system's response to an operator's command) shall be provided for operator station as follows:

a. Calling up a mimic : 1 sec or better

b. Updating status signal in mimic : 1 sec or better

c. Updating variables in a mimic : 1 sec or better.

d. Issuance of command to output : 2 sec. or better

(without considering travel time and process lag)

4.05.03.9.4 Programmable Controller shall be responsible for real time process Parameter monitoring, storage and display. Basic requirements are (i) Operator Interface, (ii) Basic

Calculation, (iii) Alarm Monitoring & Reporting, (iv) Display generation, (v) Logs, (vi) Trend Recording & (vii) Historical Storage & Retrieval.

4.05.03.9.5 The displays at the operator console shall be classified into overview Display, group display, point display, alarm display and trend display.

a) Overview display – This display is to enable the operator to set an overview of the entire plant section.

b) Group display – The group display page shall display several sub-sections & present status information.

c) Point display – Along with the specified parameter value, this page should indicate historical trend of the parameter.

d) Trend display – This display include real time/historical trend display facility including Dynamic Graphic Display & Bar Graph Display.

e) Alarm Message Display – It shall be possible to display process as well as system and diagnostic alarms for operator's attention and action. Alarm shall appear immediately on the operator station as and when they occur on priority basis. In addition to alarms appearing on displays, the system shall also be able to display alarm summary and alarm history listing the date and time of occurrence, tag number, point description, type of alarm (absolute value or deviation), serial number of alarm in the sequence of occurrence etc. Alarm shall disappear from display only when they are acknowledged and cleared. Any abnormal condition in any sub-system or any other function devices shall be displayed as system alarm message on the operator console irrespective of display selected.

4.05.03.9.6 The system shall print the following logs as minimum as defined in the Following clauses. The printing of these logs shall be initiated automatically at prescribed time intervals, or initiated on demand by the occurrence of predefined events.

Shift/Daily Log

A Shift/daily log shall be provided to furnish data for routine analysis of plant performance. This log shall be automatically printed at specified time each day and on demand at any time.

4.05.04 **Salient hardware / software features of the PLC system**

The salient hardware / software features of the PLC system for I/O handling shall be as follows.

1. Input filters to attenuate noise.
2. SWC of 500v DC common mode and 500V AC peak to peak
3. Comm. Mode Noise rejection for analog inputs of 120dB at 50 HZ
4. Normal mode noise rejection for analog inputs of 60 dB at 50 HZ
5. LED indicators on each card to show status of input
6. All the outputs shall be with individual fuse.
7. K type thermocouple mV input where applicable.
8. Pt-100 three wire resistance thermometer input where applicable.

9. 24 V DC power supply to field mounted two wires transmitters.

4.05.04.1 The salient hardware / software features of the CPUs as follows:

a)	Watch dog timer	:	Periodical reset, Alarm and interruption, if not reset within stipulated time.
b)	Max. Scan time for I/Ps	:	1 sec. max. for measurments
c)	Maximum Scan Rate	:	2.5 ms (per k word)
d)	Memory Capacity	:	40% spare capacity after full utilization Expandable in multiples of 16K.
e)	Comm. Processor	:	Integral / Separate
f)	Power Supply	:	Dual redundant at each CPU rack
g)	Control Processor	:	32 bit processor , RISC based.
h)	Battery back up for RAM	:	Ni-Cd / lithium type, at least for 96 hrs continuous Operations during power failure.
i)	Diagnostic feature	:	Periodic, automatic, self-diagnostic. Result available at the Operator's Station.

4.05.04.2 **Input / Output Modules:**

Bidder to note that All I/O cards shall be sourced from their original manufacturers/Principal. Indigenous cards shall not be accepted. No. of channels per I/O card may reduced to meet the I/O cards features specified in NIT. The salient features of the Input / Output modules are as follows:

a) All I/O Cards

1.	Ambient temp.	: 0-50 degree C
2.	Surge withstand capability	: IEC-255.4
3.	Power Supply	: Dual redundant at each I/O rack

b) Digital General

1.	No. of channels / card	: 32 max
2.	Interrogation voltage	: 24/48 VDC
3.	Status Indicator	: LED Type./channel
4.	Isolation	: Optical (channel to channel)
5.	Electrical Isolation	: between system and field

c) Digital Input Module

1.	Contact bounces filtering	: Adjustable time constant of 15m.sec.
2.	Self Diagnostic	: Wire break, Short Circuit

d) Digital Output Module

1.	Output protection	: Short ckt protected and individual fuse

e) Analog General

1.	No. of channels/card	:	Input /output – 16 channel
2.	Isolation	:	Galvanic/Optical (channel to channel)
3.	Status Indicator	:	LED Type./channel
4.	Fuse protection for failure	:	Individual for each signal

f) Hi-Level Analog Input Module

1.	Type of input	:	4-20mA DC & 1-5VDC
2.	A/D Converter	:	14 bits + Sign (or better)
3.	Accuracy	:	0.1% or better
4.	Diagnostic	:	A to D / Channel fault, Short circuit, wire break
5.	Power of transmitter	:	24 V DC 2W type

g) Low Level Analog input Module

1.	Type of output	:	PT-100; T/C (As required)
2.	C-J-C	:	On Module
3.	Accuracy	:	0.1% or better
4.	A/D converter	:	14 bits + sign (or better)
5.	Diagnostic	:	A to D / Channel fault, short circuit, wire break

h) Analog Output Module

1.	Type of output	:	4-20mA DC
2.	Accuracy	:	±0.1% or better
3.	Load	:	600 OHM
4.	Diagnostic	:	Channel fault

i) The maximum number of channels with LEDs indications that can be provided in a single module shall be:

(i) Digital input module/ Digital output module - 32
(ii) 4-20mA input/output modules - 16
(iii) Thermocouple / RTD input module - 16

j. Input/Output modules shall have the following features:

The functions performed on digital inputs shall include:

(i) Signal isolation (optical)
(ii) Fuse protection & monitoring
(iii) Short circuit protection
(iii) Contact bounce protection
(iv) Contact monitoring for trip and causes of trip inputs
(v) Contact interrogation at 24/48 V DC
(vi) Configurable as status input, latched input or pulse input
(vii) Direct or reverse sense
(viii) Alarming of abnormal state

k. Digital outputs shall have the following characteristics:

i) Individually fused
ii) Individual contact suppression
iii) Configurable as momentary, latched or pulse- width modulated Outputs
iv) Individually definable default state
v) Output read back verification
vi) Short circuit protection

l. Analog inputs can be 4-20 mA DC, RTD, thermocouple. A/D converter shall have a minimum resolution of 14 bits. Functions performed on analog inputs shall include

i) Signal isolation (Galvanic/opto coupling)
ii) Fuse protection and fuse failure detection
iii) Transmitter power supply at 24 V DC
iv) Input filtering for noise level
v) Cold junction compensation for thermocouples
vi) Transmitter monitoring for parity, wire break, live zero and end limit values
vii) Monitoring of A/D conversion
viii) Test for substituted value
ix) Conversion to engineering units
x) Test for normal or extended range
xi) Detection of open circuit for thermocouples
xii) Alarm limit testing for high, low, high high and low low substituted values
xiii) Rate of change - positive and negative dead band
xiv) All analog signals fed to the control system shall be acquired and validated.

m. Analog outputs shall be 4-20 mA DC with the following characteristics:

i) Direct or reverse operation
ii) D/A per output and power regulator per output
iii) Loop check back of output
iv) Default options upon failure
v) 5-segment output characterization
vi) Go to zero current

4.05.05 **PLC Configuration**:

The PLC configuration will have a hierarchy of industrial grade open system architecture for management information system (MIS) and closed system architecture for plant operation and control system.

The specification of Peripherals for Operator Station, Engg Station & printers for PLC/microprocessor based system shall be as same as specified at cl. no. 4.03.03.04.

The complete MIS system including hardware, software, cables etc, as required shall be provided. This shall acquire dynamic pre configured points and mimics as required by Owner.

The closed system architecture for plant operation and control system is secure and deterministic system for real time operations of the plant.

Industrial grade managed type Ethernet switches shall be provided with features as same as specified at cl. no. 4.03.03.07.

PLC Network shall also be provided with external surge protection system and firewall.

"The Bus systems (like Profibus/ Modbus etc) or the Serial Port Systems (like RS-232/ RS-485 etc) shall be protected with suitable surge protection devices, confirming to the latest IEC-61643-21 guidelines. The surge handling capacity of device shall at least be 10 KA, 8/20 µSec between core-core and 20 KA, 8/20 µSec between core-ground. The device shall be pluggable & on-site testable".

All the operator stations will be 'work stations grade' as same as specified at cl. no. 4.03.03.04 and are required to reside on the main redundant bus running on IEEE 802.4 or IEEE 802.5 to facilitate determinism.

4.05.06 Redundancy Criteria (For details also refer chapter no. 2)

i. Redundancy of components and systems shall be dictated by availability criteria to ensure the system availability target as well as safety considerations in critical applications.
ii. Dual/Triple redundancy for sensors and transmitters will be used for critical and semi critical applications i.e for interlocks/trip/protection conditions (as decided by Owner).
iii. The Wiring Scheme for inputs/outputs to/from PLC control system shall be as same specified at Vol. V, cl. No. 4.02.08.02.1.
iv. Sensor redundancy (1 out of 2 or 2 out of 3) requirement shall be indicated in the respective control system.
v. The CPU / Controllers, communication modules, data highway, power supply modules, etc for all PLCs shall be 100% hot standby redundant.
vi. All drive input/output modules redundancy shall be as per Annexure – B.
vii. All input/output of SCADA from/ to breaker & isolators shall be redundant.
viii. Redundant Cooling fans with fire retarded filter for panels/cabinets

4.05.07 CONTROL PANEL AND OPERATOR INTERFACE (For details also refer chapter no. 6)

i. Operating console desks for OPERATING STATION's and KB shall be provided by bidder along with their printers in AC control room.

ii. OPERATING STATION/KBD shall generally be used for control and monitoring.

iii. Complete industrial grade Furniture for mounting Operating stations, Swivel Chairs, Printers, Keyboards, Computer etc. shall be furnished by bidder.

iv. In the Back up Control desk and relay based system following operator interface devices shall be provided as per Annexure A.

a) Control station (illuminated P.B. stations, Desk P.B., control switches etc).
b) Hardwired Annunciator with push buttons.
c) Coloured Mimic with LEDs for Drive status (ON, OFF, & trip) and level (Low & High) of tanks.
d) Process recorders, indicators & Ammeters as decided during detailed engineering.

v. Control panels housing the control cards/equipment marshalling cabinets shall be located in a control room; and shall have IP-32 min. degree of protection as per IS-13947 offering dust and vermin protections, 2 mm thick steel sheets (CRCA) shall be adopted for fabrication, consistent with weight of devices, control equipment to be mounted. UPS panels shall be with 2 mm thick steel sheet (CRCA). Cable gland plate thickness size shall be 3mm. Mimic shall be made of Acrylic sheet with thickness of minimum 6/7 mm.

vi. Panels shall be furnished complete with requisite accessories such as transformers, regulators, switch fuse units, MCB, MCCB and other power supply equipment to adopt the sources of power supply to requirements of panel mounted instruments and devices.

vii. All panels, cabinets and enclosures shall be furnished, fully, wired with necessary provisions for convenience outlets, internal lighting, grounding, ventilation, space heating, and vibration isolation pads, double compression cable glands, integral piping and other accessories as per IS: 5039- 1969.

viii. The sealing of panels/cabinets/enclosures bottom with bottom plate. Double compression cable glands and suitable sealing material to prevent entry of dust shall be in the Bidder's scope. Suitable arrangement for preventing fire propagation through cable entry points like fire seals etc. shall also be provided at cable entry points.

xi. Fire/Smoke Detector, Neoprene/silicon Gasket, Exhaust Fans with louvers & filters shall be provided in all consoles and panels.

x. All the panels shall be equipped with Anti vibration pad of 15 mm size.

xi. PLC with OWS –

a. All winding/Bearing Thermocouple/ RTD shall be connected to PLC.
b. All analog inputs i.e. Temperature, Pressure, flow, level, vibration etc. shall be connected to PLC.
c. Only important parameters shall be display on desk / Panel.
d. Bidder shall provide Ammeter on panel for all HT Motor current & $\geq$ 15 KW LT Motor and very important LT drives as decided during detail engineering.

Checklist for Serial Communication between maxDNA Systems and Foreign Device :BHEL

A Device Specific :

SN	Parameters	Options available	Remarks if any
1	Modle No.& Make of Device		
2	Communications Link Options	☐ Multidrop ☐ Peer to Peer ☐ N/w topology attached	
3	Protocol Mode (Device is a)	☐ Master ☐ Slave ☐ Master/Slave	
4	Protocol	☐ RTU ☐ ASCII ☐ Other ----------	
5	Master	☐ System maxDNA ☐ Other ----------	
6	Dist.bet.maxDNA System & Device*	☐ ---------- Feet ☐ ---------- Meters	

B Electrical Spcific :

1	Interface Type	☐ RS232 ☐ RS422 ☐ RS485	
2	Wiring at Device end	☐ 2 Wire ☐ 4 Wire	
3	Transmission Channel	☐ Half Duplex ☐ Full Duplex	
4	Baud Rates (bps)	☐ 1200 ☐ 2400 ☐ 4800 ☐ 9600 ☐ 19200	
5	Databits	☐ 8 ☐ 7	
6	Stopbits	☐ 1 ☐ 2	
7	Parity	☐ None ☐ Odd ☐ Even	
8	H/w & Software Handshake	☐ Yes ☐ No	
9	Response Timeout time (Sec)	☐ ---------- ☐ Configurable timeout	
10	Data Formats Supported	☐ Boolean ☐ Real ☐ Char ☐ Sn.Int ☐ UnSn.Int	
11	Transmission mode	☐ Asynchronous ☐ Synchronous	

C Application Specific : *

1	Primary Function*	☐ Data Acquisition ☐ Data Acquisition & Control	
		☐ Download parameter sets	
2	Analog Points to read	--------Nos. ☐ Details attached ☐ Details not attached	
3	Analog Points to write	--------Nos. ☐ Details attached ☐ Details not attached	
4	Digital Points to read	--------Nos. ☐ Details attached ☐ Details not attached	
5	Digital Points to write	--------Nos. ☐ Details attached ☐ Details not attached	
6	Memory / Flag Points to read	--------Nos. ☐ Details attached ☐ Details not attached	
7	Memory / Flag Points to write	--------Nos. ☐ Details attached ☐ Details not attached	

D Hardware Specific :

1	Cable type	☐ Boolean cable ☐ Twisted pair cable	
2	Cable Details Enclosed	☐ Yes ☐ No	
3	Any specific Converter required	☐ Yes ☐ No ☐ Details enclosed	

E Device Documents :

1	Manufacturer's Documents*	☐ Tech., Spec. ☐ Operating Manual	

***Notes:**

A6 To identify converter requirement and cable length.

C The sr.no.1 to 7 are reqd.to be furnished for interface impl. :such as Tagname,Description,point type, modbus(Register) address,EU,range & device (dlave) address

C1 What is the primary purpose of the communications link?

E1 Reqd. Contents : This document must provide an overview of the device including its intended use(a general technical,communication & electrical details)

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Format for vendor to furnish signal
Exchange list between DCS-PLC

Tag Name	Tag Description	Modbus address	Point type	Range	Alarm Setpoint	Alarm priority	History reqd	Function code	

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STANDARD QUALITY PLAN
FOR
PROGRAMMABLE LOGIC CONTROLLER

QUALITY PLAN NO.:	**PE-QP-999-145-I036___**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 24.08.2007
SHEET	1 OF 8

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
1.0	**Materials /Components**											
1.1	Panels & Control Desks	Physical Inspection for Dimensions, Painting, Cutouts, Lifting / Locking Arrangements, Components, Drawing Pocket, Mounting accessories, Plinth & AV Pads, Cable Gland Plates, Hardwares, Hinges, Louvers & Filters, Fans & Panel Lamps	MA	Visual	100%	Contract specifications, Approved GA Drawings, BOQ	As per ref documents. No physical damage.	BHEL Quality Inspection Report.	3/2	2	1	
1.2	Power Supply/Packs, Battery & Battery charger, Transformer, UPS.	Physical Inspection Physical Damages Dimensions Mounting Accessories	MA	Visual	100%	Contract specifications, BOQ.	As per reference documents, Test Report	BHEL Quality Inspection Report.	3/2	2	1	
1.3	Indicating Lamp, Annunciator, Meters, Transducers, Signal Converters, Instruments, Single Loop Controllers	Physical Verification Physical Damages Dimensions Accessories	MA	Visual	100%	Contract specifications, BOQ.	As per ref documents No physical damage. Test/ Calibration report.	BHEL Quality Inspection Report	3/2	2	1	
1.4	PLC processors, I/O modules, Power Supply modules, Communication modules, Mounting Racks, Ethernet	Physical Inspection • Identification Labels • Physical Damages • Quantity • Spare Capacity	MA	Visual	100%	Product Catalogue, Data sheets, Approved Configuration diagram, BOQ	As per ref documents. Test Certificates	BHEL Quality Inspection Report.	3/2	2	1	

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LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics
$ P - Agency Performing the Test.; W - Agency Witnessing the Test.; V - Agency Verifying the Test.
1 - BHEL; 2 - Vendor; 3 - Sub-vendor

PEM :: C&I

STANDARD QUALITY PLAN
FOR
PROGRAMMABLE LOGIC CONTROLLER

QUALITY PLAN NO.:	**PE-QP-999-145-I036___**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 24.08.2007
SHEET	2 OF 8

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
1.5	CPU, Monitor, Keyboard, Mouse, CD Drives, Printers, OS, System Software, Engineering software in the form of Licensed CD.	Physical Inspection Identification Labels, Tech. Specification Physical Damages Accessories Installation arrangements for Computers & Printers	MA	Visual	100%	Contract specifications, Product Catalogue, Approved GA / Configuration drawing, BOQ.	As per reference documents.	BHEL Quality Inspection Report.	3/2	2	1	

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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	
2.0	**Assembly**											
2.1	Functional Test for HMI/OWS devices such as Monitors, Keyboards, Mouse, Printers etc.	Operation	MA	Functional	100%	Approved Configuration Diagram & BOQ and FAT	Correct Operation of interconnected Devices of HMI system.	BHEL Quality Inspection Report.	2	1	1	
2.2	Hardware Functional Verification.	Physical arrangement, Wiring check & labeling, Continuity Checking, IR & HV test	MA	Visual/ Electrical	100%	Approved GA Drawing, Panel Wiring Diagram, IR & HV as per relevant International standard	Test Certification	BHEL Quality Inspection Report.	2	2	1	
2.3	Powering Up	Healthiness of all the modules/equipment, associated with Powering of PLC system	MA	Visual /Electrical	100%	Approved power supply scheme	All equipment to be healthy on power ON	BHEL Quality Inspection Report.	2	1	1	
2.4	Burn in test for PLC modules	Healthiness of PLC modules on Continuous Energisation, Temperature maintenance	MA	Visual/ Electrical	100%	FAT Procedure	Test certification as per FAT	BHEL Quality Inspection Report.	2	2	1	

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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
3.0	**Factory Acceptance Test (FAT)**											
3.1	Input Output Functional Verification	I/O configuration, I/O operation	MA	Visual/ Eletrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.2	Processor Verification	Processor configuration, Powering up, standby operation (as applicable) and Loading	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.3	Power Supply Module Verification	Redundancy Operation	MA	Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.4	Communication System Verification	Redundancy operation of Communication System, Measurement of Response Time, Communication with third party system	MA	Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.5	Diagnostic Verification	Self Diagnostic features of PLC system	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.6	Control Panel/Desk Verification	Operation of PLC driven annunciation system, Mosaic, Push buttons & selector switches, Indicating lamps	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.7	Software Verification	(i) Control Logics (ii) Engineering Features (iii) HMI Features	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	

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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

FACTORY ACCEPTANCE TEST (FAT) PROCEDURE

This document covers procedure to conduct/witness PLC system functional tests in order to demonstrate conformity to purchase specifications and related engineering documents. The test shall be conducted at the system suppliers works. The system supplier shall conduct all functional tests before commencing FAT and test results shall be made available during FAT. Vendor must furnish following relevant drawings, duly approved by BHEL Engineering, for reference during FAT.

a) Technical Specification of PLC.

b) PLC System Configuration

c) General Assembly Drawings.

d) Panel Wiring Diagrams.

e) Bill of Quantity for PLC System.

f) Logic Diagram.

g) HMI Schematics.

h) Input / Output List.

Further the vendor shall furnish applicable product specification, datasheets, catalogues, test-certificates, and internal inspection records to enable FAT. Vendor shall also submit, to the inspecting agency, his standard test procedure, for clauses given below; where vendor's standard practice has been referred.

APPLICABLE TEST PROCEDURE:

1. Input/Output Functional Verification.

Check for correctness of addressing of racks, slots and I/O modules as per applicable PLC configuration diagram. Appropriate signal generators shall be used to simulate Inputs and outputs to check operation and SCAN time. Check online replacement of cards, processors, power supply etc.

2. Processor Verification

PLC Configuration drawing to be referred for ascertaining

i) Redundancy

ii) Type (Hot or Cold)

Both the processors are to be checked for healthiness in case of redundant configuration as per vendor's standard practice. In case of hot redundancy, switchover of control from primary processor to standby processor shall be demonstrated for uninterrupted control and data processing as per vendor's standard practice. Switchover shall be witnessed, by manual power off or resetting the Primary CPU or simulating failure of primary processor. Checking should be by witnessing the lighting up of Processor's LEDs as per manufacturer's product standard.
Vendor shall demonstrate, as per Vendor's standard practice, adequate Loading (Spare Capacity) of Processors, as mentioned in contract specs. This shall be done, by simulating worst load operation of fully integrated PLC system.

3. Power Supply Module Verification

Check if PSM is in redundant mode as per specification. Check the healthiness of power supply from both the modules' lamp indication/measurement. Simulate failure of one PSM and verify that standby PSM has taken over without any interruption.

4. Communication System Verification

Communication system has to be in line with approved PLC Configuration Diagram. Verify that both the communication buses are intact and connected. Communication between PLC processors, I/O rack, OWS etc. is to be checked through simulation of input data. Simulate the bus failure by disconnection of working bus. Check that the communication continues without interruption or loss of data.

Following response times are to be demonstrated as per vendor's standard practice for conformance to contract specifications:

1. Screen update time
2. I/O scan time
3. SOE resolution time
4. Data transfer time with third party system using Communication Protocol as per Contract specification and as per quantum of data as per approved signal exchange list.

5. Diagnostic Verification

Product Catalogue/Literature shall be referred for checking of all diagnostic features. Hardware failure to be simulated by removing an I/O

6. Control Panel /Desk Verification

i) PLC driven annunciation system should be checked by alarm signal simulation.

ii) Push Button and selector switch operation should be checked by verification of corresponding change of status of Data Base point.

iii) Indicating lamp / MIMIC should be checked by corresponding Data Base point simulation.

7. Software Verification

i). Control Logics:– Software switches, lamps and Analog sources shall be used for simulation of field conditions .Control logics shall be checked for its correct functionality as per approved logic schemes

ii). Engineering features:-
a) Online changing of parameters, set points.
b) Online modification in Control Logic Diagrams.
c) Online configuration of Graphics, Trends, Logs, HSR.

iii). HMI features:-
Check for configuration & operation of Graphics, Trends, Logs, HSR and Alarms, in the form of Displays and Printouts, by simulation of Inputs as per approved documents.

8. Burn in Elevated Temperature test

Electronic equipments shall be subjected to Burn in elevated temperature test as per the procedure detailed below:

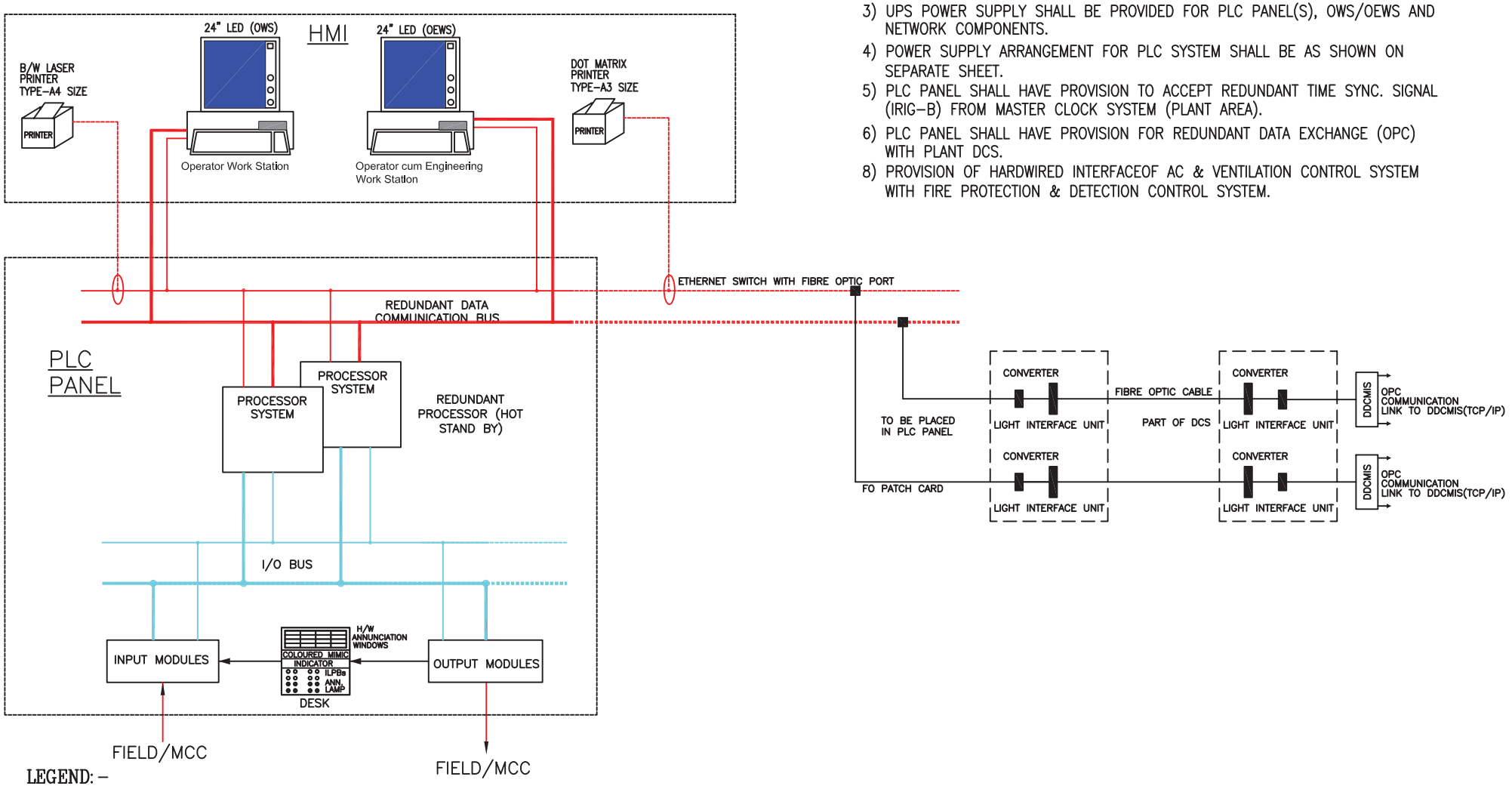
a) (i) PLC modules are kept at 50 Deg c under continuous energized condition for 48 hours.

ii) 48 hours test period shall be divided into 4 equal time segment of 12 hours duration each. For every 12 hours duration segment, after lapse of first 11 hours 110% of nominal voltage shall be applied to the panel under test for a period of 30 minutes followed by application of 90% of nominal voltage for the next 30 minutes.

b) Assembled Panels with complete wiring shall be kept under continuous energized condition for 120 hours at ambient temperature. Temperature rise in panels should be below 10 Deg C above ambient.

NOTES:

1) TABLE TOP OWS/OEWS SHALL BE OF LED 24" OR AVAILABLE INDUSTRY STANDARD.
2) PLC SYSTEM SHALL HAVE REDUNDANCY IN PROCESSOR, COMMUNICATION SYSTEM AND POWER SUPPLY.
3) UPS POWER SUPPLY SHALL BE PROVIDED FOR PLC PANEL(S), OWS/OEWS AND NETWORK COMPONENTS.
4) POWER SUPPLY ARRANGEMENT FOR PLC SYSTEM SHALL BE AS SHOWN ON SEPARATE SHEET.
5) PLC PANEL SHALL HAVE PROVISION TO ACCEPT REDUNDANT TIME SYNC. SIGNAL (IRIG–B) FROM MASTER CLOCK SYSTEM (PLANT AREA).
6) PLC PANEL SHALL HAVE PROVISION FOR REDUNDANT DATA EXCHANGE (OPC) WITH PLANT DCS.
8) PROVISION OF HARDWIRED INTERFACEOF AC & VENTILATION CONTROL SYSTEM WITH FIRE PROTECTION & DETECTION CONTROL SYSTEM.

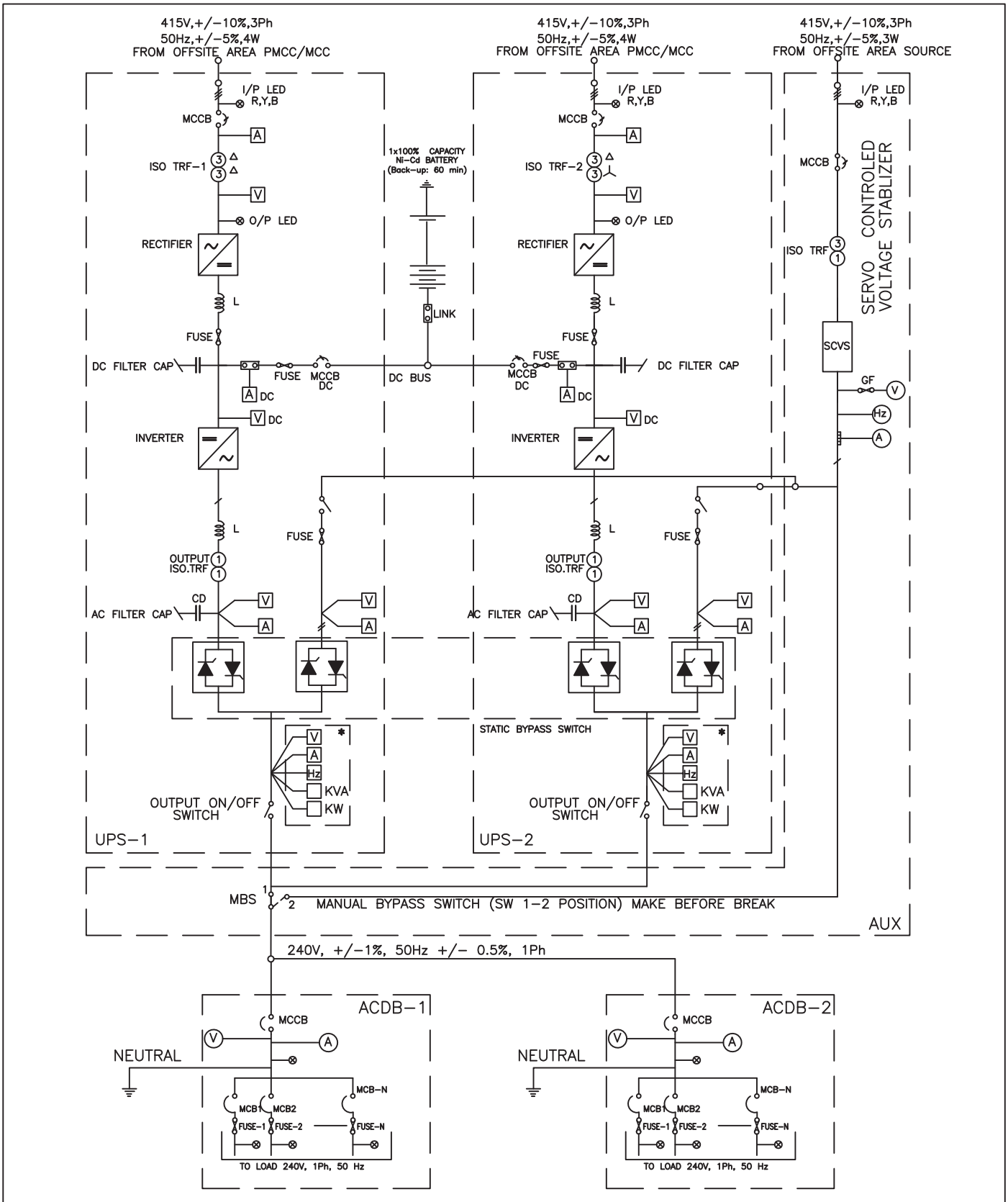


LEGEND: –

PLC	–	PROGRAMMABLE LOGIC CONTROLLER
DCS	–	DISTRIBUTED CONTROL SYSTEM
UPS	–	UNINTERRUPTED POWER SUPPLY
OEWS	–	OPERATOR CUM ENGINEERING WORK STATION
HMI	–	HUMAN MACHINE INTERFACE
NTP	–	NETWORK TIME PROTOCOL
OPC	–	OLE PROCESS CONTROL
MCCB	–	MOULDED CASE CIRCUIT BREAKER
MCB	–	MINIATURE CIRCUIT BREAKER

BHEL	TITLE:– PLC SYSTEM CONFIGURATION AC & VENTILATION	DRG. NO.	
		REV. No.	DATE
		SHEET	1 OF 1

Anshul
S A Khan
Praveen Kishore



* V, A, Hz, KVA, KW READINGS/VALUES SHALL BE READY ON THE MIMIC DISPLAY PROVIDED ON THE UPS PANEL FRONT DOOR.

NOTES:−

1) POWER SUPPLY TO PLC SYSTEM/RIOs/RPUs PLACED IN THE BTG AREA MAY BE PROVIDED FROM MAIN PLANT UPS.
2) UPS POWER DISTRIBUTION FOR PLC & HMI SHALL BE AS PER REQUIREMENT MENTIONED IN SHT 04 OF 06.

BHEL	TITLE:− TYPICAL POWER SUPPLY ARRANGEMENT FOR PLC BASED CONTROL SYSTEM	DRG. NO.	PE−DM−412−145−I900	
		REV. No.	01	DATE 04.03.2015
		SHEET	06 OF 06	

Anshul S A Khan Praveen Kishore

F. SPECIFICATION

FOR

UN-INTERUPTED

POWER

SUPPLY

CHAPTER-7

UNINTERRUPTIBLE POWER SUPPLY SYSTEM & 24 V DC SYSTEMS

7.01.00 GENERAL REQUIREMENTS

7.01.01 This subsection covers design, construction and performance requirements of parallel redundant industrial grade Uninterruptible Power Supply (UPS) System & parallel redundant 24 V DC System to be furnished by the Bidder for BTG, Station C & I Package & BOP/offsite packages & any other control system/sub system specified elsewhere in the specification. The Bidder shall furnish separate parallel redundant industrial grade UPS System for each unit DDCMIS/DCS Package and separate parallel redundant industrial grade UPS System for each BOP package including static inverters, static switches, manual bypass switch, chargers, A.C. Power distribution panels and Batteries with all required isolating and protecting devices and all other equipment and accessories required for completeness of this system. Bidder to note that there will be no common component like in phase transformer (IPT), common power supply to any redundant component and common point of failure in the UPS & 24 V DC system.

7.01.02 The requirements of UPS system & 24 V DC system are specified herein on system basis. The Bidder shall be responsible for engineering and furnishing a complete and operational system fully meeting the intent and requirements of this specification and Owner approved drawings.

7.01.03 The equipment furnished under this subsection shall meet the requirements of all applicable codes and standards including ANSI, NEMA, TEEE, NEC and IS.

7.01.04 The UPS System & 24 V DC system hardware shall be from the latest established product range of a qualified manufacturer. The Bidder shall furnish documents to satisfy the owner that the design, performance and high availability of the proposed UPS System, 24 V DC system and all system components have been established by a considerable record of successful operation in utility power station for similar application. All UPS system & 24 V DC system cabinets, enclosures and distribution boards shall be manufactured, assembled, wired and fully tested as a complete assembly as per the requirements of this specification in the manufacturing works of a qualified manufacturer prior to shipment to the project site. Class of insulation of wound components (All transformers, chokes/inductances etc.) shall be class H with temp rating up to class B.

7.01.05 The UPS, 24 V DC system equipment and the complete system shall have surge withstanding capability (SWC) to meet the requirements of ANSI C 37.90a – IEEE Standard 472 –1974. UPS & 24 V DC charger system should be provided with Class C type surge protection device. The Class C type surge arrester should be single MOV type , pluggable, should have fault indication and should be tested as per IEC 61643-1 to withstand 40KA 8/20 µs pulse. The arresters should have potential free contact to ensure maintainability.

7.01.06 All non-interrupting components of UPS system & 24 V DC systems shall be capable of withstanding all available short circuit current without damage. Additionally, all circuit interrupting components shall be capable of withstanding and interrupting all encountered short circuit currents without damage.

7.01.07 All control and instrument circuits shall be fused. Fuses shall be mounted inside the enclosures and shall have easy accessibility. Fuses shall be Buss man low-peak type or Owner approved equivalent. All load fuses shall be to Owner's approval equal. The Bidder shall co-ordinate all load and line fuses applications to ensure that load fuses operate properly.

7.01.08 The bidder shall be responsible for ensuring that UPS System, 24 V DC system and the downstream power distribution system for equipment to be serviced by are coordinated such that UPS loads continue to operate without interruption and in accordance with the power supply tolerance requirements (both voltage and frequency) for these UPS loads as long as at least one source is within the limits of voltage and frequency as specified herein. The Bidder shall furnish single line diagrams with his proposal to demonstrate how this requirement is met for all equipment and system covered under Bidders scope.

7.01.09 The UPS system & 24 V DC System shall be installed in AC room.

7.01.10 Acoustic noise at rated linear load shall be < 75 dBA at 1 meter distance from UPS as per ISO 3746.

7.02.00 FUNCTIONAL REQUIREMENTS OF UPS

7.02.01 CAPACITY OF UPS SYSTEM FOR main plant PACKAGE, remote I/O panels and BOP/OFF-SITE PACKAGES

Parallel redundant UPS shall be sized by the bidder to cater to power for the bidder furnished loads such as plant control, monitoring system. Min. capacity shall be considered as 150 KVA (or as per system requirement in case capacity is higher than 150 KVA) at 50 deg. C ambient. All microprocessor based system, I/o cards, digital equipments, operating stations, printers, peripherals, receiver instruments, SWAS, CEMS, LVS, HMS, TSI, VMS, PADO, C&I Lab, Operator training Simulator system and other devices mounted in supervisory control desk, control panels and other microprocessor based system for BTG shall be operated on UPS power.

Each Individual parallel redundant UPS shall be designed considering 20% design margin over and above any capacity mentioned in specification; UPS sizing calculation shall be submitted for approval. While computing the base capacity of the UPS, inrush requirements of connected loads shall be duly considered. The inrush shall be taken as 300% of steady state load lasting for 100 milli seconds. The base capacity shall be computed by bidder on above basis and to provide for at least 10% variation to cater to changed load requirements during detailed engineering stage. Bidder shall detail in the technical bid, the steady state as well as inrush requirements of each of the loads furnished by him and justify the selection of UPS capacity duly satisfying the requirement of 20% design margin.

This base capacity shall be guaranteed at 240 V AC, 50 Hz single phase output at 50 deg. C & 95 % RH – non condensing at ambient conditions. Ratings other than standard ratings of the manufacture shall not be acceptable. Number of distribution feeders in completely redundant configuration shall be offered to suit the load distribution as decided during engineering. Spare feeders of at least 20% of the total number of feeders with 2 nos. minimum spare feeder of each rating shall be built in.

Separate industrial grade parallel redudnat UPS system for each set of Remote I/Os cum processor panel of DDCMIS and each BOP/Offsite package & any other control system/sub system specified elsewhere in the specification, shall be provided of suitable capacity with similar features as of main plant UPS by the bidder. UPS system for remote I/Os panels and BOP/Offsite package & any other control system/sub system specified elsewhere in the specification shall be kept in the respective package UPS rooms.

UPS sizing calculation shall also be submitted for approval for each system/package. Diversity factor shall be considered as 1 for calculating the UPS capacity.

7.02.02 The parallel redundant Uninterruptible Power Supply (UPS) system of continuous duty shall supply, regulated, filtered and uninterrupted 240 V, 50 Hz, single phase power, within specified tolerances, to system AC loads, UCB mounted monitoring system, and other critical loads. Each of these critical loads shall receive one feeder from the AC Distribution Board of Inverter-"A" and another feeder from the AC Distribution Board of Inverter-"B". However, each inverter shall supply only 50% loads under normal conditions as indicated below. SLD of UPS as per NIT drawing # 114-17-0100 shall also be referred by bidder.

7.02.03 All necessary equipment required for protecting UPS equipment and connected inputs and outputs shall be furnished by the Bidder as an integral part of this system. Complete UPS system shall be automatic without any manual interference at any time of operation.

7.02.04 True, 100% parallel redundant configuration also means availability of "Criss-Cross Redundancy". Hence The UPS system design shall ensure that in case of one of the charger failure, the other healthy charger, shall feed to one of or both the invertors as the case may be and continue to charge the common/individual DC battery banks at all load conditions. UPS system shall work in "Criss-Cross Redundancy" configuration to safeguard the battery bank from unnecessary drainage. The bidder should note that this situation should not in any way lead to the discharge of the DC battery and maintain the UPS power supply to all loads.

7.02.05 The industrial grade UPS system for BTG & for each individual BOP package shall include the following equipment:

Sr. No.	Descriptions	Quantities for UPS of main plant Package	Quantities for UPS for each remote I/O panel & BOP package
1.	100% capacity of IGBT based PWM Inverter with output Voltage, current, frequency, KVA & KW digital display/meter.	2 nos.	2 nos.
2.	100% capacity static switches with input Voltage, current, frequency digital display/meter at bypass line.	(As required) 2 no. (Min)	(As required) 2 no.(Min)
3.	Manual by-pass switch	1 no.	1no.
4.	100% capacity of 12	2 nos.	-

	pulse controlled floats-cum-boast Chargers		
5.	100% capacity of 6 pulse controlled floats-cum-boast Chargers	-	2 nos.
6.	100% Battery Set each	2 set (each For 2 hour back-up)	1 set (For 1 hour back-up) in case of UPS rating less than 15 KVA. 2 sets (For 1 hour back-up) in case of UPS rating more than 15 KVA.
7.	Step-down transformer (415 V, three phase , to 240V, single phase) of required capacity)	1 no.	1 no.
8.	Static Votage Stabilizer with input & output ON Red indication and input & output Voltage, current, frequency digital display/meter.	1 set	1set
9.	Input isolation transformer with input & output ON red indication and input Voltage, current, frequency digital display/meter. Out put isolation transformer	1 no. each	1 no. each
10.	A.C. Power Distribution Panels (including 20 % spare feeders on each panel with 2 nos. minimum spare feeder of each rating) and digital type Ammeter, Voltmeter, Frequency meter, PF meter, Watt meter & VA meter	2 sets (Quantities of feeders shall be as on required basis).	2 sets (Quantities of feeders shall be as on required basis).
11.	Interconnecting Armored FRLS ST2 (inner & outer sheath), PVC type C insulated stranded Copper conductor power Cable between UPS equipment & battery, UPS & ACDB, ACDB & loads. For emergency trip push	As required	As required

	buttons, Fire alarm system, safety critical circuit, trip protection circuit and for other services specified elsewhere in the specification shall be fire survival power cable conforming to IEC 60331, BS6387 (CWZ), BS6207 standard and this specification.		
12.	MCCB (At input, output, battery side, Bypass side, ACDB side etc) and tie breaker with ON, OFF & Trip indication.	1 no. each	1 no. each
13.	Online Battery Health Monitoring System	1 set	1 set
14.	Battery Junction Boxes with MCCB, Voltmeter & Current meter.	1 set each	1 set each
Any other equipment necessary for completion of the system shall be provided by bidder.			

All equipment, enclosures and accessories for UPS system shall be designed, arranged assembled and connected in accordance with the requirements of this specification.

7.02.06 NORMAL OPERATION

Two inverters each of 100% capacity, two battery packs of 100% capacity and two 100% battery chargers are used for main plant UPS. Two inverters each of 100% capacity, one battery packs of 100% capacity and two 100% battery chargers are used for BOP packages UPS.

1. During normal operation, UPS loads shall be supplied by both 100% capacity inverters each working at 50% load. The inverters shall receive power from DC source (Charger / Battery), their static switches shall be in the respective “Inverter” position and the manual by-pass switch shall be in “Position-2”. In this mode the two inverters shall act as standby for each other.

   Necessary paralleling networks shall be included to ensure equal load sharing by both inverters. Load sharing network details shall be detailed to establish all functionalities including fuse clearance. Capabilities of the UPS System as well as each 100% rated inverters are fully satisfied. In addition to UPS output paralleling, Rectifier DC outputs shall also be properly paralleled.

2. One inverter will act as “Master”, working on its internal oscillator and the other inverter will follow by using the synchronizing signal from master inverter for automatic control of its output frequency.

7.02.07 EMERGENCY OPERATION

The static transfer switches and the manual by-pass switch shall provide switching means during emergency operation as follows:

1. In case of failure of any inverter the static switch shall automatically transfer the UPS Loads of faulty inverter (say Inverter – "A") to the healthy Inverter-"B" which will start working at 100% capacity. Thus the feeding of UPS power is continued automatically to all load connected to both inverters despite power supply to all UPS loads connected to both inverters shall be maintained without interruption. Isolation of faulty inverter shall be automatic and achieved in less than 4 milli seconds.

2. Based on inverter failure alarm, the operator will transfer manual by-pass switch to "Position-1" bringing in the plant AC source as the standby source to healthy Inverter –"B" now working at 100% capacity. In this mode the healthy Inverter-"B" shall get the synchronizing signal from the stand by-AC source and automatic synchronization, operation on internal oscillator and transfer / retransfer to standby source shall be as follows:

   i) The output frequency of the concerned inverter shall be automatically synchronized with the plant stand-by source by using synchronizing signal from the standby source. The frequency limits for this synchronism are specified in clause 7.03.05. If the frequency of the standby source is beyond these limits, the Inverter frequency control shall be automatically disconnected from stand-by synchronizing signal and the inverter shall maintain the output frequency at 50 Hz within $\pm$ 0.1 percent under all conditions of load and input voltage by working on their own internal oscillators.

   ii) During operation on its own internal oscillator, the inverters shall continuously monitor the frequency of standby source. Upon restoration of proper frequency conditions of stand-by source, the inverter shall automatically start using stand-by source frequency as the synchronizing signal for inverter output frequency control.

   iii) During the operation of any inverter on its internal oscillator due to synchronising frequency being beyond the specified limits, the transfer of static switch from "Inverter" to "Standby" shall be inhibited.

3. During any fault in the branch circuit feeders or inverter output bus, the inverter shall be capable of clearing a fast acting fuse of largest rating in 4 milliseconds and simultaneously provide UPS power to all connected loads (i.e. 50% capacity). In view of the above fault clearing capability of each inverter and due to availability of plant AC source as standby source for inverters the static switches shall not transfer the loads to the other inverter for fault clearing purposes.

4. Retransfer of static switch shall be manual in all cases and shall be accomplished only after synchronism of the inverter output with the stand-by source has been automatically accomplished.

5. The manual bypass switch shall have the provision (position –4) for fully by-passing the UPS system and connecting all UPS loads to the standby AC source. This provision may be used during start up to limit the inrush current and at other occasions at the option of the operator.

7.03.00 STATIC INVERTERS AND AUXILIARY EQUIPMENT

7.03.01 The static inverters shall be solid state type using proven IGBT based pulse width modulation (PWM) to convert direct current power to essentially sinusoidal alternating current power as per this specification. The inverter equipment shall include all necessary circuitry and devices to conform to requirements like voltage regulation, current limiting, wave shaping, transient recovery, surge suppression network, automatic synchronization etc. as specified herein.

7.03.02 INVERTER CAPACITY

Each static inverter shall have the following minimum capabilities without causing any damage to the components and with current limit not operation :-

1) Continuous full load rating

2) Over load capacity: 125% of full load rating as above for 10 minutes, 150% for 1 minute, 200% for 10 seconds minimum & 300% for 4 msec for all specified input voltages.

3) Fuse clearing capacity : Upon a fault in any branch circuit lateral feeder, the inverter shall have the capacity to carry a load equal to one half of its full load rating plus it shall clear the largest rated fast acting fuse in 4 milliseconds or less. All fuses used in inverter power and control circuit shall be fast acting type operating in less than 5 millisecond and each of these fuses shall be provided with kick fuse and alarm contact. Indication and alarm shall be provided to enable fault location.

4) Step load pick up: Upon transfer of full load, the inverter output voltage shall not drop below 85% of nominal voltage during the first half cycle after transfer and 90% of nominal voltage in the next half cycle. The recovery to within ± 1% of voltage shall be in less than 50 milliseconds.

5) The inverter shall have sufficient I2t capacity to clear a slow acting HRC fuse having a continuous current rating equal to at lease 20% of the continuous full load current rating of the inveter, while feeding 100% rated loads of the inverter.

7.03.03 INPUT VOLTAGE

The inverters shall be fed from a DC Battery and chargers which do not feed any other loads. Input voltage shall be nominal DC output voltage of battery and charger of range from final voltage after discharge of battery to maximum DC bus voltage during equalize charging of battery. The inverter shall also be capable of working satisfactorily meeting the specification requirements with only the chargers connected to its input without battery in circuit. DC input window of each inverter shall be either 315-434 or 320-450 V

DC. Filtering on the input of the inverters shall be furnished is required to operate within the output ripple of the chargers furnished by the Bidder. Each inverter shall include equipment necessary to protect itself from damage resulting from excursios, loss, or restoration of DC input voltage and synchrnising voltage. The inverter output voltage shall be 230 V AC , 50 Hz, Single phase.

7.03.04 OVER LOADS, SHORT CIRCUITS AND LOAD LOSS PROECTION

1. The inverters shall be provided with suitable fuses at the input and output which will permit proper co-ordination with other protective devices and at the same time protect the inverter against damage due to internal faults. All necessary equipment shall be provided to protect the inverters against over loads, short circuits and 100% loss of load. The inverter shall be self protecting against damage if energized with full load connected.

2. The inverter shall be provided with current limiting circuitry which will limit the output current to a value which will not damage the inverter or blow its fuses.

3. The inverter shall have sufficient I^2 t capability to prevent damage to itself until short circuit conditions on the output are cleared.

4. Each inverter shall be capable of operation with nonlinear loads. For bidders loads bidder shall detail the nature of non linearity. For loads provided by owner, bidder may assure a non linear wave form with a current crest factor of 3.0 occuring coincident with voltage peak. With nonlinearity consisting of third, fifth and seventh order harmonics. Output waveform of the inverter(s) shall remain within specified limits when operating with nonlinear loads at 100 percent rated load.

5. The inverters shall be self protecting against all AC and DC transients, voltage surges and steady state abnormal voltages and current likely to be encountered in utility power station.

7.03.05 Automatic Synchronisation

Inverter equipment shall include stable solid state oscillator devices designed to automatically maintain the inverter output in phase and in synchronization with the standby AC source. The frequency regulation shall be automatic within $\pm$ 0.1 Hz of all conditions of inputs, loads and temperature occurring simultaneously or in any combination.

Facility shall be provided for automatic transfer to internal oscillator operation when the standby source frequency is not within the synchronization limits.

Provision shall be made for step less adjustment of synch disconnect frequency range from 50 Hz +/- 0.5 Hz to 50 Hz +/- 2 Hz.

Automatic adjustment of phase relationship between inverter output and standby AC source shall be gradual, at a controlled slew rate, which shall not exceed 0.1 Hz per second.

The inverter shall normally work on the internal oscillator with either of the two inverters as master synchronizer and the other following it. Suitable selector facility shall be provided to select the master. When any one inverter fails the healthy inverter gets the synchronizing signal from the standby AC source.

The DC inputcurrent shall never exceed the full load current except for a short circuit within the inverter. The limitation applies to transient as well as steady state currents and includes in rush currents upto initial energisation of the UPS, load energisation, short circuits external to the inverter etc. For any value of the load and load power factor drawn by the equipment served, the inverter shall not impose on DC source any voltage oscillations in excess of 5 volts (RMS total, all frequencies) or any current oscillations in excess of 3 %(RMS total, all frequencies) of the DC current at full load.

7.03.06 The inverter shall meet the following specifications in addition to other requirements stated herein :-

1.	Voltage input (Battery output)	:	As per system requirement
2.	Nominal voltage output:		240V, 50Hz, single phase
3.	Inverter capacity (output KVA)	:	As per clause 7.03.02
4.	Voltage regulation	:	
	a) Steady state (0-100% load at all input voltages & all power factors)	:	± 1 %
	b) Transient voltage regulation (on application or removal of 100% load)	:	± 5%
	c) Time to recover from transient to normal voltage with ± 1% of steady state (on application or removal of 100% load)	:	<50 milli second
5.	Wave Form		
	a) Nominal Frequency	:	50 Hz
	b) Frequency regulation for all conditions of input supplies, loads and temperature occurring simultaneously or in any combination (automatically controlled)	:	± 0.1Hz

c)	Synchronization limits (for maintenance & synchronism between the inverter and standby AC source).	:	48 Hz to 52 Hz (factory test)
d)	Field adjustment range for (c) above	:	50 ± 0.5 Hz to 50 ± 2 Hz
e)	Total harmonic content	:	<4% max.
f)	Harmonic content max.for any single harmonic	:	<2.5%

6. Rated output current at rated output voltage with current limit not operating :

a)	Current	:	200%
b)	Duration	:	10 seconds

7. Overload capacity at 100% voltage :

a)	For 4 ms (fuse clearing):		App. 300%
b)	For 10 seconds	:	200%
c)	For 10 minutes	:	125%
d)	The proposed inverter has the capacity to clear largest acting fuse in 5 milli second & without entering into current limiting mode	:	---

8. Efficiency (watt output/watt input)

a)	at 100% load 1.0 P.F. / 0.8 P.F:		>91%/ 91%
b)	at 75% load 1.0. P.F. / 0.8 P.F.	:	>90% / 90%
c)	at 50% load 1.0 P.F. / 0.8 P.F.	:	>89% /89 %

9. Duty : Continuous

10. Cooling : Natural convection or forced cooling using redundant fans.

Equipment to be designed for operation with full load even without cooling availability.

11. Ambient temperature : 50 deg C, maximum

12. SCR derating from : 50%

peak voltage and peak ratings.

7.03.06 STATIC INVERTER AUXILIARY EQUIPMENT

In addition to the inverter equipment specified above, auxiliary equipment shall be furnished with each static inverter as follows:

1) Equipment and material furnished, mounted and wired on the front panel of the inverter enclosures :

ITEM	QUANTITY
Output ammeter, AC, indicating, Scale-0 to 150 percent of rated continuous full load inverter output current, 1 percent accuracy.	1
Output voltmeter, AC, indicating 0-300 volt scale, 1 percent accuracy.	1
Output KVA, AC indicating scale 0-150 percent of Rated capacity, 1 percent accuracy.	1
Input voltmeter DC, indicating 0-300 volts scale, 1 percent accuracy.	1
Frequency meter, 45-55 hertz, 1 percent accuracy.	1
Power factor meter, (0-1. 0-0), 1 percent accuracy	
Inverter ON-OFF switch	1
Alarm Reset Push Button	1

2) Indicating lights listed below with proper actuating devices, circuitry and legend shall be furnished on front of the Ups panels. For these abnormal conditions which could be of a momentary nature, the indicating lights shall remain energized and the contract remain closed until cleared by a reset push button furnished on the panel. The indicating lights shall be of make subject to Owner's approval.

The following indications shall be provided as a minimum :

a) DC voltage to the Inverter - Low
b) DC voltage to the Inverter - High
c) Loss of DC input to the inverter
d) Inverter output voltage - High
e) Inverter output voltage – Low (after a time delay to avoid unnecessary alarm due to low voltage on load in rush etc.)
f) Inverter A failure / Inverter B failure
g) Standby AC source failure
h) Inverter A / Inverter B not synchronized with AC source
i) Automatic transfer to AC source. Blown Fuse or Tripped Breaker.
j) Inverter A/ Inverter B feeding 100% UPS Load
k) Standby source feeding 100% UPS loads
l) Redundant fan failure and temperature high (if provided)

7.04.00 STATIC TRANSFER SWITCHES AND AUXILIARY EQUIPMENT

7.04.01 The static transfer switches shall be provided to perform the following functions

1) To transfer the load automatically without any break between the inverter to the standby inverter as required to maintain the continuity of power supply to UPS connection loads. The load shall be automatically transferred from "Inverter" to the inverter source upon any malfunction of one inverter.

2) To transfer UPS load under manual control from standby AC source to inverter when placing the UPS System in service and from inverter to standby AC source when taking the UPS out of service.

7.04.02 The static transfer switches shall have two modes of operation namely automatic and manual.

7.04.03 The static transfer switches shall use silicon controlled rectifiers and other static devices required for automatic transfer of load from "Inverter" to Standby" source and vice versa.

The static switches shall conform to the requirements specified herein including the following:

1. Capacity (continuous) : Equal to the continuous full load capacity of the inverter.
2. Capacity (overload) : 200% for 10 seconds, 150% of continuous for 60 seconds and 125% of continuous rating for 10 minutes and 300% of continuous rating for 4 msec.
3. Capacity (Peak) : 1000 % of continuous rating for 5 cycles.
4. Transfer Time : < 4 msec. The transition shall be "make before break", voltage failure shall be sensed at the output of the static switch.
5. Voltage Rating (Nominal) : 240 Volts, 50 Hz. Single phase.
6. Transient Voltage Tolerance : 340 Volts peak above the normal line voltage.
7. Ambient temperature : 50 deg C max.
8. Cooling : Natural or forced circulation , using redundant fans.
9. Duty : Continuous

7.04.05 **<u>TRANSFER INITIATION</u>**

1) The transfer of static switch from normal "Inverter" position to "Stand-by" position shall be initiated by one of the following causes :

   a) Inverter failure and UPS System trouble
   b) Inverter output voltage failure
   c) Over current
   d) Manual push button operation
   e) Static Output voltage failure.

2) The UPS bus shall be monitored by two voltage detectors. One fast acting circuit shall be used for detecting a complete and instantaneous, voltage loss while the other slower acting averaging circuit with adjustable trip level shall be employed to detect voltage deviation beyond selected limits. Both voltage detector circuits shall automatically initiate operation of static transfer switch.

3) The static switch shall automatically transfer the load from inverter to stand-by AC source when the maximum I^2t capability of the inverter is reached when the inverter output voltage drops below 90%.

4) UPS bus current shall be continuously monitored by a current monitoring detector. This detector shall operate the static transfer switch when the load current exceeds the overload rating of any inverter. The detector shall rest when the load current falls below the rated current of the inverter resulting in retransfer of static switch with inverter position.

5) Over current transfer limit shall be continuously adjustable from inverter continuous rating to inverter current limit rating.

7.04.06 TRANSFER INHIBIT

The transfer of static switch shall be inhibited under the following conditions:

1) Automatic or manual transfer of load from inverter to stand-by AC source or vice versa, shall be inhibited when the inverter frequency is not synchronized to the alternative source.

2) Transfer resulting from overload shall be inhibited when the standby AC source is not available. In this case the load fed by the inverter shall be automatically disconnected

7.04.07 RETRANSFER TO NORMAL

1) The retransfer to normal shall be manual in all cases.

2) Manual transfers shall be initiated by push button actuation.

7.04.08 Static transfer switches shall be provided with necessary protective devices (circuit breakers / current limiting fuses) both in “Normal” as well as “Stand-by” position.

7.04.09 The static transfer switches shall be provided duly mounted and wired in enclosures furnished by the bidder.

7.04.10 The static switches shall be furnished with contacts to alarm failure of the alternate source or opening of any fuse protecting the static switches.

7.05.00 MANUAL BY-PASS SWITCH

7.05.01 The manual by-pass switch will be used to isolate any static switch from its load and stand-by power supply and to take the static switch out of service without power interruption to the load. In doing so the manual by-pass switch shall connect both load buses to a single inverter. The manual by-pass switch shall also provide the facility for by- passing the entire UPS system during start up at the option of the operator.

7.05.02 The manual bypass switch shall have make before break contacts to ensure continuous supply to UPS loads during the operation of this by-pass switch.

7.05.03 The manual by-pass switch shall be rated for 600 Volts, 50 Hz, single phase operation. It shall have continuous load carrying capacity equal to full load inverter current and necessary short term load carrying and interrupting capacity to meet the requirements of the UPS system.

7.05.04 All other by-pass and disconnect devices shall be provided by the Bidder as required for orderly start up and shut down and maintenance of UPS system and system components.

7.05.05 The Bidder shall provide potential free contacts, one closed in each position, for use in DDCMIS & PLC system.

7.05.06 The manual by-pass switch and required disconnect devices shall be furnished duly mounted and wired in enclosure, furnished by the Bidder.

7.06.00 FLOAT-CUM-BOOST CHARGERS AND AUXILIARY EQUIPMENT

Two no. 100% capacity SCR based fully controlled 12 pulse float cum boost chargers shall be furnished for main BTG UPS system and Two no. 100% capacity SCR based fully controlled 6 pulse float cum boost chargers shall be furnished for BOP packages UPS system. Each charger shall confirm to the following requirements.

7.06.01 CHARGER CAPACITY

Each charger furnished for UPS system shall be adequately rated to ensure that any one shall meet full DC load of UP system operating at 100% rating plus recharge the fully discharged UPS battery within 8 hours.

The Bidder shall furnish the charger rating calculations to the Owner to satisfy that this requirement is met. The charger shall be furnished as per rating approved by the Owner during engineering stage.

7.06.02 The chargers shall be supplied from a 415 volt, 50 Hz. 3 phase system. The chargers shall maintain the output voltage within plus and minus 0.5 percent from no load to full load with an input power supply deviation in voltage level of plus or minus 10 percent and input power supply deviation in frequency of plus or minus 5 percent and with both deviations present in any combination.

7.06.03 In addition to supplying DC power for inverters, the chargers shall be designed to charge a fully discharged battery without over loading or causing over voltage or without causing interrupting operation of AC or DC circuit breakers for the entire range of intended operating regimes. Suitable solid state electronic circuits shall be provided to ensure that the charging current is voltage regulated and current limited. After the battery is recharged the charger shall maintain the battery at full charge until the next emergency operation when the UPS battery is again required to provide DC power.

7.06.04 Float and equalizing controls shall have an adjustment range of ± 5% continuous (without steps).

7.06.05 The chargers shall be self-regulating, solid state, silicon controlled, full-wave rectifier type designed for single and parallel operation with the battery specified under clause 7.07.00. The chargers shall be designed for automatic load sharing during parallel operation.

7.06.06 The charger shall be current limited at 125% of full load to reduce output voltage for charger circuit protection and for protection of battery from overcharge. The current limit shall be continuously adjustable from 80% to 125%.

7.06.07 All necessary equipment and devices shall be provided to protect the charger from short circuits, transient voltage surges, load and supply fluctuation including sudden loss of input or load.

7.06.08 The charger shall have a slow walk-in circuit which shall prevent application of full load DC current in less than 10 seconds after AC power is energized.

7.06.09 The minimum full load efficiency at nominal input and float output shall be 96 %.The output regulation, ripple content and power factor shall meet the requirements of UPS system as well as the inverters furnished by the Bidder as per clause 7.03.00.

7.06.10 Chargers and auxiliary equipment shall be mounted in free standing cabinets furnished by the Bidder. Charger cabinets shall be folded steel construction with top, front, back and sides fabricated from not less than 3 mm thick sheet steel. The cabinet front, back, end sides shall extend to the floor to present a finished appearance. Cabinet door shall be provided to permit easy access to all components for maintenance or replacement. Doors shall have concealed hinges and three-point latches. Louvers shall be provided for ventilation as required for operation at the specified ambient but the cabinet top shall be solid. All louver openings shall be covered with corrosion resistant fine screen coverings.

7.06.11 **GROUND DETECTOR SYSTEM**

a) Each charger shall be furnished with a ground detector system consisting of a relay and a center tapped resistor. The resistor shall be connected between the positive bus and the negative bus.

The relay coil shall be connected between the centre tap of the resistor and ground. The relay shall be furnished with one normally open and one normally closed contact wired to terminal blocks for connection to external circuits.

7.06.12 **UPS Signal interfacing with DDCMIS/DCS & PLC**

a) The bidder shall provide alarms and status indications, current, voltage ,frequency, PF etc through serial link with MODBUS or another compatible protocol .

b) The Bidder shall furnish 4-20 mA signals to DDCMIS/PLC for the following:

i) Inverter A & B output voltages
ii) Inverter A & B output currents
iii) Inverter A&B output frequency

c) List of alarms (min.) to DDCMIS through potential free contacts shall be as follows:-

i. Rectifier – 1 Trip.
ii. Inverter – 1 Trip.
iii. UPS battery low.
iv. Rectifier – 2 Trip.
v. Inverter – 2 Trip.
vi. Load on static Bypass.
vii. Static Bypass failure
viii. ACDB – 1 Incomer Tripped.
ix. ACDB – 2 Incomer Tripped.
x. UPS – 1 Fan Tripped.
xi. UPS – 2 Fan Tripped.

7.07.00 UPS/24 V DC System BATTERY AND ACCESSORIES

The UPS/24 V DC system batteries shall be heavy duty *Ni-Cd type* as specified below:

i. Expected service life is greater than 20 years when operated on float or trickle charge.
ii. Low maintenance – minimal topping up frequency and self - discharge.
iii. Capable of rapid recharging.
iv. Transparent containers for ease of inspection and maintenance.
v. Battery racks provided for battery shall be 2 tier made from heavy teak wood to bear 150% over load, anti acid paint etc.
vi. One no. 2 sided Folding Aluminium ladder (height 180 cm) for maintenance & removal of battery cells and mounting bracket for ladder shall be provided by bidder with each battery set.

The batteries shall be **heavy duty Nickel-cadmium Fiber plated type** and shall be sized for an hour of full load operation during non-availability of AC supply / chargers. The Ni-Cd batteries shall conform to IS:10918. For sizing calculation, design margin of 120%, an aging factor of 0.8 and a temperature correction factor (Based on temperature characteristics curve to be submitted by the Bidder and at a temperature of 4 deg. C). Capacity factor shall be taken into consideration, and ambient temperature shall be considered as the electrolytic temperature. The sizing of the battery shall be as approved by Owner during detailed engineering. However, Bidder shall consider a suitable voltage drop from battery room to UPS and UPS to load, while sizing the battery. The system shall also be suitably designed to overcome any over voltage that may arise during low-load operation of the charger. The bidder shall clearly bring out in his offer how the same is being implemented.

The battery size shall be calculated taking UPS/24 V DC system capacities as base load. Bidder shall also consider voltage drop from battery room to UPS/24 V DC systems, while sizing the battery. For Plant UPS & plant 24 V DC system, battery backup time shall be 2 hours and for BOP packages UPS & BOP 24 V DC system, the back up time shall be for 1 hour.

For Fire alarm panels, batteries shall be provided with min. 10 hours backup.

7.07.01 In order to monitor the batteries, **online battery health monitoring system** shall be employed. It is a battery management system based on monitoring the voltage of individual battery cell, which provide the information/details about battery health status to end user/owner. Complete hardware like detector units, Battery clips, cables, monitor (power control unit) and other accessories etc as required to complete the system shall be provided by bidder. LED indication shall be provided on detector units for power, alarm and RUN indication etc. Data from Online Battery Health Monitoring System shall be communicate/transferred to DDCMIS for Monitoring and analysis using different protocol like RS485 Modbus/OPC etc.

7.07.02 One complete set of all accessories and devices required for maintenance and testing of batteries shall be supplied for each set of the batteries of each unit/plant auxiliary system. Each set include at least the following:

a)	Hydrometer	5 Nos
b)	Set of hydrometer syringes suitable for the vent holes in different cells	5 Nos
c)	Thermometer for measuring electrolyte temperature	5 Nos
d)	Specific gravity correction chart	5 Nos
e)	Wall mounting type holder made of teak woodfor hydrometer & thermometer	5 Nos
f)	cell testing voltmeter(3-0-3 V)	5 Nos
g)	Alkali mixing jar	5 Nos
h)	Rubber aprons	5 Nos
i)	Pair of rubber gloves	5 Nos
j)	Set of spanners	5 Nos
k)	No smoking notice for each battery room	2 Nos
l)	Goggles (industrial)	5 Nos
m)	Instruction card	10 Nos
n)	Minimum and maximum temperature indicator for battery room	1 No.
o)	Cell lifting facility	1 Set
p)	Vent Caps	2 set
q)	Terminal Bolts & Washers	1 Set
r)	Plastic Filling Bottles	10 Nos.
s)	Alkali resistant funnel & Mugs	10 Nos.

7.07.03 Cell booster charger shall be provided with main plant UPS & 24 V DC batteries set to charge the new & sick cell for revival of cell. The cell booster shall be built in separate portable panel. Resistive load discharge bank shall also be provided with main plant UPS & 24 V DC batteries set to discharge the batteries in case of over charged batteries.

7.08.00 VOLTAGE STATIC STABILISER

7.08.01 One 415 Volt, 3 phase to 240 Volt, single phase transformer along with associated static voltage stabilizer shall be furnished with each UPS set.

This transformer and stabilizer combination shall convert 415 Volt ± 10% plant auxiliary AC supply to 240V ± 1% single phase standby AC Power which will serve as UPS system back up supply source.

7.08.02 The transformer and stabilizer shall be sized for 100 percent UPS load and shall coordinate with the largest branch circuit protection device for feeder short circuit current without sacrificing voltage regulation. The voltage stabilizer shall employ silicon solid state circuitry and shall maintain the specified output voltage for 0-100% load with input voltage variations as indicated above. Class of insulation of wound components like transformers etc shall be class H with temp rating up to class B.

7.08.03 The stabilizer shall meet the following characteristics as a minimum
- Fast rate of correction - within 5 cycles
- Output distortion - less than 5% under worst conditions
- Efficiency - better than 95%
- Overload Capacity – 300% for 200 mSec.

The make and rating shall be subjected to Owners approval.

7.10.00 AC & DC Power supply for BOP packages

7.10.01 The UPS system shall be separate for each BoP/offsie package. The UPS shall be designed as specified at clause no. 7.02.00 to 7.08.00.

7.10.02 Parallel redundant 240 V AC to 24 V DC convertor with 50% sharing & 125 % capacity shall be provided for 24 V DC power supply in each cubicle separately as per requirements for BOP/Offsite package's PLC control system and microprocessor based control system.
The UPS power supply shall be extended to Parallel redundant 240 V AC to 24 V DC convertor thru redundant UPS feeders.

AC to DC convertor shall be SMPS based and shall have wide range of AC/DC input voltage (85-264 V AC & 90-350 VDC). It shall have the necessary diagnostic functions like indications for DC OK, automatic overload monitoring etc. The MTBF for the power supplies shall not be less than 500,000 hours (in Accordance with (IEC – 1709) with operating temp. from –25deg. C to 70 deg. C.

7.11.00 CONSTRUCTIONAL FEATURES FOR CABINETS/ENCLOSURES

The Construction details for UPS & 24 V DC charger system cabinets/enclosure shall conform to the requirements indicated in chapter 6.

7.11.01 Grounding

Normal, AC power supply will be grounded at the source. For grounding other than this, I/P and O/P isolation transformers shall be furnished with the UPS.

7.11.02 All the transformers used any where in UPS & 24 V DC charger circuitry shall be copper wire winded with class H insulation.

7.12.00 DC DISTRIBUTION BOARD PANEL

7.12.01 Distribution board shall be furnished with components, devices and materials meeting the requirements specified herein.

7.12.02 Each DC distribution board shall be constructed for 2 wire DC distribution .All bus bars shall be of solid copper. Each panel shall have four double pole 800 amps MCCB and properly sized fuses for three incoming feeders (two from chargers and one from battery) and two double pole 800 amps Moulded case circuit breakers with thermal over current relays and electromagnetic over current relays for two out going feeders to inverters. Isolators and circuit breakers shall open and close with snap action. Fuses of appropriate capacity shall be provided for incoming feeder from battery. All switches, fuses, circuit breakers and buses shall be rated for D C system fault level, which shall be indicated by the bidder in his proposal. Circuit identification cards mounted in card holders shall be provided on the hinged panel board front. The number of feeders (WITH 20% spare feeders) and rating of each feeder shall be to suit the individual load keeping in view the fuse clearance capability of UPS system already stipulated and shall be as finalised during engineering. No price implication is admissible for the number ratings of feeders as decided during engineering and owners decision in this shall be final. Each feeder shall have fast acting semi conductor fuse, MCB & LED indication for ON status.

7.13.00 AC DISTRIBUTION BOARDS PANEL

7.13.01 Panel boards for distribution of continuous AC power to essential loads shall be dead-front type panel boards rated for 600/1100 V, AC service. The hinged panel board front shall cover the fuses and wiring gutter but not the switch handles. The hinged front and switch handles shall be covered by the enclosure door.

7.13.02 Each panel board shall be constructed for 2 wire, single- phase distribution with a solid neutral bar. Phase and neutral bars shall be of copper. Rating of the main lugs shall be equal to the rated continuous full load current of each inverter.

7.13.03 Each panel board shall have one fused disconnect switch & MCCB of adequate rating for incoming feeder for A C Bus and requisite double pole, suitably rated ampere fused, disconnect switch branch circuit devices (MCB). Fused switches shall be equipped with arc quenchers, visible blades, and quick-make quick-break operating mechanisms. Maximum size fuse which branch circuit fuse holders will accept shall be rated at 60 amperes. As each UPS fed load will be provided with two hot

redundant 100% rated feeders. Main feeders to ACDB shall be provided with digital type Ammeter, Voltmeter, Frequency meter, PF meter, Watt meter & VA meter. One from ACDB-A and other from ACDB-B, boards with feeders shall be constructed in line. The number of feeders (WITH 20% spare feeders) and rating of each feeder shall be to suit the individual load keeping in view the fuse clearance capability of UPS system already stipulated and shall be as finalised during engineering. No price implication is admissible for the number ratings of feeders as decided during engineering and owners decision in this shall be final. Each feeder shall have fast acting semi conductor fuse, MCB & LED indication for ON status.

G. SPECIFICATION

FOR

CONTROL PANELS

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.

H.DRIVE

CONTROL

PHILOSOPHY

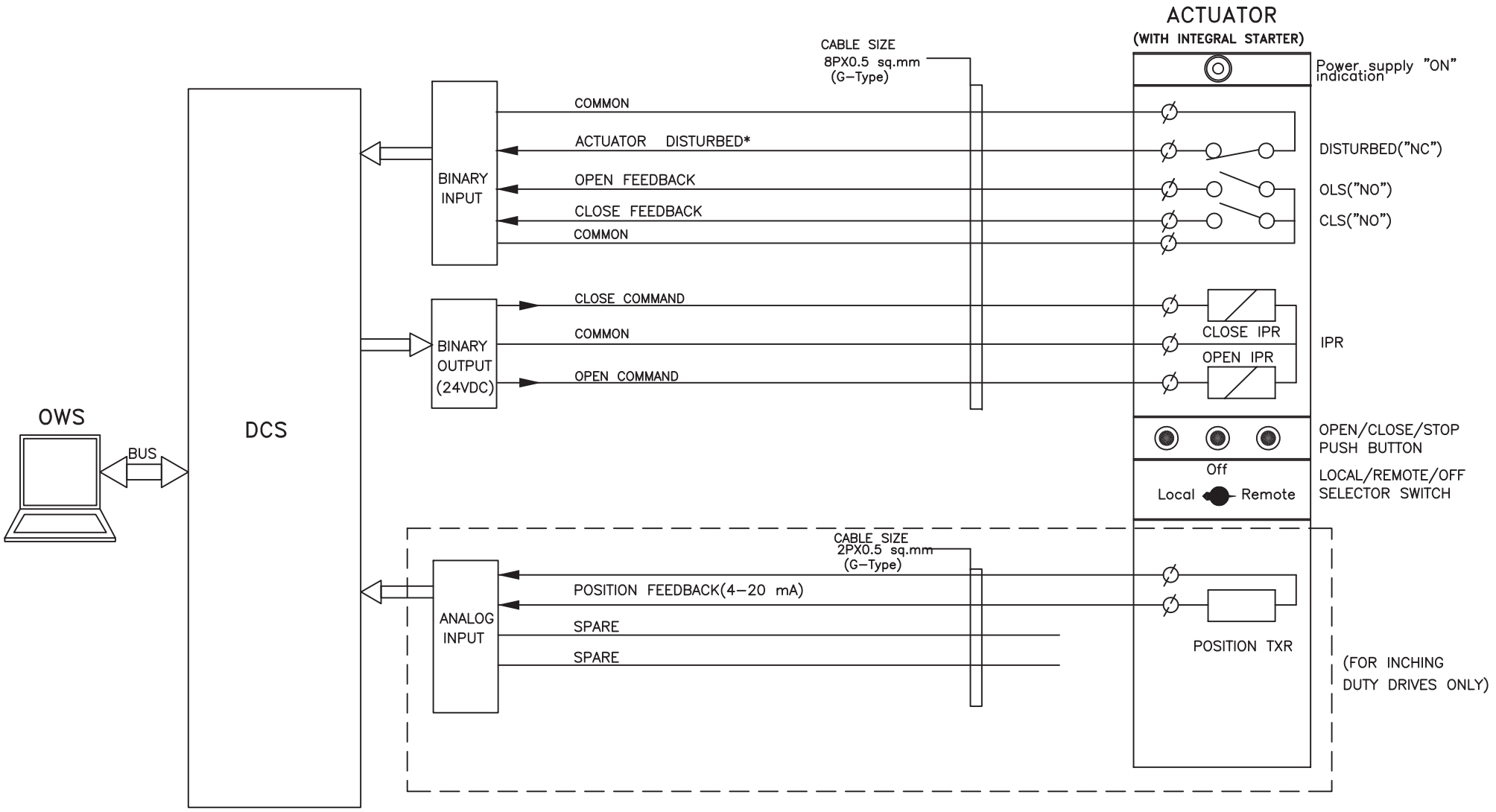
FOR

ANALOG
&

BINARY

DRIVES

DCS INTERFACE FOR BIDIRECTIONAL DRIVE(WITH INTEGRAL STARTER)

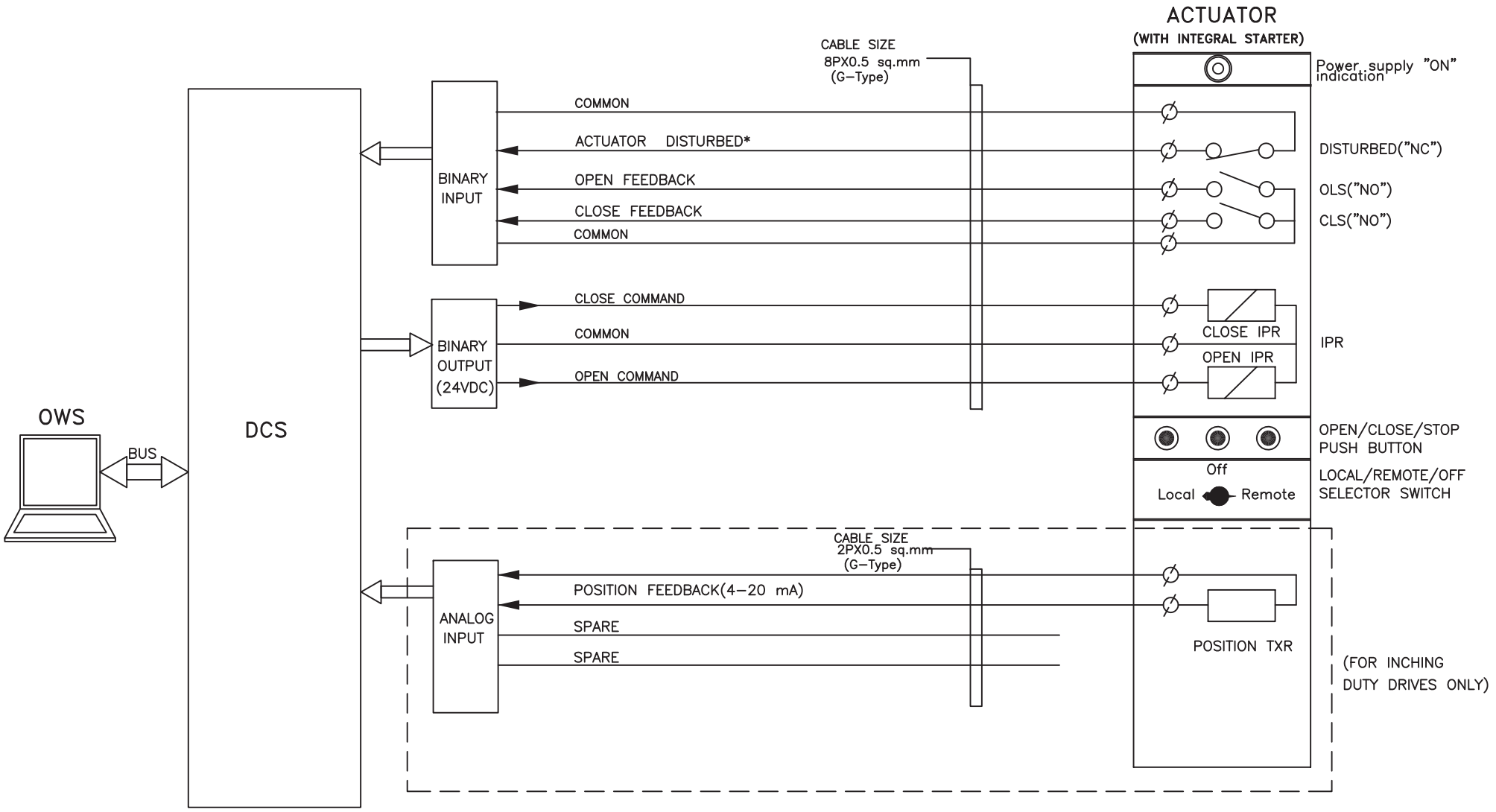


NOTE:

* 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)

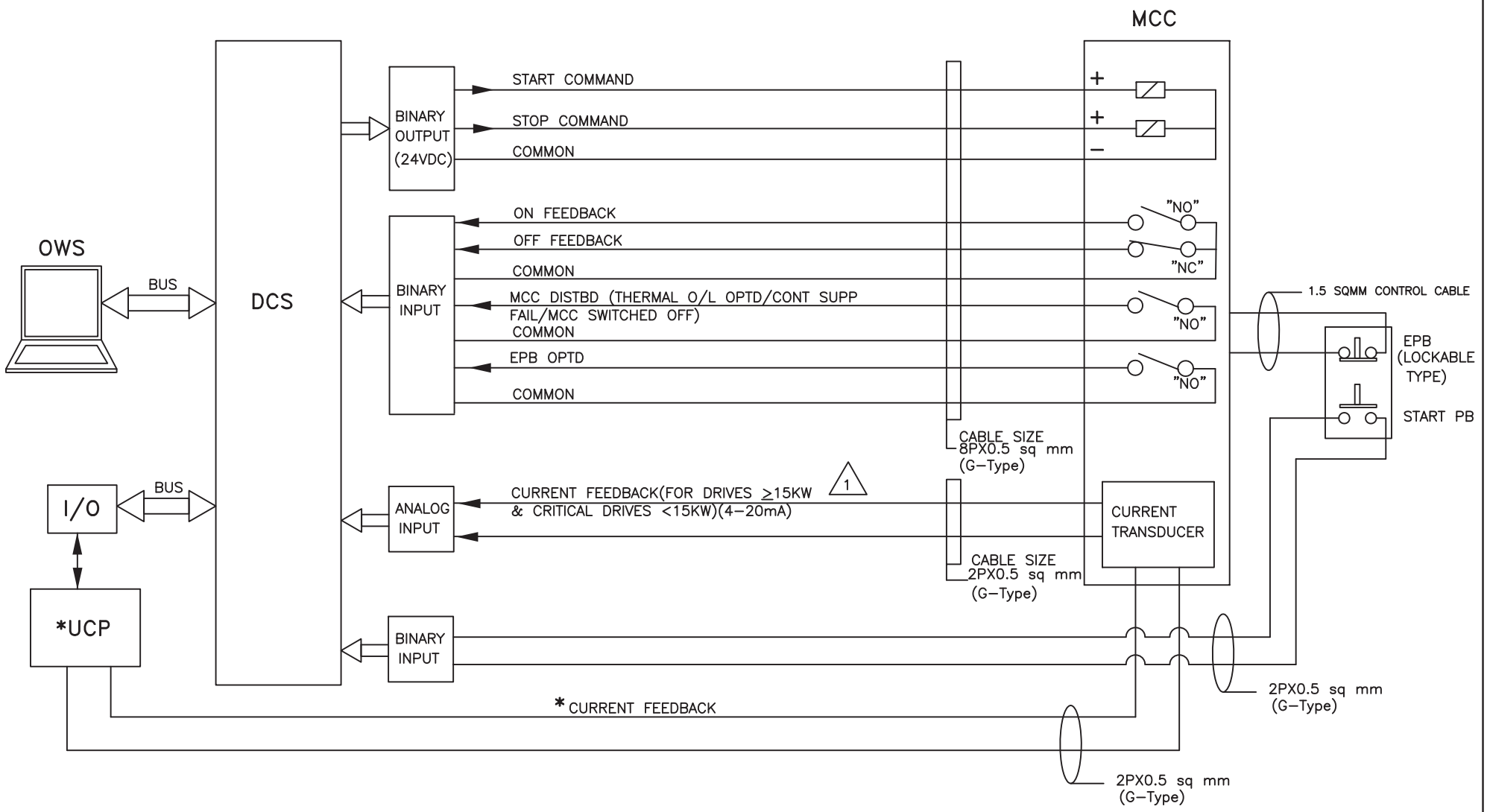


NOTE:

* 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

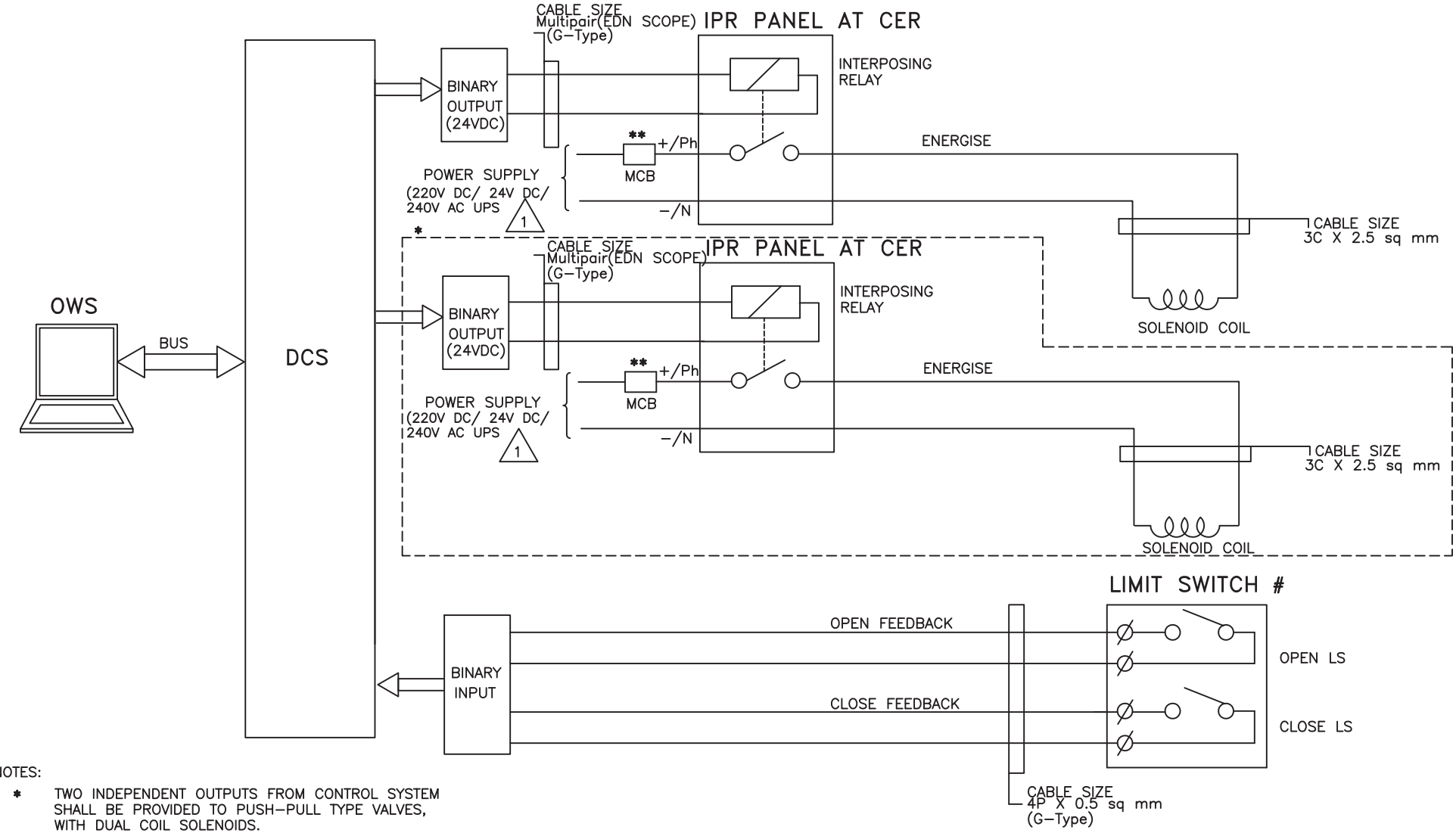


NOTE:

*WHEREVER APPLICABLE

BHEL	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

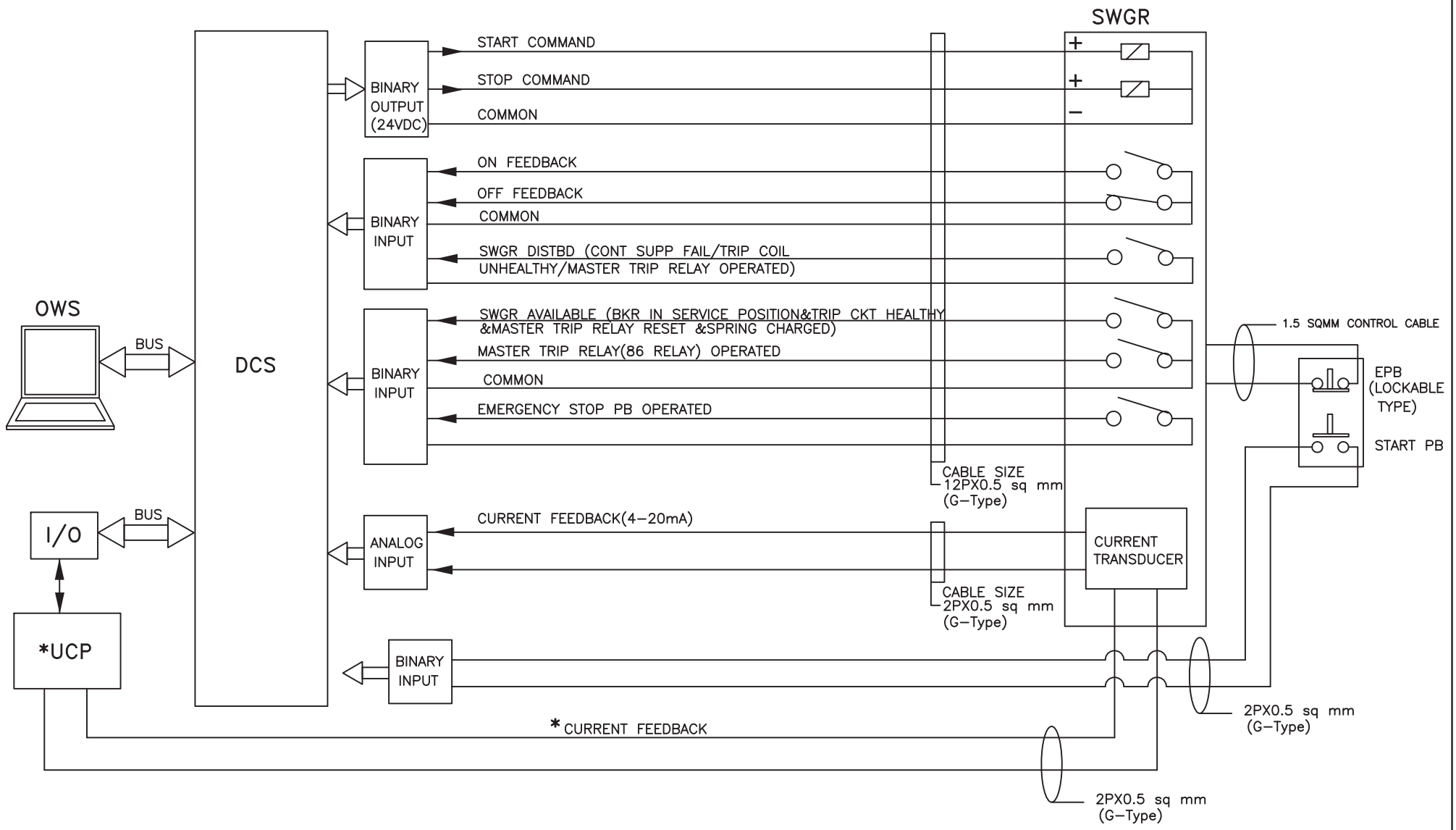
△1 # FOR ON/OFF TYPE, SOLENOID ACTUATED VALVE. RELAY CONTACTS SHALL BE WIRED AS FEEDBACK WHEREVER LIMIT SWITCH FEEDBACKS ARE NOT AVAILABLE.

△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

Anshul
S A Khan
Praveen Kishore

DCS INTERFACE FOR HT/LT UNIDIRECTIONAL DRIVES(BREAKER OPERATED)



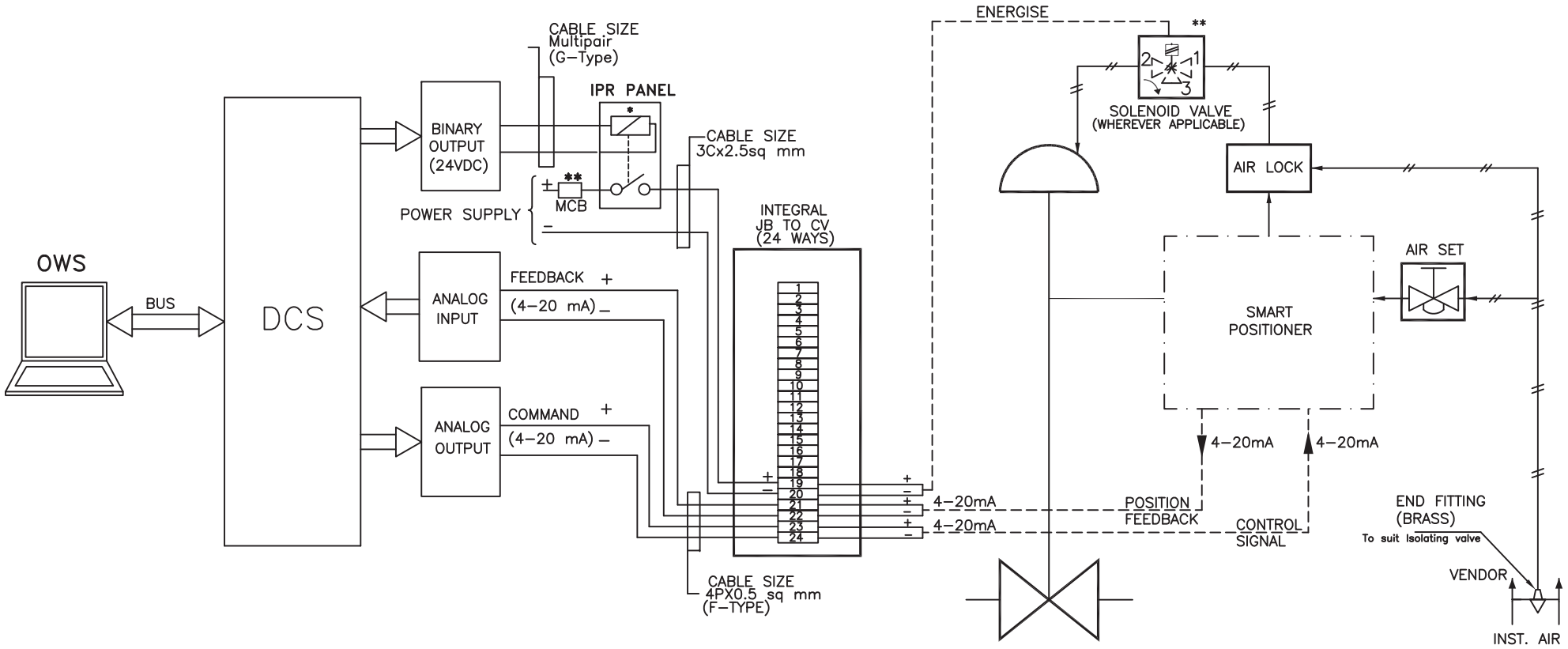
NOTE:

* 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

Anshul
S A Khan
Praveen Kishore

J.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

I.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.

14.02.04.16 **Factory Acceptance Tests for DDCMIS, DCS, Simulator & PLC**

GENERAL	1	FACTORY ACCEPTENCE TEST (FAT): REF NOTE-1	✓
	2	FACTORY ACCEPTENCE TEST (FAT) PROCEDURE: REF.NOTE -2	✓
	3		
	4		
	5		
TEST REQUIREMENTS	6	TEST SHALL BE PERFORMED WITH THE COMPLETELY ASSEMBLED SYSTEM AND ALSO WITH COMPLETE	✓
	7	I&C SOFTWARE AND PERFORMING ALL FUNCTIONS EXPECTED OUT WHILE IN ACTUAL SERVICE AND	
	8	WITH STSTEM CONFIGURATION AS FINALISED.	
	9	PROCESS INPUT/OUTPUT CONDITIONS AND OTHER LOAD ON THE SYSTEM TO BE STIMULATED	✓
	10	EITHER BY HARDWARE/SOFTWARE.	
	11	ALL SYSTEM SOFTWARE and APPLICATION SOFTWARE TO BE LOADED AND OPERATIONAL ON THE	✓
	12	SYSTEM PRIOR TO FAT	
	13	FAT TO BE CONDUCTED AT ELEVATED TEMP. OF 45 DEG C FOR MINIMUM 48 HOURES	✓
	14	FAT UNDER FOUR CYLES OF VOLTAGE FLUCATIONS VIZ NOMINAL AT 110 % OF RATED VOLTAGE	✓
	15	PERFORMANCE TEST:	✓
	16	-	
	17	-	
TEST DOCUMENTS DRAWINGS	18	TOTAL SYSTEM CONFIGARATION DRAWINGS	
	19	FAT PROCEDURE CONSITING OF:	
	20	(i) TEST EQUIPMENT	
	21	(ii) TEST ENVIRONMENT	
	22	(iii) TEST CONFIGURATION	✓
	23	(iv) TEST PROCEDURE	
	24	(v) TEST SCHEDULE	
	25	(vi) TEST VENUE	
	26	(vii) TEST REPORTS- SPECIMEN COPIES	
	27	FUNCTION DESIGN SPECIFICATION FOR EACH EQIPMENT / SYSTEM	
	28	-	
	29	-	
PRELIMINARY CHECKS	30	GENERAL APPEARENCE CHECK and BILL OF MATERIALS CHECK	✓
	31	CONSTRUCTION CHECK AS PER OVER ALL GENERAL ARRANGEMENT DRAWINGS	✓
	32	DIMENSIONAL CHECK	✓
	33	LABELLING, TERMINAL ARRANGEMENT AND EQUIPMENT IDENTIFICATION CHECK	✓
	34	POWER SUPPLY VOLTAGE LEVEL CHECK and POWER 'LEDs -ON CHECK	✓
	35	COOLING FAN OPERATION CHECK	✓
	36	GROUNDING NETWORK CHECK	✓
TEM	1	POWER SUPPLY UNDER VOLTAGE AND OVER VOLTAGE CHECK (± 10%)	✓
	2	PROCESSOR and MAIN DATA BUS NETWORK REDUNDANCY CHECK, IF APPLICABLE	✓
	3	COMMUNICATION COUPLER IF APPLICABLE REDUNDANCY CHECK	✓
	4	COMMUNICATION MODULE OF THE CONTROLLER TO NETWORK REDUNDANCY CHECK, IF APPLICABLE	✓
	5	POWER SUPPLY REDUNDANCY CHECK	✓
	6	HARDWARE ON-LINE MAINTAINABILITY CHECK,	✓
	7	-	
	8	-	
CONTROLLER ENGINEERING	9	CLOSED LOOP CONTROL SIMULATION CHECK	✓
	10	OPEN LOOP CONTROL SIMULATION CHECK	✓
	11	CONTROL LOOP RESPONSE CHECK	✓
	12	BUMPLESS AUTO MANUAL TRANSFER CHECK	✓
	13	OPERATING STATION – GRAPHIC OVERVIEW CHECK	✓
	14	OPERATING STATION- TREND CHECK	✓
	15	OPERATING STATION- REAL TIME TREND CHECK	✓
	16	OPERATING STATION- MIMICS CHECK	✓
	17	OPERATING STATION- CHECK FOR OPERATING CONTROL DIRECTLY FROM MIMICS	✓
	18	OPERATING STATION- FUNCTION KEYS CHECK	✓
	19	OPERATING STATION- TOUCH SCREEN FUNCTION CHECK	✓
	20	OPERATING STATION- ANALOG CONTROL DISPLAY CHECK	✓
	21	OPERATING STATION- SEQUENCE CONTROL DISPLAY CHECK	✓
	22	OPERATING STATION- OPERATOR GUIDENCE MESSAGE CHECK	✓
	23	OPERATING STATION- ALARM MANAGEMENT FUNCTION CHECK	✓

	24	OPERATING STATION LOGGING FUNCTION CHECK	✓
	25	OPERATING STATION / RESPONSE / UPDATING CHECK	✓
	26	KEYBOARD LOCK FUNCTION CHECK	✓
	27	OPERATING STATION INTERCHANGEBILITY and ASSIGNABILITY CHECK	✓
	28	PRINTER ASSIGNABILITY and BACK-UP FUNCTION CHECK	✓
	29	FLOPPY DISK/ STD / OPTICAL DISK UNIT STORAGE and RETRIEVAL CHECK	✓
	30	OPERATING STATION ASSIGNABILITY CHECK FOR HARD COPIER FUNCTION	✓
	31	PLANT PERFORMANCE CALCULATION CHECK	✓
	32	COMMUNICATION INTERFACE TO OTHER'S SYSTEM SIMULATION CHECK	✓
	33	-	
	34	DATA BUS DISTANCE BUILDING CHECK (REFER NOTE- 3)	✓
	35	GRAPHIC DISPLAY BUILDING FUNCTION CHECK	✓
MAINTENANCE	36	CLOSED LOOP CONTROL SYSTEM MODIFICATION CHECK	✓
	37	OPEN LOOP CONTROL SYSTEM MODIFICATION CHECK	✓
	38	ALARM DISPLAY PRIORITISATION CHECK	✓
	39	SYSTEM SECURITY CHECK	✓
	40	SYSTEM ALARM CHECK	✓
	41	SYSTEM DIAGNOSTIC FUNCTION CHECK	✓
	42	POINT DETAIL CONFIGURATION CHECK	✓
	43	CONTROL LOOP TUNING CHECK	✓
	44	SYSTEM SELF DOCUMENTATION CHECK	✓
NOTES	1. THE INTENT OF THE FAT IS TO DEMONSTRATE AND ENSURE THAT THE I&C SYSTEM MEETS ALL THE FUNCTIONAL REQUIREMENTS AS INTENDED IN THE SPECIFICATION / CONTRACT. A COMPLETED INTEGRATED TEST OF THE SYSTEM SHALL BE CARRIED OUT AT VENDOR'S WORKS IN THE PRESENCE OF OWNER, ON COMPLETION OF INTEGRATION/MANUFACTURING OF THE SYSTEM. THE SHIPMENT OF I&C EQUIPMENT TO SITE WILL BE EFFECTED ONLY AFTER THE FAT HAS BEEN ACCEPTED BY THE OWNER.		
	2. FAT PROCEDURE SHALL BE PREPARED BY VENDOR AND TO BE SUBMITTED FOR OWNER'S/ APPROVAL WELL IN ADVANCE PRIOR TO THE COMMENCEMENT OF FAT		
	3. FAT SHALL BE CONDUCTED WITH THE DISTANCE BETWEEN THE PROCESSOR AND OTHER SUPPORTING PERIPHERIALS AS PER THE FINAL LAYOUT IN THE CONTROL ROOM.		
	4. ALL THE RELEVANT APPROVED DOCUMENTS REQUIRED FOR FAT SHALL BE SUBMITTED BY THE BIDDER IN ADVANCE PRIOR TO COMMENCEMENT OF FAT.		

14.02.04.17 **Tests to be performed during FAT of PLC system**

Following minimum tests shall be performed during FAT at manufacturer's place of PLC system:

1) Hardware Inspection of PLC Sub System
   - i) Heat run test
   - ii) Hardware check / physical software package check
   - iii) I/O loading specification
   - iv) PLC start-up and power fail restart
   - v) PLC processor back-up function
   - vi) Communication redundancy

2) Application Inspection for Logic Functions
   - i) Ladder logic functional check and graphic screen check

3) Application Inspection for PLC Panels
   - i) General arrangement
   - ii) Appearance and construction
   - iii) Panel wiring
   - iv) Panel functional check
   - v) Power supply redundancy check

4) PLC System Checks

i) PLC Scan time functional test
ii) PLC/IO panel/Engineering station functions
iii) Diagnostic and process alarm test
iv) Controller redundancy test
v. I/O cards redundancy test.
vi) Controller loading test

In addition to above test, Bidder shall also perform other tests as per approved QAP & FAT procedure. Also bidder shall submit "Type Test" report as per IEC – 61131.2 along with FAT report for PLC.

14.02.04.19 FACTORY ACCEPTANCE TEST FOR SIMULATOR

Factory Acceptance Test (FAT) shall include all required tests to fully demonstrate to Owner's satisfaction that each equipment/sub-system/system software modules etc. furnished as per this specification, as well as Simulator as a whole, fully meets the functional, parametric and other requirements of this specification and Owner's approved drawings/documents under all operating regimes.

Bidder to note that FAT procedure given below in subsequent clauses are only indicative in order to help the Bidder in understanding the requirements and help him in submitting a detailed procedure based on these guidelines meeting all the specification requirements.

The Bidder shall also carry out the tests included in subsequent clause as pre FAT and submit its results before inviting Owner for FAT.

The Factory Acceptance Test (FAT) shall include all reasonable exercises, which the combination of equipment and software can be expected to perform. These tests shall be divided into, as a minimum, but not limited to the following categories:

i. Pre power on checks
ii. Power on check
iii. Hardware tests
iv. Functional tests
v. Parametric tests
vi. Specific tests on Electronic hardware

14.02.04.19.1 The major Functional Tests shall include but not limited to the following:

a) Verification of individual modules in line with approved documents.

b) Verification of adherence to parameters for various plant configurations at different initial conditions.

c) **Functional test for C&I Model**

Verification of proper realization of Control and Logic functions as per input documents and approved functional design specification (FDS).

d) **Functional tests for HMIPIS**

i. Verification of all types of displays, logs including their formats, bar graphs, X-Y plots etc. Verification of all function keys on keyboards and availability of all operator functions.

ii. Verification of event generation and handling capabilities of HMIPIS processors by simulating various types of events / data and observing associated event sequence display and alarm signaling boxes.

iii. Calculations:

All calculations shall be tested to demonstrate that these are in accordance with the specification and I/O schedule. The Bidder shall prepare all tests cases for calculations (3 for each calculation at low, mid and upper ranges of inputs) and submit them for the owner's approval. Test cases shall include performance calculations, flow and level calculations, pressure and temperature compensations, etc.

iv. Checking historical storage and retrieval functions including long-term storage.

v. Checking healthiness of processor, main memory. Testing of initialization and loading of configuration data, etc.

vi. Verification of all programmers' stations functions for HMIPIS and Control System, as well as for documentation facility as specified.

vii. Various display response time / System accuracy etc.

viii. Display update time on OWS

e) Functional test for networking & communication devices

i. Verification of various features as per approved documents.

ii. Verification of throughput after creating high communication traffic.

f) Instructor's workstation Functions

Verification of all features of instructor functions like malfunction, initial conditions, snap shots, trainee exercises etc. in line with specification & approved documentation.

g) Programming and Documentation functions

i. Verification of all programming function like, modification of application software, database, administrator's function etc. in line with specification and approved documents.

ii. Verification of all documentation functions in line with specification and approved documents.

14.02.04.19.2 FAT Procedure

The Bidder shall submit a detailed FAT procedure for owner's approval during detailed engineering stage based on the above guidelines. The FAT procedure to be submitted by the Bidder shall be detailed and exhaustive enough such that owner is satisfied that all the Simulator System specification requirements and features are being tested and the system meets these requirements.

14.02.04.20 Tests to be performed during FAT of Peripherals & other control system

1. Colour Graphic Video Display Unit (OWS)

   i. Functional tests (As per FAT procedure. Note-1)
   ii. Test for capabilities of OWS including error detection for the complete system (Both hardware & software) simulating worst conditions
   iii. Noise test
   iv. Surge withstanding capacity as per IEEE or equivalent
   v. Quality assurance as governed by BS 5750 or equivalent
   vi. Design, construction, components, finishes and testing of electronic equipment as per EES-1980 (General specification of electronic equipment) or equivalent

   Note-1: Test to be witnessed by Owner.

2. Keyboard

   i. Test for satisfactory operation of keyboard controls, push buttons and all associated functions (As per FAT procedure. Note-1)
   ii. Quality assurance as governed by BS 5750 or equivalent for functional test for the complete system simulating worst conditions
   iii. Design, construction, components, finishes and testing of electronic equipment as per EES-1980 (General specification of electronic equipment) or equivalent

   Note-1: Test to be witnessed by Owner.

3. Printers

   i. Noise level test for the printer
   ii. Test of interlock performance and error detection feature.
   iii. Quality assurance as governed by BS 5750 or equivalent
   iv. Design, construction, components, finishes and testing of electronic equipment as per EES-1980 (General specification of electronic equipment) or equivalent

4. Floppy / Tape Drive Unit / Bulk Memory Unit / DVD, CD drive Unit / DAT Drive

   i. Noise test
   ii. Surge withstanding capacity as per IEEE or equivalent
   iii. Quality assurance as governed by BS 5750 or equivalent
   iv. Design, construction, components, finishes and testing of electronic equipment as per EES-1980 (General specification of electronic equipment) or equivalent
   v. Test of Control unit and drive for all features, date checking features.

5. Vibration Monitoring & Analysis System

   i. Simulated functional test (Note-1)
   ii. Tests for server, LED monitor, Printer, Keyboard

   Note-1: Test to be witnessed by Owner.

6. PADO (Performance & Optimization System)

   i. Simulated functional test (Note-1)
   ii. Tests for server, LED monitor, Printer, Keyboard

   Note-1: Test to be witnessed by Owner.

7. ERP System

   i. Simulated functional test (Note-1)
   ii. Tests for server, LED monitor, Printer, Keyboard

   Note-1: Test to be witnessed by Owner.

8. MIS System

   i. Simulated functional test (Note-1)
   ii. Tests for server, LED monitor, Printer, Keyboard

   Note-1: Test to be witnessed by Owner.

9. HMS System

   i. Simulated functional test (Note-1)
   ii. Tests for server, LED monitor, Printer, Keyboard

   Note-1: Test to be witnessed by Owner.

NOTES:

1. The intent of the FAT is to demonstrate and ensure that the I&C system meets all the functional requirements as intended in the specification / contract. A completed integrated test of the system shall be carried out at vendor's works in the presence of Owner or Owner's representative, on

completion of integration / manufacturing of the system. The shipment of I&C equipment to site will be effected only after the FAT has been accepted by Owner.

2. FAT procedure shall be prepared by vendor and to be submitted for Owners approval well in advance prior to the commencement of FAT.

14.02.04.21 **Calibration of Instruments**

The Bidder shall carry out the calibration of instruments as indicated below by submitting the test procedure and quality assurance plan for the Owner's approval. Bidder shall also prepare detailed checklist/calibration sheets for each of the systems/equipment clearly indicating the step-by-step procedures to be carried out for calibration pre commissioning, loop checking, powering and commissioning.

The calibration of all instruments shall be checked and calibration records prepared for the Owner's use. If the instruments require recalibration, Bidder shall recalibrate the instruments and revise the calibration records and submit to the Owner.

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 : $\pm$ 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
6.	Temperature switch
	Calibration / Material test / Accuracy test / Bore concentricity : 1.5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.) / Contact rating test.
7.	Resistance temperature detector assembly.
	Calibration / Material test / Bore concentricity test / Insulation test ($\leq$ 500 MΩ at 500V DC) as per ISA, Hydro test for TW. Bore concentricity: $\pm$ 5% of wall thickness, Accuracy test.
8.	Thermocouple assembly
	Calibration / Material test, Insulation test ($\geq$ 500 Ω at 500 V, DC) as per ISA, Hydro static test (1.5 times max. pr.), Bore concentricity : $\pm$ 5% of wall thickness.
9.	Thermowells
	Material test / Bore concentricity : $\pm$ 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.

K.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.		
1.00.01	**Measuring Instruments**				
1.00.01.01	**Indicators, Recorders, Electrical Metering and Skid Mounted Instruments**				
(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		
(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		
1.00.01.02	**Temperature Elements and Thermowells**				

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.		
(ii)	Thermowells	Nos.	10% for each type of temperature sensors or a minimum of one for each type, whichever is more		
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.		
~~1.00.01.04~~	**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)				

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	
a)	Electronic Module/Mother Board	Nos.	10% of installed or at Least one number of each type of module for each analyser type.		price included at s.no. 1.00.01 above
b)	Cooling and purging air blower unit	Nos.	One No. for each analyser type		price included at s.no. 1.00.01 above
c)	Light source and detector unit for smoke density analyser.	Set	One set for each analyser type		price included at s.no. 1.00.01 above
d)	Infrared source and detector unit for CO analyser	set	One set for each analyser type		price included at s.no. 1.00.01 above
e)	Zirconia Cell, ceramic filters, heater & thermo couple assembly for flue gas oxygen analyzer.	Nos.	Two Nos. of each type		price included at s.no. 1.00.01 above
f)	of chopper motor, two nos. protection	Nos.	Two No. of each type		price included at s.no. 1.00.01 above
	window, one no. of heater cartridge for CO analyser				price included at s.no. 1.00.01 above
g)	Power supply module	Nos.	1 no. of each type for each analyser type.		price included at s.no. 1.00.01 above
h)	UV Lamp with adopter with SO2 analyser	Nos.	2 no. of each type.		price included at s.no. 1.00.01 above
i)	Light source and detector unit for SPM, and NOX/SOX analyser.	Nos.	1 no. of each type for each analyser type.		price included at s.no. 1.00.01 above
j)	Set of filters	Nos.	1 No. of each type for each analyser type.		price included at s.no. 1.00.01 above
k)	Analysers spares like transmitter lens and receiver lens, protection windows for transmitter & receiver, intergral pressure and temperature sensors, signal processing unit, electronic modules	Nos.	1 No. of each type for each type of flue gas analyser.		price included at s.no. 1.00.01 above
1.00.02	**DDCMIS/PLC system, Master slave clock system, Hart Management System, Vibration Monitoring system, CAAQMS, ERP/MIS/LAN/Simulator/ WAN, CCTV, Microprocessor based control system, and other Control System/Sub-systems/electronic system listed in NIT.**				

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	
1.00.02.01	I/O cards				
a.	Analog Input module	Nos.	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)		
b.	Analog output module	Nos.	10% of qty Installed of each category/ model or at least 2 No. of each type/model (Whichever is more)		
c.	RTD/TC cards/modules	Nos.	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)		
d	Digital input module	Nos.	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)		
e.	Digital output module	Nos.	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)		
1.00.02.02	All types of electronic modules, controllers, function modules, cards, terminal boards, relay boards, power supply cards etc for above mentioned system and other Control System/Sub- systems and any other type of PCB not covered above	Nos.	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)		

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.

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TANGEDCO				Total Ex-Works price	*Remarks
Sl no	Name of spares	Unit	Qty	in INR	
1.00.02.03	Electronic Cards/modules	Nos.	10% of number for each type or minimum of 2 number for each type whichever is high.		
1.00.02.04	Auto/Manual stations, set-point/bias stations etc	Nos.	10% of the number of stations offered for the project from each type or a minimum of 2 number from each model, whichever is more.		
1.00.02.05	Control logic power supply fuses, MCB,MCCB, at each current rating required for the project.	Nos.	20% spare for each type/Model		
1.00.02.06	Electronic cards of each type used for each type of Servers supplied with any control system	Nos.	Ten (10) percent or 2 no. (Whichever is more)		
1.00.02.07	Electric to pneumatic converters of each type utilized with automatic control system using pneumatic drives	Nos.	Ten (10) percent of each type or a minimum of one of each type, whichever is more.		
1.00.02.08	Plug-in type keyboard	Nos.	10 nos. of each type/model.		
1.00.02.09	Control OWS	Nos.	Two No. of each type with complete accessories & monitors.		
1.00.02.10	Utility/Engineering OWS	Nos.	Two No. of each type with complete accessories & monitors.		
1.00.02.11	DVD/CD	Nos.	10 boxes		
1.00.02.12	Data highway cable with adequate connectors of each type	set.	200 mts. each		
1.00.02.13	Hard disc drive unit	Nos.	Five nos of each type		
1.00.02.14	Prefab cable connectors	Nos.	10% or 5 nos (whichever is more) of each type of Installed		
1.00.02.15	Cubicle power supply power supply modules	Nos.	Ten (10) percent or 5 nos (whichever is more) of Installed of each type and rating		
1.00.02.16	Interposing/coupling relays.	Nos.	Ten (10) percent Installed of each type and 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.

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TANGEDCO				Total Ex-Works price	*Remarks
Sl no	Name of spares	Unit	Qty	in INR	
1.00.02.17	Ethernet Switches, Routers & other communication hardware	Nos.	10% of qty Installed of each type or a minimum of 2 numbers from each model, whichever is more.		
1.00.02.18	Sensors with special cables, Power supply modules, Relay, Interface Module, and electronic modules used for vibration monitoring system.	Nos.	10% of qty installed or Five no. (Whichever is more) of each type)		
1.00.02.19	Printer toners for all printers	Nos.	Ten (10) percent of qty installed or 3 no. (whichever is more)		
1.00.02.20	DMP printer head of the total quantity	Nos.	2 nos. of 132 colums of each type		
1.00.02.21	Drum for A3 sized scanner cum copies, printer	Nos.	2 nos. of each type		
1.00.02.22	24“ LED monitor,	Nos.	3 nos.		
1.00.02.23	29” LED monitor	Nos.	1 no		
1.00.02.24	22” LED monitors.	Nos.	5 nos		
1.00.02.25	RJ 45 connector with box of each type	Nos.	Twenty (20) percent or 2 no. (Whichever is more)		
1.00.02.26	Hooters, Buzzers, Cooling fans of each type.	Nos.	Ten (10) percent or 2 no. (Whichever is more)		
1.00.02.27	Interface cables	Set	2 sets of each type/model		
1.00.02.28	Power supply modules (AC to DC convertors)	Nos.	10% or Five no. (Whichever is more) of each type/model		
1.00.02.29	DVD/CD drive unit of each type	Nos.	5 nos.		

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.

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TANGEDCO				Total Ex-Works price	*Remarks
Sl no	Name of spares	Unit	Qty		
1.00.02.30	Mouse	Nos.	20 nos. of each type/model.		
1.00.03	**Steam and Water Analysis System (SWAS)**				
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**				
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.		

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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	
1.00.05	**Alarm Annunciation System**				
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**				
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		

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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		
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**				
1.00.07.01	Instrument valves	Nos.	Ten (10) percent of each type & Size installed		

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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**				
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**				
(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**				

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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		
1.00.13	**Mandatory Spares for Control valves, Power Cylinder, Control Dampers, Actuators and Accessories**				
(A)	Following spares shall be furnished for control valves, Power Cylinder, Control Dampers as applicable.				
	One set of spare control valve stem packing for each control valve.				
	Two moulded rubber diaphragms for each control valve.				
	One sets of each of O-rings and rubber gaskets for each control valve.				
d)	100 percent qty. of lubricants for gaskets for each control valve on one year consumption basis.				

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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	
	2 sets of limit switches and 1 set of valve positioner for each control valve.				
f)	20 percent of position transmitter (4-20mA) for total qty. of control valve.				
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.				
h)	One completes actuator of each type or min 10% for each type and size whichever is more.				
i)	20 percent of Solenoid valves or min 2 no. of each type for total qty. of control valves.				
j)	20% of I to P converters, Pressure regulators.				
B)	Mandatory spares for each critical applications special control valves as specified in NIT				
C)					

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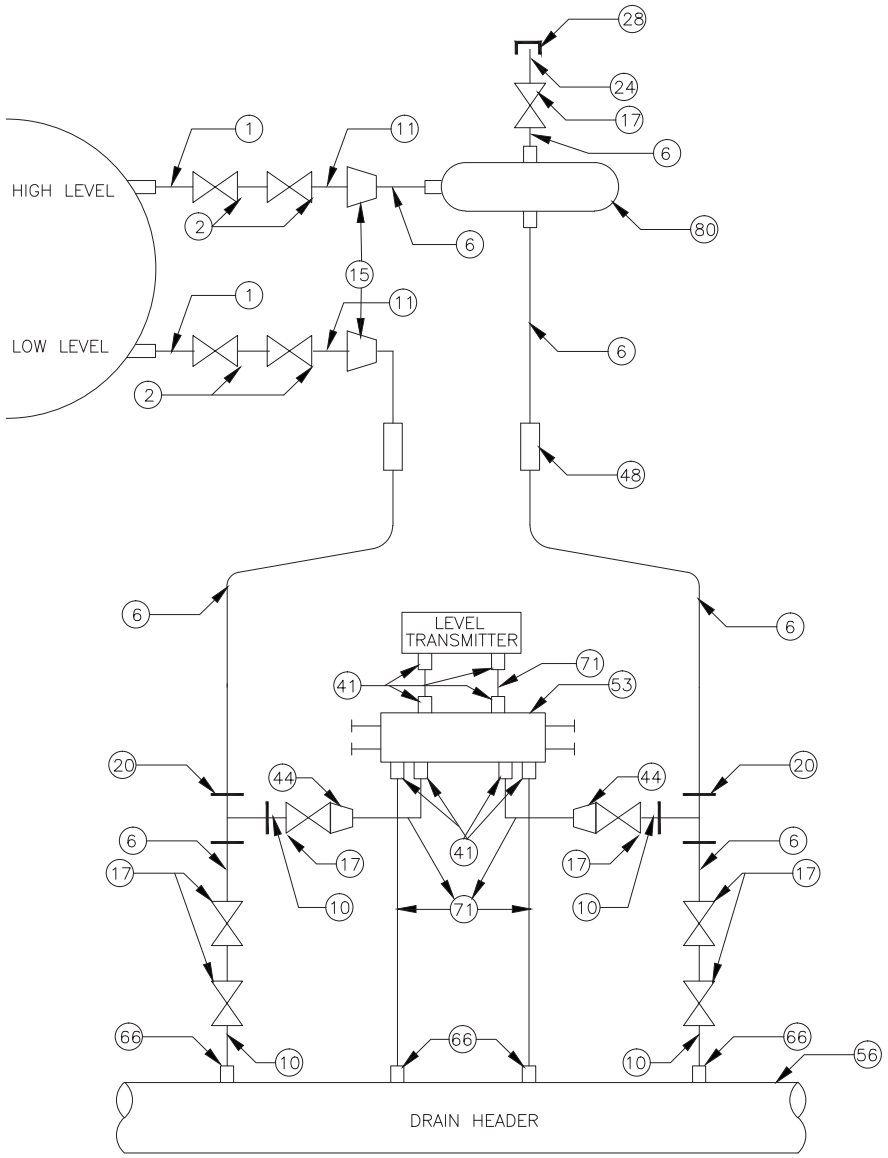
1. C&I Mandatory spares are indicated in above list. These spares shall be considered as per the applicable items in main supply of AC system package.
2.The spares shall be considered as unit wise except for any item/equipment supplied as common for both units.

TANGEDCO				Total Ex-Works price	*Remarks
Sl no	Name of spares	Unit	Qty	in INR	
6)	Consumables like batteries, fuses etc. for two years operation of boiler tube leak detection system.				
1.00.15	**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.				
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.			
(ii)	Flame Scanner Lens.	100%			
(iii)	Electronic cards for scanners	10% or 2 nos. of each type whichever is more.			
(iv)	Power Supply Modules	10% or 2 nos. of each type whichever is more.			
2	**Coal Feeders**				
(i)	Calibration Motor	10% or 2 nos. whichever is more.			
(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.

L.DRAWINGS



TRANSMITTER MOUNTED BELOW INST. SOURCE POINT

TAG NO.	DESCRIPTION	BOM
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.

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 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

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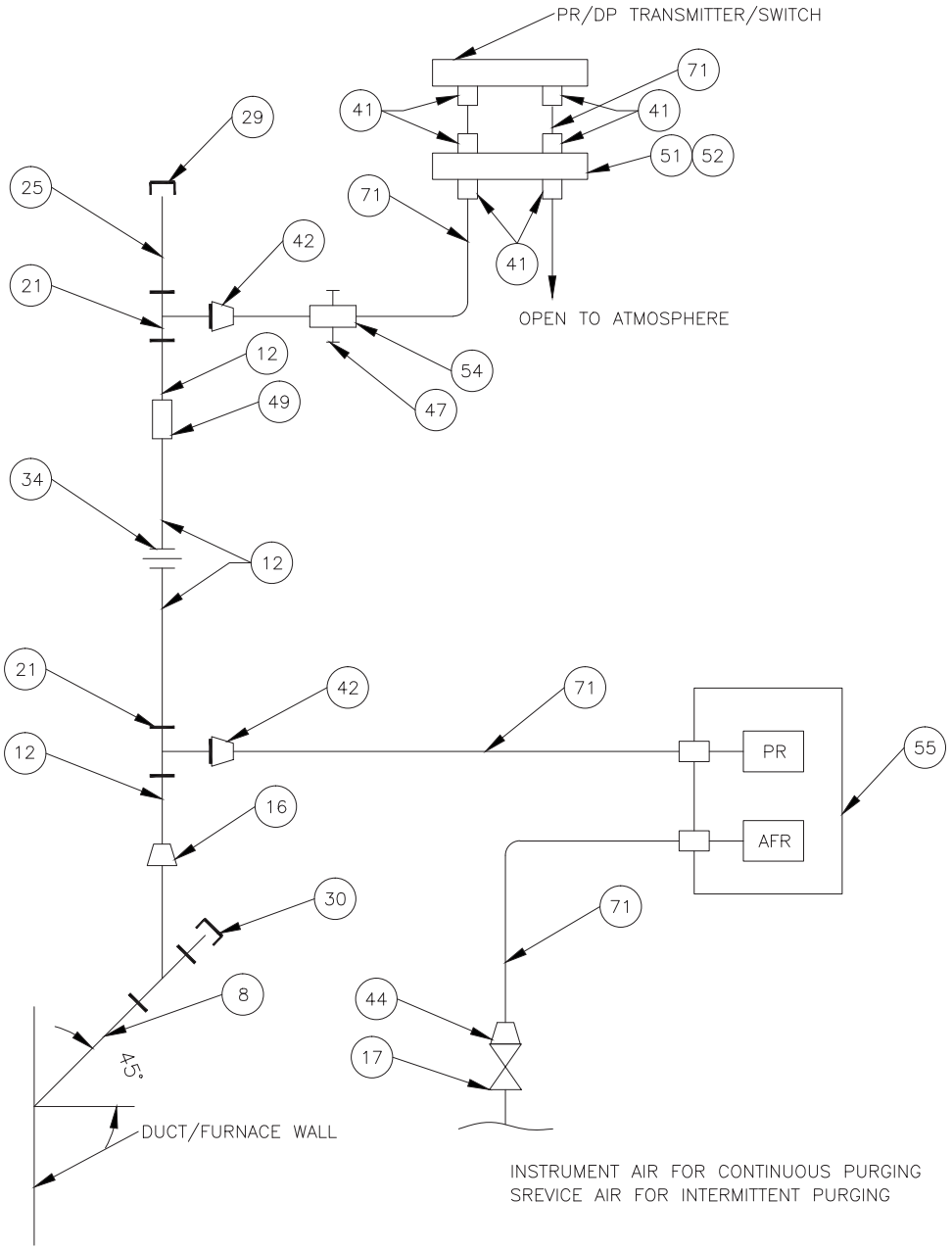
CLIENT: TAMILNADU GEN. & DIST. CORPORATION
PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.
TITLE :- INST. DRAWING FOR LEVEL TRANSMITTERS
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DWG.No.	114-04-0110		REV. 0

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INSTRUMENT AIR FOR CONTINUOUS PURGING
SREVICE AIR FOR INTERMITTENT PURGING

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.

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

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Praveen Kishore

REFERENCE DRAWINGS.

NOTES

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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.

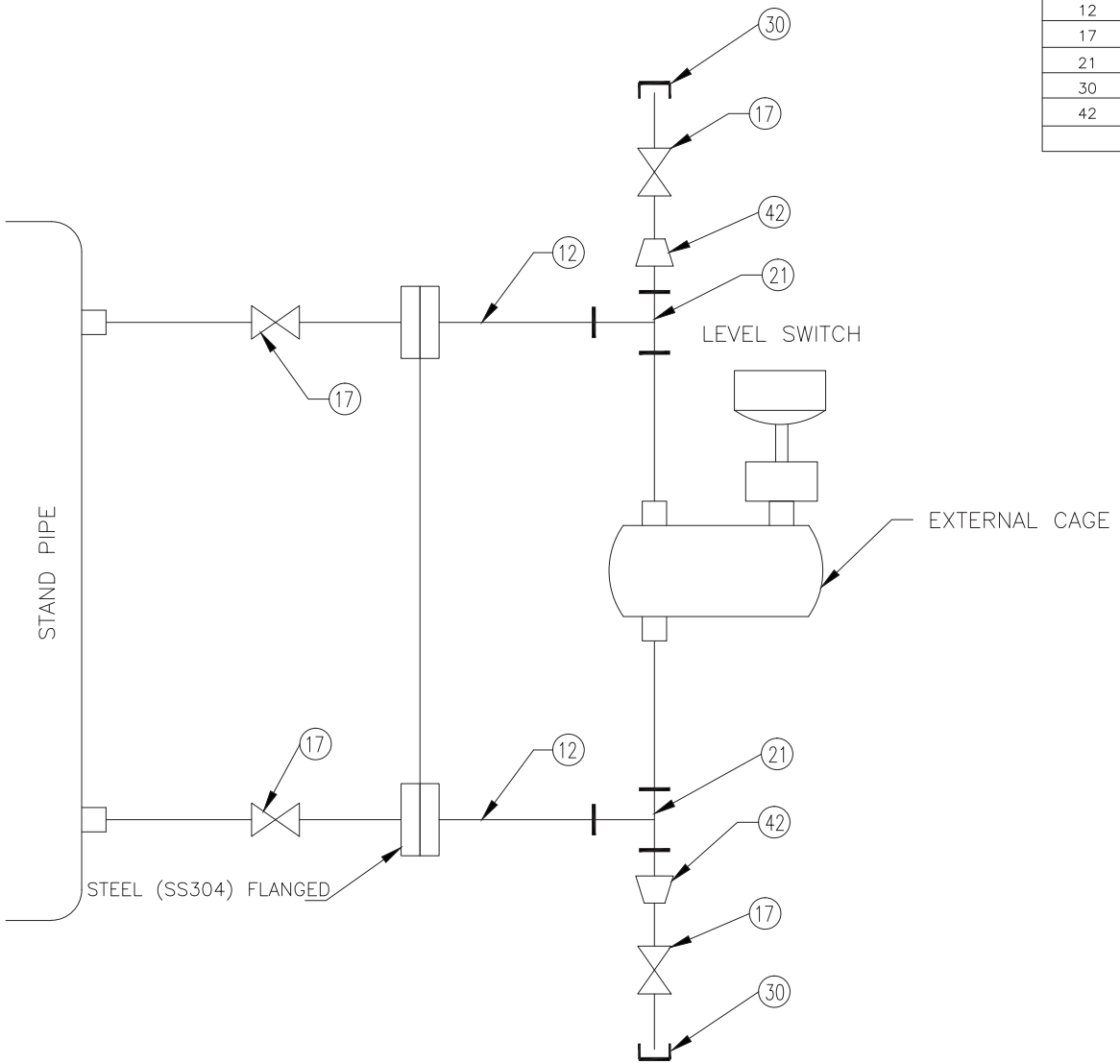
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BILL OF MATERIAL		
TAG NO.	DESCRIPTION	QTY.
12	3/4" NPS SCH-80 CARBON STEEL PIPE	AS REQD.
17	1/2"/3/4"/1" SOCKET WELDED GLOBE VLV/ROOT VLV.	4
21	3/4" EQUAL TEE,CS	2
30	1/2" NPT (F) CS CAP	2
42	3/4"BW X 1/2"OD TUBE FITTING,SS-316	2



REFERENCE DRAWINGS.

NOTES

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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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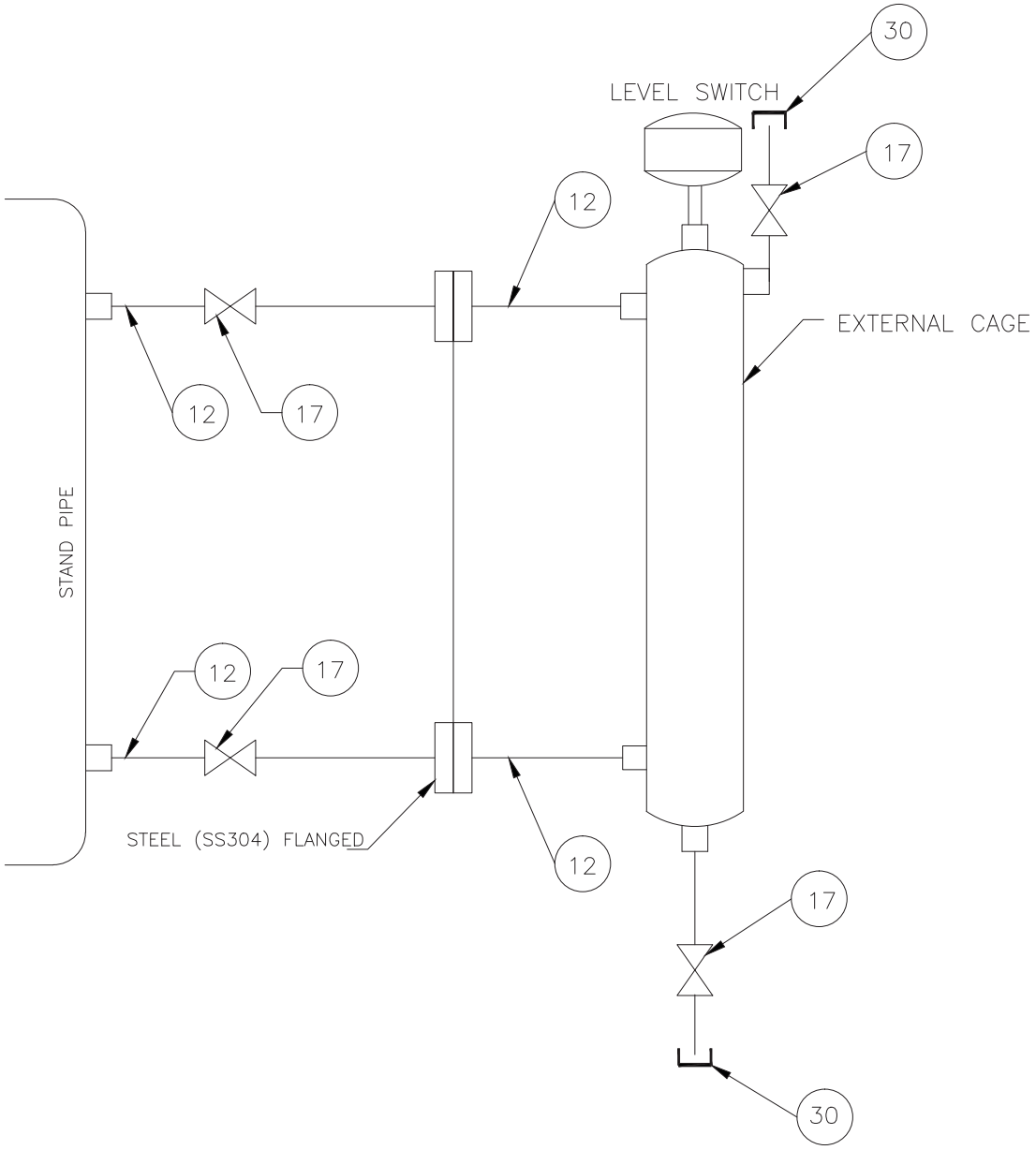
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JOB. No.	D-4027		
DWG.No.	114-04-0113		REV. 0

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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

REFERENCE DRAWINGS.

NOTES

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4. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

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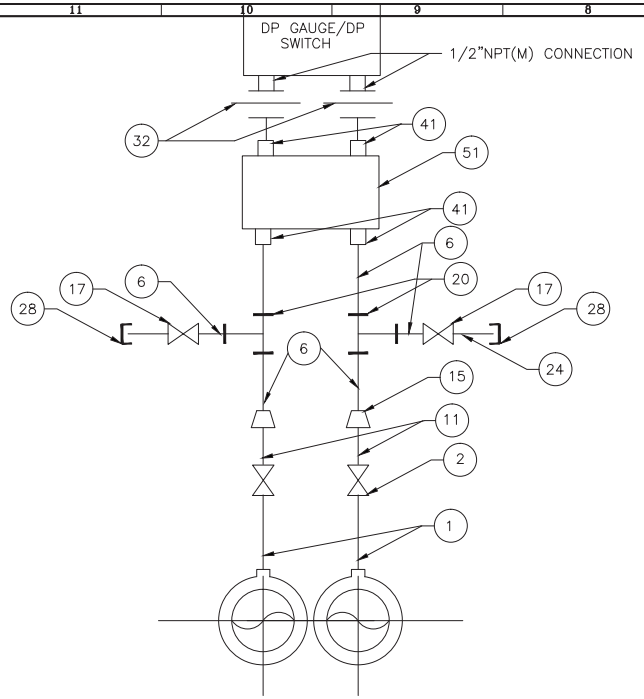
TITLE :- INST. DRAWING FOR LEVEL SWITCH OPTION-2 WITH FLANGED CONNECTION

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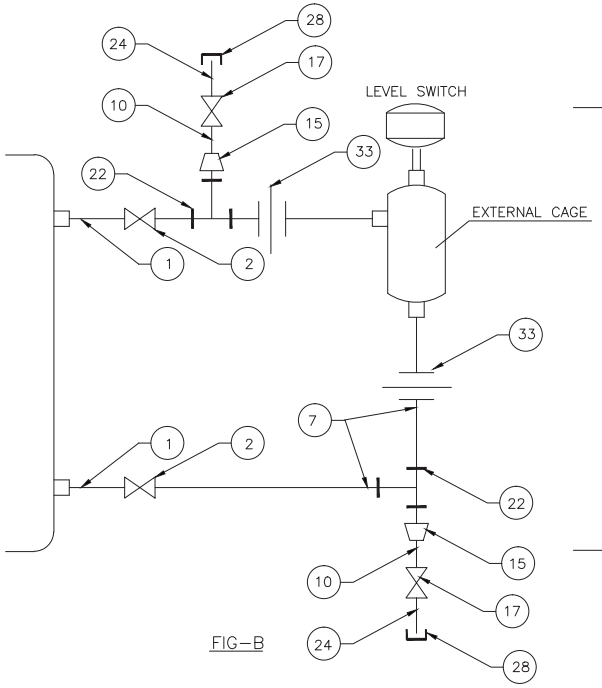
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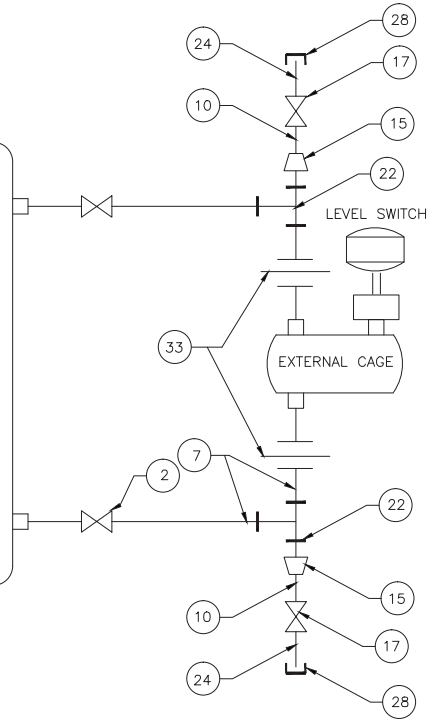
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FIG–A



FIG–B



FIG–C

TAG NO.	DESCRIPTION	A	B	C
		QTY.		
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.		

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.
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TITLE :– INST. DRAWING FOR DIFF. PRESS. SWITCH/GAUGE/LEVEL SWITCHES

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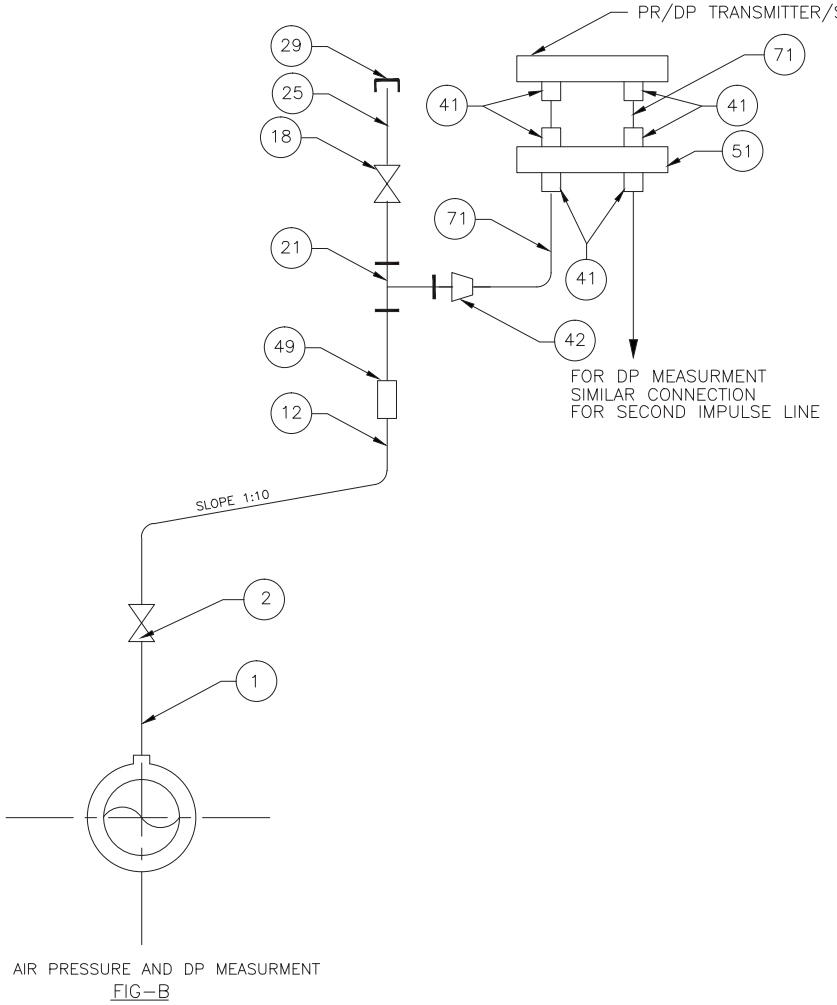
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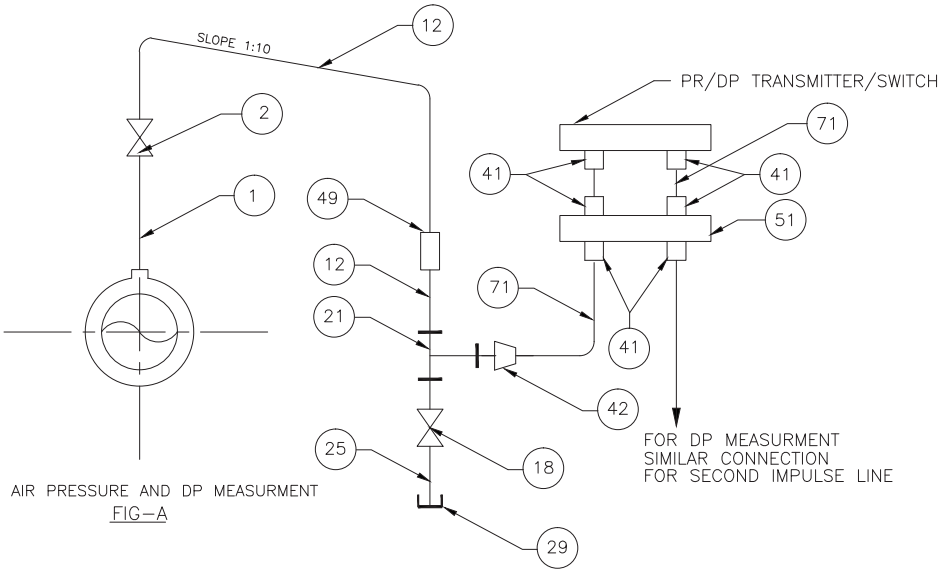
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AIR PRESSURE AND DP MEASURMENT
FIG–B



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

REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
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TITLE :– INST. DRAWING FOR PRESS. & DIFF. PRESS. TRANSMITTERS/SWITCH (AIR SERVICE)

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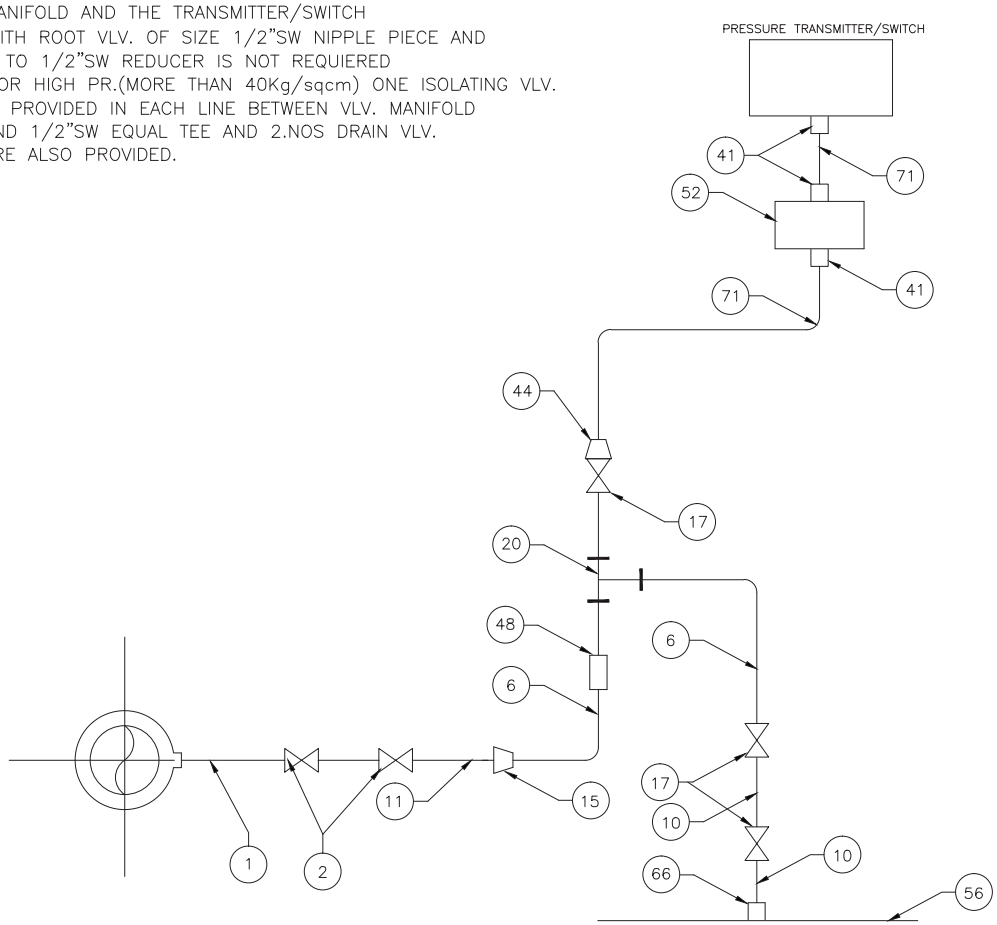
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Praveen Kishore

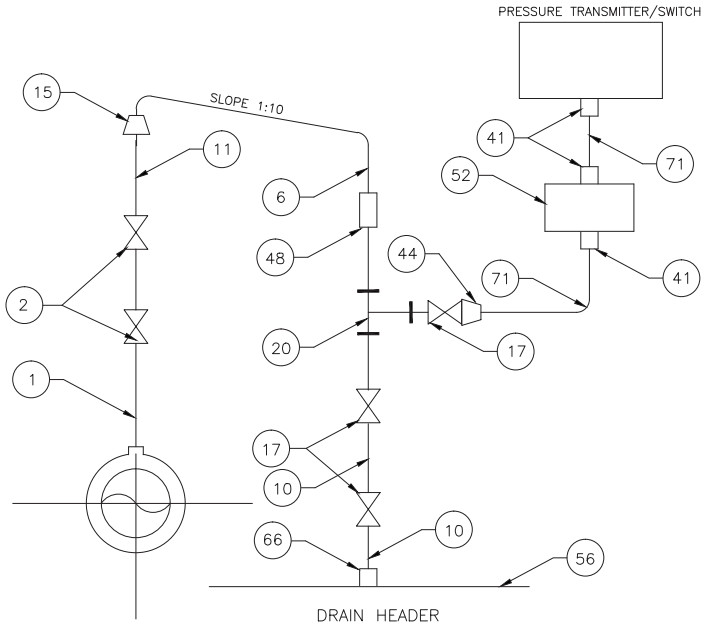
NOTE:–

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	AS REQD.	
66	1/2" GI SOCKET	1	1
56	2"NB GI DRAIN HEADER		
52	5/3/2–VALVE MANIFOLDS,SS–316	1	1
48	1/2"SW,CS/AS BULK HEAD PIPE UNION	1	1
44	1/2"BW 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 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.

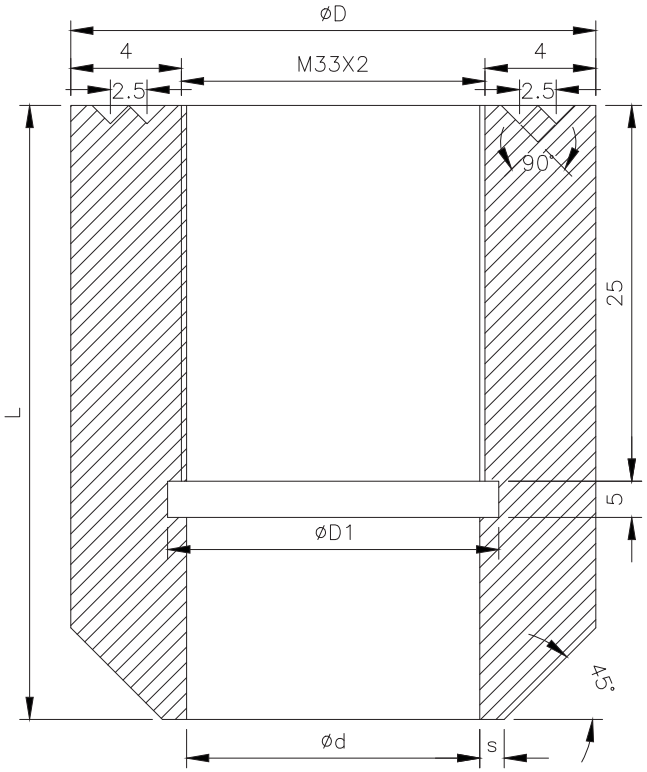
TITLE :– INST. DRAWING FOR PRESS. & DIFF.PRESS. TRANSMITTERS/SWITCH (STEAM & LIQUID SERVICE)

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SCALE	N.T.S.		
JOB. No.	D–4027		
DWG.No.	114–04–0104		REV. 0

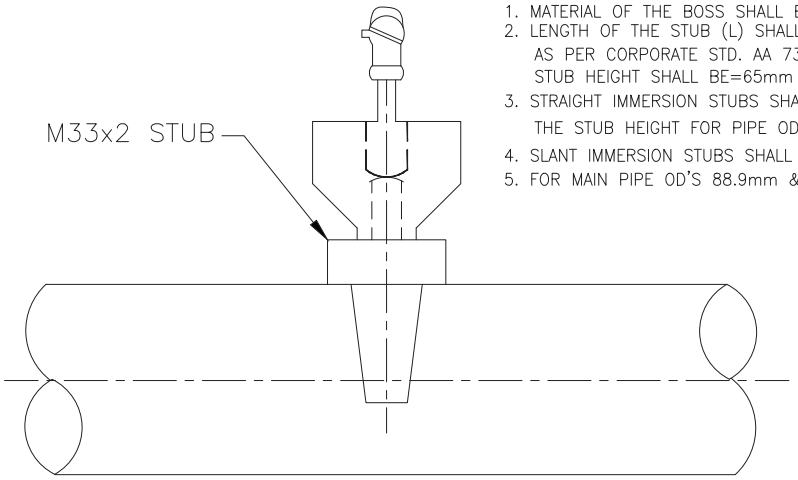
Sheet No. 7 of 19

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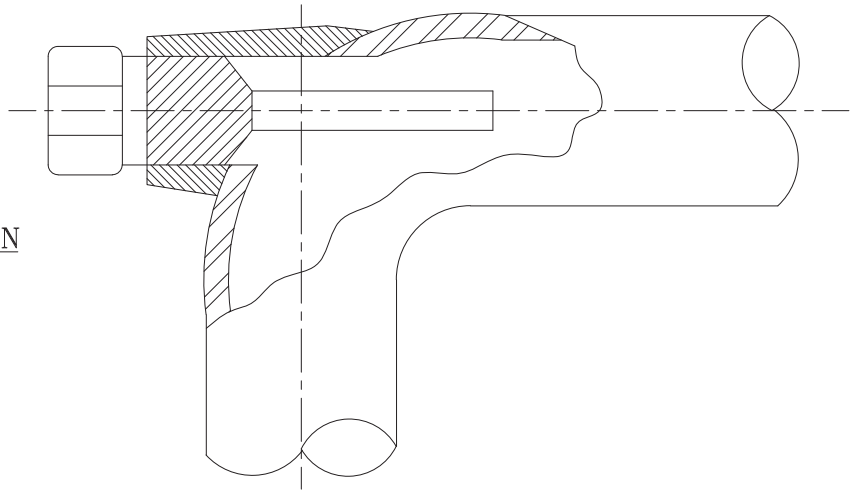
TEMPERATURE STUB FOR STRAIGHT IMMERSION

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
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Praveen Kishore

Page 533 of 701

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.
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6. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

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TITLE :- INST. DRAWING FOR TEMPERATURE STUB

FOR BID PURPOSE ONLY:

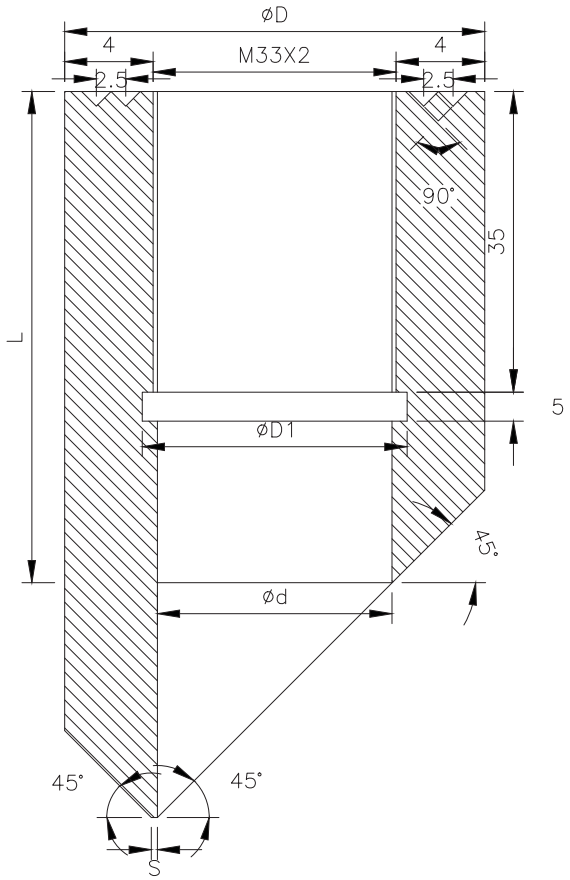
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JOB. No. D-4027

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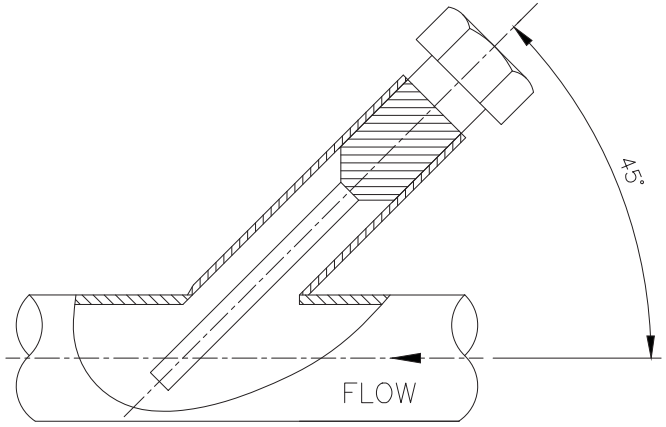


TEMPERATURE STUB FOR SLANT IMMERSION

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

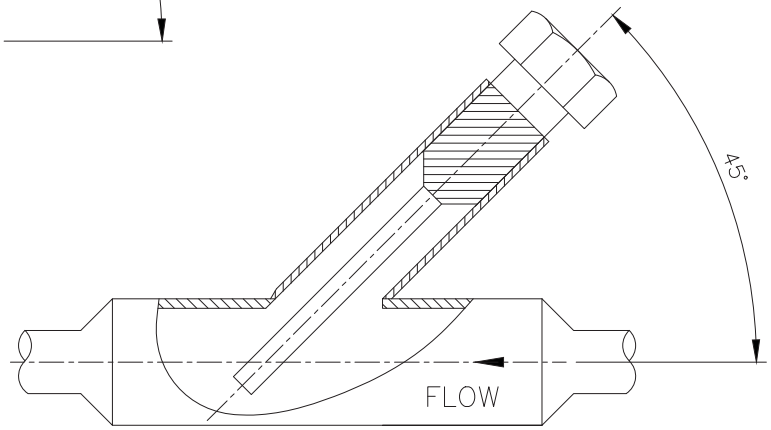
NOTE :–

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)
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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)

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Praveen Kishore

Page 534 of 701

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 CONTRACT AGREEMENT WITH DESEIN.

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TITLE :– INST. DRAWING FOR TEMPERATURE STUB

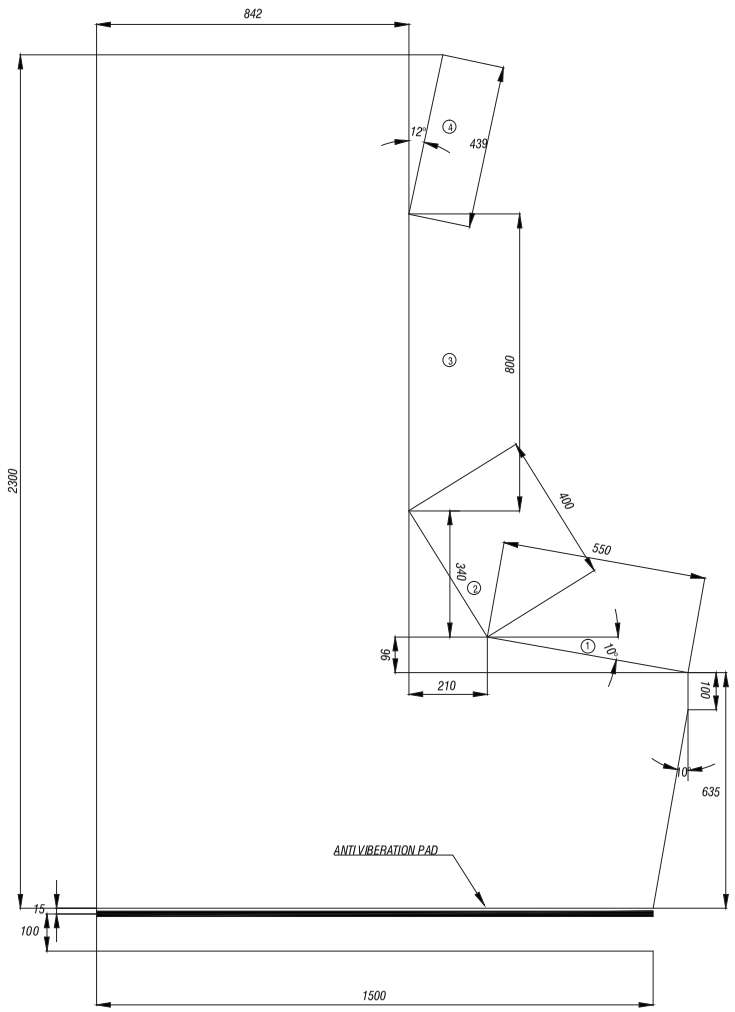
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JOB. No. D–4027

DWG.No. 114–04–0111 REV. 0

Sheet No. 15 of 19



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.

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TITLE :– GEN.ARRG.OF DESK CUM PANEL (TYP) FOR BOP PACKAGES

FOR BID PURPOSE | SHEET NO. 1 of 1

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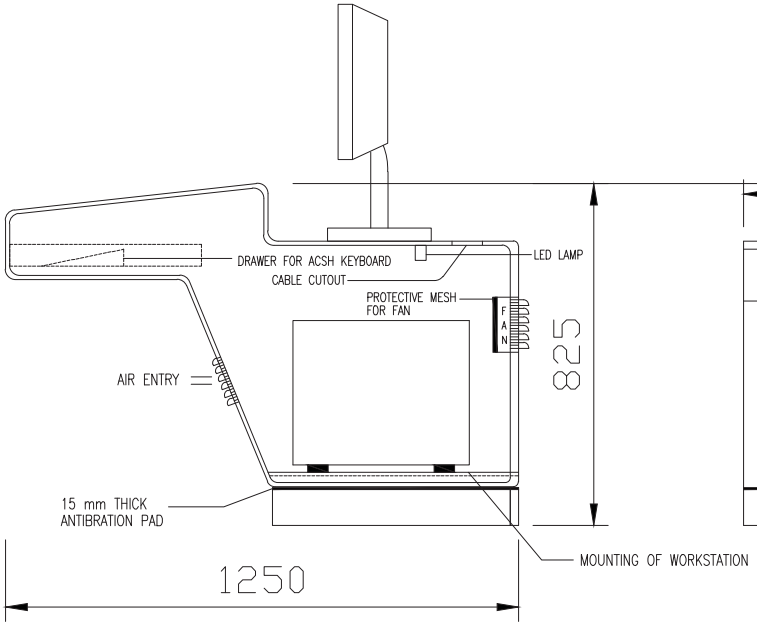
JOB NO. D–4027

DRG NO. 114–05–0105 | REV. 0

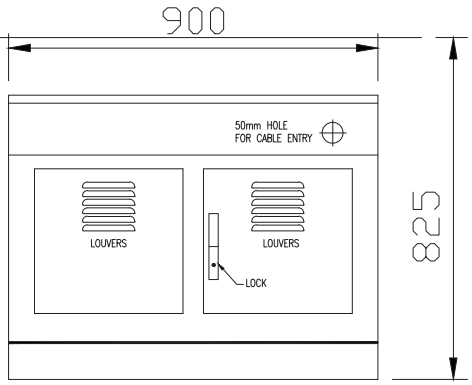
DRG. NO. 114-05-0108



FRONT VIEW



SIDE VIEW



REAR VIEW

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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.

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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.

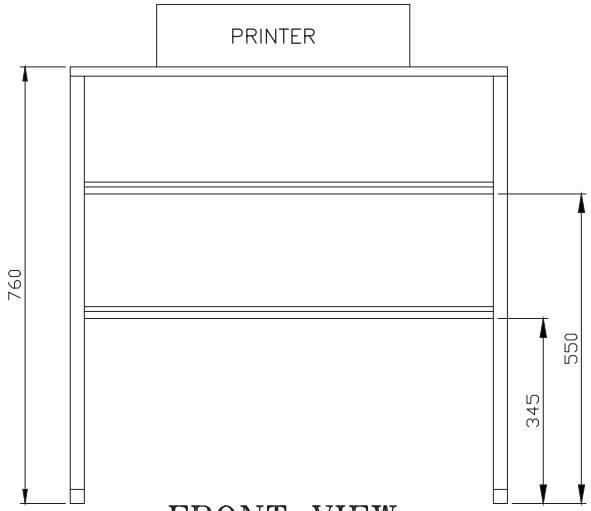
SHEET NO. 3 of 4

SCALE N.T.S

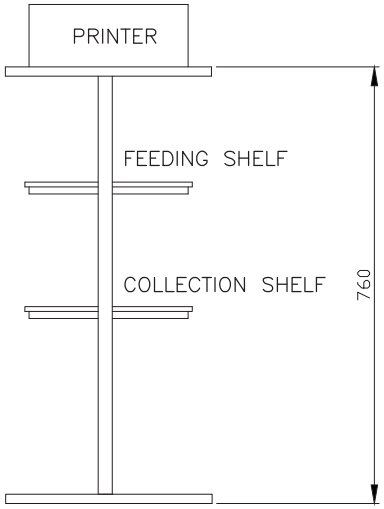
JOB NO. D–4027

DRG. NO. 114–05–0108

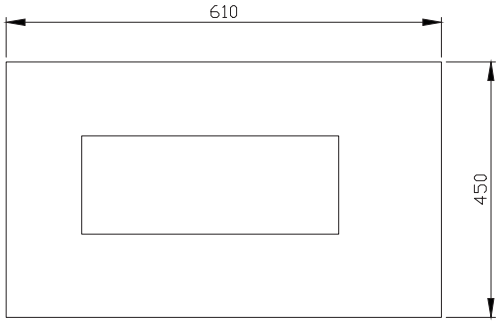
REV. 0



FRONT VIEW



SIDE VIEW



TOP VIEW

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S A Khan

Praveen Kishore

NOTES	NOTICE
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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

FOR BID PURPOSE

SHEET NO. 4 of 4

STANDARD TECHNICAL SPECIFICATION FOR CENTRAL AIR-CONDITIONING PLANT

1. GENERAL

1.1 This specification covers the design, manufacture, testing at Manufacturer's works, delivery to site, handling at site, installation, commissioning and carrying out acceptance tests and final painting at site of various equipment of the central air conditioning plant, as specified hereinafter.

2. CODES & STANDARDS

2.1 The design, manufacture and performance of air conditioning equipment shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment are to be installed. The equipment shall also conform to the latest applicable Indian/British/American standards. Nothing in this specification shall be construed to relieve the tenderer of this responsibility. In particular the equipment shall conform to the latest editions of the following standards.

2.1.1	IS-660	:	Safety code for Mechanical Refrigeration.
2.1.2	ARI 520-90	:	Standard for Positive Displacement Refrigerant compressors and condensing units.
2.1.3	IS-5111	:	Code of Practice of Measurement for Testing Refrigeration compressors.
2.1.4	ASHRAE/23-93	:	Method of Testing for Rating Positive Displacement Refrigerant compressors and condensing units.
2.1.5	ARI-450:		Standard for water-cooled Refrigerant condensers, Remote Type.
2.1.6	ASME (Section VIII)	:	Unfired pressure Vessels Code.
2.1.7	IS-2825	:	-do-
2.1.8	IS-4503	:	Shell and tube type heat exchangers.
2.1.9	ASHRAE/22-92	:	Method of Testing for rating of Water Cooled refrigerant condensers.
2.1.10	IS-659	:	Safety code for Air conditioning.
2.1.11	IS-2379	:	Color Code for Identification of pipe lines.
2.1.12	TEMA	:	Standards of Tubular Exchanger manufacturers Association.
2.1.13	IS-1239 (Part-I)	:	Seamless steel tubes (Up to & including 168.2 mm OD.).
2.1.14	IS-3589	:	For piping above 168.2mm to 2032mm Outside Diameter.
2.1.15	IS-778	:	Valves up to 50 MM.
2.1.16	IS-780	:	Valves 50 MM to 300 MM.
2.1.17	ASHRAE 24	:	Method of Testing for Rating liquid coolers.

2.1.18 ARI-480: Standard for refrigerant cooled liquid coolers-Remote type.

3. DESIGN & CONSTRUCTION REQUIREMENTS

3.1 The components of Central air conditioning plant comprising compressor, chiller refrigerant piping, valves and fittings etc. Shall be as given in Data sheet A. The type of all accessories, controls and instrumentation shall also be as indicated in data sheet A.

3.2 The various equipments supplied under this specification shall be fully compatible with each other & capable of operating as fully balanced integrated system to deliver the specified output under design conditions.

4. TESTING AND INSPECTION

(Refer standard quality plan)

4.1 Hydrostatic, Volumetric and refrigerant leak tests etc. shall be carried out at manufacturers works before dispatch of equipment in accordance with the applicable codes and standards.

Following minimum tests amongst others shall be conducted.

4.1.1 Material analysis, testing and identification (Data sheet/ Drg. Shall clearly indicate the specification, grade, class and Heat treatment condition of material for which TC will be furnished)

4.1.2 Hydrostatic pressure test of all pressure parts.(Testing pressure shall be clearly indicated for each component/ subassembly/ assembly)

4.1.3 Static and Dynamic balancing test of rotating parts at rated and over speed and to determine vibration & noise level.(Grade of balancing, type- whether dynamic or single plane balancing for components/ subassembly/ assembly shall be clearly indicated in data sheet/ approved drg.. Permissible vibration (velocity and displacement –peak to peak and noise level in dB(A) to be indicated in Data Sheet/Approved Drg.)

4.1.4 Radiography & magna-flux examination of materials & welds.(Components to be subjected to NDT with applicable, procedures and acceptance norms to be clearly indicated in Data sheet/ approved drg. If in a component only certain areas are to be subjected to NDT same shall be clearly brought out else it will be understood that the entire component is subject to NDT)

4.1.5 Ultrasonic test of castings & forgings.(Procedure and acceptance norms with areas subject to NDT to be clearly indicated in Quality Plan).

4.1.6 Performance test including determination of capacity, efficiency & characteristics etc.(Applicable standard, Acceptance norms, Procedure for test (if not covered in applicable standard),performance characteristics with applicable tolerances and drive to be used during shop test to be clearly indicated in Quality Plan). Performance data to be indicated in Approved Drg./ Data Sheet)

4.1.7 Functional checks and adjustments of controls & instrumentation. (Functional checks required to be clearly indicated with extent of check and applicable standard in approved check list / Quality plan. Class of instruments / tolerances and performance data to be incorporated in Approved Data Sheet / Drg.)

4.1.8 Checking of working clearances.(desired working clearances to be indicated in approved Drg.)

4.1.9 Examination after selective opening up after testing.(basis/ reasons for selective opening up, areas to be examined and parameters to be checked to be brought out in Quality Plan)

4.2 TESTS AT SITE

Tests to prove guaranteed performance of the air conditioning plant, shall also be carried out at site after proper installation. The site test shall include performance testing (as per FQP) of equipment for 72 continuous hours each in all three seasons i.e. Summer, Winter and Monsoon. Unless specified elsewhere. All instruments, tools etc. as may be required to carry out site tests shall be arranged by the tenderer.

5. PERFORMANCE GUARANTEE

5.1 Each equipment of air conditioning system shall be guaranteed for its rated capacity under the specified site conditions.

5.2 If the shop/site performance tests indicate failure of equipment to meet specified requirement, it would be tenderer's responsibility to carry out required alterations at no extra cost to purchaser. Tests shall be repeated after carrying out the modifications to demonstrate the performance.

5.3 The air conditioning plant before being taken over by purchaser shall be subjected to running test for a minimum period of one week during which all readings shall be recorded. Any deficiencies noted during this period, shall be rectified by the tenderer /at no extra cost to purchaser. These running tests shall be in addition to the seasonal performance test specified under clause 4.2. The inside design conditions shall be guaranteed throughout the year.

6. DRAWINGS/DOCUMENT/DATA REQUIRED AFTER AWARD OF CONTRACT

6.1 Final version of all drawings & data submitted with the along with technical schedules enclosed in Volume III.

6.2 Drawings including equipment layout, foundation & loading details etc. for civil works for the entire plant. These drawings must cover sufficient details so that design of civil works can be completed.

6.3 Inspection, operation & Maintenance Manuals.

6.4 Manuals for method of testing & calibration of all instruments.

6.5 Equipment description giving complete design calculations, basis of design, selection criteria etc.

6.6 Schematic piping diagrams.

6.7 Layout of piping.

6.8 Electrical drawings.

6.9 Test Certificates.

6.10 Final as built documentation i.e. final-version of all drawings, data & information as per the requirement specified elsewhere.

DESCRIPTION		DATA
1.	**GENERAL**	
1.1	Type of AC plant	: Chilled Water Type.
1.2	Plant configuration/capacity.	: Refer to Section-C of Specific Technical Requirements.
1.3	Location of AC plant rooms	: As per Tender drawings.
1.4	Type of lifting facility provided.	: Chain Pulley block with monorail (by BHEL)
1.5	Electrical work scope: -	
	i) MCC for AC plant	: By Others
	ii) Power cables / Control cables.	: By Others
	iii) Drives	: By Bidder.
	iv) Whether separate alarm/annunciation Panel/control panels required	: Yes (By bidder), Refer to Section-C of Specific Technical Requirements.
	v) Termination of cabling & earthling at Equipment end.	: By Bidder for bidder supplied equipment.
2.	**REFRIGERATION COMPRESSOR**	
2.1.	Type	: SCREW CHILLE
2.2.	Nos. (working + standby)	: Refer to Section-C of Specific Technical Requirements.
2.3.	Type of capacity control	: Automatic.
2.4.	Type of drive	: Direct driven.
2.5.	Restart after tripping	: Manual.
2.6.	Type of start	: As per manufacturing standard.
2.7.	Shaft Seal	: Mechanical shaft seal.
2.8.	Purge Recovery unit	: As per manufacturing standard.
2.9.	Type of lubrication	: As per manufacturing standard.
2.10.	Refrigerant used	: Environment friendly HCFC, (CFC is not acceptable)

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3. DESIGN REQUIREMENTS

3.1.	Minimum capacity at Design conditions	: Refer to Section-C of Specific Technical Requirements.
3.2.	Capacity control	: Microprocessor based Control Panel sheet metal panel, located on each Compressor/chiller unit including protection devices
3.3.	Vibration isolator	:Neoprene rubber pads/Equivalent approved to suit chiller package.
3.4.	Type of foundation	: Floating / As per manufacturing standard

4.0 CONDENSER

4.1	Type	: Horizontal shell & tube type water-cooled
4.2	Number required	: One no. for each machine.
4.3	Design requirements	
4.3.1	Fluid	: Refrigerant (Shell side) Water (tube side)
4.3.2	Cooling Water Quantity	: To suit requirement.
4.3.3	Capacity of condensers	: To match compressor & to provide at least 2°C sub cooling.
4.3.4	Cooling water inlet temp.	: Refer to Section-C of Specific Technical Requirements.
4.3.5	Leaving Water Differential.	: Refer to Section-C of Specific Technical Requirements.
4.3.6	Max. flow velocity through tubes.	: 2.5 m/sec.
4.3.7	Design fouling factor	: 0.0002 (MKS Unit)
4.3.8	Maximum pressure drop.	: 0.6 Kg/cm2 (g)
4.3.9	Tube wall Thickness	: Not less than 18 SWG
4.4	Materials of construction	
	i/ Shell	: M.S. Plate fusion welded.
	ii/ Tube	: Integrally bonded Seamless copper

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iii/ Head ends	: Cast Iron.
iv/ Tube sheet material	: Steel
v/ Baffle plate	: Steel.

4.5 Accessories required

i/ Purge & drain connections with valves.	: Yes
ii/ Relief valves	: Yes
iii/ Liquid line shut off valve.	: Yes
iv/ Isolating valves on water side.	: Yes
v/ Flow switch	: Yes (interlocked with control of individual refrigeration system)
vi/ Pressure/temperature gauges at inlet/outlet	: Yes
vii/ Descaling tee	: Yes
viii/Charging valve	: Yes
ix/ MS supporting frame work	: Yes
viii/Cooling thermostat	: Yes
ix/ MS supporting frame work.	: Yes

5.0 **CHILLER** (Applicable for chilled water type plant only.)

5.1	Type	: Horizontal shell & tube flooded type
5.2	Number required/standby	: One no. for each chiller package.

5.3 Design requirements

5.3.1	Fluid to be cooled	: Water
5.3.2	Water flow rate (Inside tube)	: To suit requirement.
5.3.3	Water inlet temperature	: 12 ^{o}C approx.
5.3.4	Water outlet temperature	: 7 ^{o}C approx.
5.3.5	Super heating of refrigerant material	: By at least 3 deg. C.
5.3.6	Insulation /thickness/finish	: As per the manufacture standard.
5.3.7	Design fouling factor	: 0.00010(MKS Unit)

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5.3.8	Maximum pressure drop.	: 0.6 Kg/cm2 (g)
5.3.9	Tube wall Thickness	: Not less than 22 SWG.

5.4 Materials of construction

i/	Shell	: M.S. Plate fusion welded.
ii/	Tube	: Integrally Seamless copper (internally Corrugated)
iii/	Head ends	: Cast Iron.
iv/	Tube sheet material	: Steel.
v/	Baffle plate	: Steel.

5.5 Accessories required

i/	Purge & drain	: Yes
ii/	Gate valves at water inlet/outlet.	: Yes
iii/	Flow switch	: Yes
iv/	Pressure/temperature gauges at inlet/outlet	: Yes
v/	Anti-freeze thermostat	: Yes
vi/	Thermostatic expansion valves	: Yes
vii/	Pilot solenoid valve	: Yes
viii/	Cooling thermostat	: Yes
ix/	MS supporting frame work.	: Yes

Note :-

The system shall also incorporate:

1) Auto operation of chilling plant for operation of the whole AC system.

2) A Central Control Panel with fault annunciators with provision for remote extension besides local control kiosks.

3) Water Chiller package shall be skid-mounted unit with microprocessor based control panel complete with all accessories and controls are assembled at manufacturing works on single unit.

4) Screw chiller shall be suitable for 415V $\pm$ 10 %/50 Hz $\pm$ 3%/3 phase operation with voltage & frequency variation as specified with built in starter etc.

5) Only supply feeders shall be provided for chillers.

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STANDARD TECHNICAL SPECIFICATION
FOR
AIR HANDLING UNITS

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1. GENERAL

1.1 This specification covers the design, manufacture, Construction features, installation, commissioning, inspection and performance testing at site of AHUs.

2. CODES AND STANDARDS

2.1 The design manufacture and performance of AHU shall comply with all currently applicable statutes, regulations and safety codes in the locality where the AHU is to be installed. The equipments shall also conform to the requirements of the latest editions of applicable Indian/British/US standards. Nothing in this spec. shall be construed to relieve vendor of this responsibility. In particular the equipment shall conform to the latest editions of the following standards:

2.1.1 IS-659 : Safety code for air conditioning

2.1.2 IS-660 : Safety code for mechanical refrigeration

2.1.3 ASHRAE: Method of testing forced circulation air-cooling and air heating coils. standard 33

2.1.4 ARI 41 : Standard for forced circulation air cooling and air heating coils.

2.1.5 ARI 430/435 : Air-cooling and air heating coils Central Station AHU / Application of Central Station AHU.

2.1.6 AMCA : 211 and 311

In case of any conflict in the standards and this specification the decision of PEM,BHEL shall be final and binding.

3. CONSTRUCTION FEATURES

3.1 The casing of AHU shall be made of insulated double wall construction of min. 24 gauge galvanized sheet steel - IS 277 Gr. 120 (parent sheet: D/DD-IS-513) ribbed and reinforced for structural strength and rigidity with 25 mm thick polyurethane insulation of minimum 40 kg/m^3 density in between. The external wall will be pre-plasticised over GI coating on the outside. Angle irons or channel sections made of 16 gauge galvanized sheet steel shall be used for reinforcing. The casing shall be of sectionalized construction with proper sealing at the joints to make them air tight. Fan section and panels with bearing support shall be reinforced with heavy gauge channels (min. 5 mm thick). Suitable number of forged hot dip galvanized (610 gm/sq.m) U brackets shall be provided for AHU suspended from ceiling/roof.

Necessary arrangement shall be provided on the casing for measuring temperature and pressure in cooling/heating coil. Class of instruments shall be min. 2.

3.2 Fan impeller shall be forwardly/backwardly inclined curved blade centrifugal type. Impeller shall be double width double inlet type. Fans shall be preferably low rpm (<=1500) to minimize vibration and noise. Noise shall be within 85 dB(A) at 1 metre distance from AHU casing. Max. Vibration level shall be acceptance and norms to be specified. Two to three wheels (impellers) shall be provided for each AHU. Impeller blades shall be fabricated from (min. 1.0 mm) galvanized/ epoxy powder coated sheet steel. Fan shall be of epoxy powder coated / galvanized sheet steel (min. 1.6

mm) scroll with die formed inlets for uniform air flow. Fan shafts shall be solid cold rolled carbon steel (EN8 normalised), ground and polished. Fan shaft bearings shall be of heavy duty type selected for average operating life of 100,00 hours. Bearings shall be self-aligning, permanently lubricated type. Make of Brgs(SKF/FAG/NORMA/TATA) to be specified. Bearing Housing shall be of casting of min. IS Gr. 210, split type and suitably supported. The V-belt drive with belt guard shall be provided. Motors shall have minimum 15% margin over maximum BHP in working range.

3.3 DX or chilled water cooling coils and steam/hot water coils shall be internally corrugated copper/ cupronickel tubes (as per manufacturer's standard) with smooth non corrugated external fins of aluminium (thickness 0.14 mm and grade 1100 as per spec) unless specified otherwise in specification. At least 5 fins /per cm. shall be provided. The chilled water/hot water coils shall have suitable (standardize class, size, threading) drain and vent connections.

3.4 The filters in the filter section shall be provided as detailed in data sheet A.

3.5 Humidifier shall be Pan type/as specified in the specification.

Pan type Humidifier consisting of SS304/316 tank, heater, geyserstat with piping connection to supply air duct shall be provided unless specified otherwise in data sheet A.

Heaters and branch line shall be of galvanized steel and nozzles shall be of brass (matl. grade) /SS 304.

3.6 Condenser water from coil or surplus water from spray humidifier shall be collected in 16 gauge SS-304 pan. Minimum 50mm dia GI pipe nipple shall be provided on each end for drain connection. The drains for these points shall be extended to the main drain in AHU room.Condensate drain pipe (GI) of required length with sealing loop shall be provided and insulated as specified in the specification for insulation. Minimum requirement For GI Pipes and fittings shall be ERW/Seamless of medium thickness as per IS-1239/3589 and Hot dip galvanized

3.7 Suitable number of Spring type vibration isolators shall be provided for fan and motor assembly. Neoprene rubber pads shall be provided below the AHU.

The AHU shall be provided with 18 G SS drain pan.

4. **TESTING AND INSPECTION AT MANUFACTURERS WORKS:**

List of TCs arranged as per Approved Quality Plan shall be furnished along with copy of TCs at the time of inspection.

4.1 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.

4.2 Galvanised sheets - Test certificate shall be furnished for visual check, coating thickness, adhesion test, sheet thickness, uniformity of coating. For pipes and fittings compliance report shall be furnished by Manufacturer for visual check, coating thickness, adhesion test, sheet thickness, uniformity of coating.

4.3 Shaft: Mechanical and chemical.

4.4 Motors (of approved make): Routine TC.

4.5 Workmanship and dimensional check as per manufacturing drg. and approved Drgs.

4.6 Balancing of impellers- Dynamic balancing certificates shall be furnished –grade 6.3 or better to ISO-1940. Balancing weights shall be positively locked to avoid loosening. Balancing weights and fasteners used shall be galvanized.

4.7 Performance test of one Centrifugal fan/per type/per size as per AMCA standard (for indigenous make).

4.8 Centrifugal fans for AHUs will be 100% run tested by main contractor of BHEL. One centrifugal fan/per type/per size will be run tested. Vibration shall be within good zone of VDI 2056 / ISO 10816-1(group- K) machines when measured on bearing housing and noise level <85 dbA at 1 metre distance. Max. Temp. on bearing housing- 40 degrees Centigrade + ambient.

4.9 Complete assembly of one AHU/per type/ per size (excluding cooling coil and filter) shall be witnessed.

4.10 Run test of one complete assembly/per type/per size (excluding cooling coil and filter). Vibration shall be within satisfactory zone of VDI 2056 / ISO 10816-1(group- K) machines when measured on bearing housing and noise level <85 dbA at 1 metre distance. Max. Temp. on bearing housing- 40 degrees Centigrade + ambient.

5. DRAWINGS/DOCUMENT/DATA REQUIRED AFTER AWARD OF CONTRACT

5.1 GA drawing of AHU & data- sheet to be submitted along with technical schedules enclosed in Volume III.

5.2 Drawing including equipment layout, foundation & loading details etc. for civil works. These drawings must cover sufficient details so that design of civil works can be completed.

5.3 Inspection, operation & Maintenance Manuals.

5.4 Equipment description giving complete design calculations, basis of design, selection criteria etc.

5.5 Test Certificates.

5.6 Final as built documentation i.e. final-version of all drawings, data & information as per the requirement specified elsewhere.

5.7 Performance Test Certificates.

DESCRIPTION		DATA
1.	Nos. required/working	: Refer to Section-C of Specific technical requirement.
2.	Location	: Refer to Section-C of Specific technical requirement.
3.	Service/type	: Air Conditioning /Double skin.
4.	Fan type	: Centrifugal (forward/backward curve Blade) limit load.
	a) Capacity	: To Suit as per calculation.
	b) Static pressure	: To suit but not less than 60 mm wc for AHU's Micro-V filters.
	c) Discharge direction	: To suit layout.
	d) Motor	: By Bidder,
	e) Local push button station (Start/Stop)	: By Others
	f) Motor location	: Inside AHU Casing.
	g) Drive	: Belt, pulley, belt guard.
5.	Face and Bypass Damper	: Required (Opposed blade type) DX AHU's having
6.	Cooling coil	
	a) Duty sensible heat	: To suit as per calculations
	b) Duty latent heat	: -do-
	c) Type of coil	: Chilled Water/DX/Hot Water.
	d) No. of rows	: To suit but not less than four (4)
	e) Material of tube /Thickness	: Seamless Copper to ASTME-75/Equivalent.
	f) Material of fins	: Aluminium to SAE-1100-/1145-0
	g) Number of fins	: Not greater than 5 per cm (13 per inch).
	h) Max. face velocity	: 2.5 m/sec.
	i) Air flow quantity	: To suit as per tender drawings/documents.
7.	3 - way motorised mixing valve with thermostat.	: Required with thermostat & actuator for chilled water system for each AHU.

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8.	Damper at discharge	: Manually operated at discharge of each AHU outlet.
	a) Material of construction	: Mild Steel, galvanised.
9.	Filters (Pre-filters)	
	a) Type & thickness	: Dry panel type/ 50 mm
	b) Filter area.	: To suit as per velocity requirements. "V" - Bank.
	c) Filter efficiency	: Average arrestance efficiency of 65-80 %
	d) Press drop (Clean)	: Not to exceed 2.5 mmwc when clean & 6.5 mmwc while dirty.
10.	Humidification section	: As per the System requirement.
	a) Type	: Pan type, unless otherwise specified.
	b) Operation	: Automatic with Humidification.
11.	Fresh air arrangement	: Required.
	a) Fresh air fan	: Tube axial flow fans with motor.
	b) Accessories	: i) Inlet cone with Bird screen. : ii) Dry panel pre-filters, : iii) High efficiency filters for control room areas. : iv) Volume Control Dampers, : v) Supports etc.
12.	Vibration isolator required.	: Yes
13.	Type of vibration isolator.	: Neoprene ribbed Rubber for AHU's.
14.	Any other requirement	: i) In addition to dry panel filters on AHU, High efficiency filters(average arrestance efficiency of 80-90 %) shall be provided in supply air duct side of AHU for all control room and allied areas. : ii) Bidder to also provide suitable electrical strip heaters for winter heating & monsoon reheating with Contactor box etc. Heaters to be interlocked with airstat.
15.	Instrument & controls	: Lot.(including Control box for strip heaters, pan humidifiers etc. in each AHU room.)
16.	Insulation of drain piping	: Lot.

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STANDARD TECHNICAL SPECIFICATION FOR COOLING TOWER

1. GENERAL

1.1 this standard specification covers the design, manufacture assembly, inspection & testing at manufacturer's works, suitable painting & packing, delivery, erection & commissioning at site of all materials and equipments for mechanical induced draught cooling tower complete with all accessories as specified hereinafter.

2. CODES & STANDARDS

2.1 the design, manufacture, inspection & testing and performance of the cooling tower as specified hereinafter shall comply with the requirements of all applicable latest Indian/British/American standards and codes of practice. the latest editions of the following standards & publications shall be followed in particular:

2.1.1 Cooling tower institute USA bulletin ATP-10S: Acceptance test procedure for industrial water-cooling tower.

2.1.2 PTC-23 ASME performance test code for Atmospheric water-cooling equipment.

2.1.3 In case of any conflict between the above codes & standards and-this specification, the later shall prevail.

3. DESIGN REQUIREMENTS

3.1 the cooling tower shall be designed for continuous operation to cool not less than design flow of water from specified inlet temperature to the outlet temperature at a design ambient wet bulb temperature as indicated under data sheet a.

3.2 all the components shall be capable of safe, proper and continuous operation at all cooling water flows upto & including those specified under data sheet a & shall be designed with regard to case of maintenance, repair, cleaning & inspection.

3.3 the cooling tower shall be of induced draught cross flow or counter flow type and with multiple cells (if specified in data sheet a.) the cooling tower shall be suitable for handling the fluid and also for achieving the specified parameter as per data sheet a. the cooling tower shall be designed such that the drift losses & evaporation losses are minimum.

4. CONSTRUCTIONAL FEATURES

4.1 CASING & LOUVERS

4.1.1 The cooling tower casing shall be made of FRP/as specified in data sheet A. The louvers shall be made of FRP/as specified. Louvers, if provided, shall be designed for air entry to the tower with low velocity for minimum pressure drop & less chance of recirculation of moist air. To eliminate splash out, louvers shall slope to shed water inwards. Air intake shall be all along the base circumference of the casing & hotdip galvanised expanded metal mesh shall be provided to protect the air intake.

4.2 FILL

4.2.1 Cooling tower fills shall be made of noncombustible PVC/as specified in data sheet A. The design & arrangement of the fills shall be so as to expose maximum air/water surface with minimum pressure drop.

4.3 Drift Eliminators

4.3.1 Multi-pass drift eliminators with minimum two pass zig-zag path shall be provided so to minimise the drift losses.

4.3.2 In case of FRP cooling tower the drift eliminators shall be of multi-blade rotary type.

4.4 Fans & Accessories

4.4.1 The fans shall be multiple blade, low speed, high efficiency axial flow type located above the top deck level of the cooling tower. Fan rotating assembly shall be statically & dynamically balanced. The fan blades shall be preferably adjustable in stand still condition for propeller action. The fan shall be either directly mounted on the shaft of a totally enclosed weather proof motor or shall be suitable for V-belt drive.

4.4.2 The rating of drive motor shall have at least 15% margin over maximum fan power consumption. The design & construction of the drive motor shall be in accordance with enclosed specification for LVAC motors.

4.5 Water basin

4.5.1 The material of construction of water basin shall be FRP or RCC as specified in data sheet A. The basin shall be provided as a part of cooling tower in case of FRP construction. The sump shall have sufficient storage capacity for safe operation of AC plant.

4.6 Hot water distribution system

4.6.1 Manually operated flow control valves shall be provided in hot water distribution piping such that each cooling tower can be isolated without affecting the operation of other cells.

4.6.2 The nozzles shall be spaced to give even distribution of water over entire space occupied by top row of fills. The nozzles shall be made of brass /SS 304/316/316L (brass shall be as per manufacturer's standard) unless specified in data sheet A:

4.6.3 In case of FRP tower water shall be distributed over the fill by means of a multiple area fail safe rotary sprinkler made of PVC pipes fitted on a aluminium alloy (as per manufacturers standard) rotary head and mounted on sealed ball bearings (make) .

4.7 Access

4.7.1 A stair case paddle ladder (as per manufacturer's standard) shall be provided external to the cooling tower at one end of each tower along with stairways hand rails etc give safe & convenient access to the top deck from ground level.

4.8 Painting

4.8.1 The cooling towers shall be painted with suitable anti-corrosive paint as per approval of purchaser. All galvanized external surfaces shall be painted to match colouring scheme. Before painting galvanized surfaces -etch primer to be applied.

5. SHOP INSPECTION & TESTING

5.1 Compliance certificates for nozzles (Or rotary sprinkler), piping, fill material, drift eliminator, louvers components etc.

5.2 Certificate of conformance for all other material components.

5.3 Balancing report for Static & dynamic balancing of fan assembly.

6. TESTS AT SITE

6.1 Hydrostatic testing of complete hot water distribution piping at site.

7. PERFORMANCE GUARANTEE

7.1 The cooling tower shall be guaranteed to meet the performance requirements as specified & when tested in accordance with ATP-105.

7.2 The vendor shall furnish performance curves for the cooling tower showing variations in performance from design duty point with change in approach to wet bulb temperature, cooling range, water loading of cooling tower.

8. DATA TO BE FURNISHED BY VENDOR AFTER THE AWARD OF CONTRACT

8.1 General arrangement drawing of complete cooling tower (showing plan, front elevation and side elevation) incorporating principal dimensions, limits of scope of supply of piping, limits of civil works included showing extent of platforms, walkways, handrails, access doors, staircase etc. and the limits of scope of supply of electrical works.

8.2 General arrangement and sectional assembly drawings pertaining to the following components of the cooling tower:

i) Tower fill with supporting arrangement.
ii) Drift eliminator installation and details.
iii) Complete hot water distribution system including flow regulating valves, distribution basin/pipes and nozzles etc.

8.3 Cooling tower performance curves showing WBT Vs cold-water temperature for design cooling range, 90% cooling range and 110% cooling range at 100%, 90%, and 110% design flow.

8.4 Performance curves of cooling tower fans.

8.5 Test procedure along with details of tests to be conducted for the offered cooling tower.

8.6 Quality Plan along with complete details of the testing and inspection requirements of mechanical and electrical items of the cooling tower in BHEL format.

8.7 Operation and maintenance instructions.

A. **GENERAL DATA**

1)	Service	: Cooling of condenser water of AC plant.
2)	Type	: Fibreglass reinforced plastic construction induced draught.
3)	Quantity	: Refer to Section-C of Specific Technical Requirements.
4)	Place of installation	: Refer to Section-C of Specific Technical Requirements.

B. **DESIGN DATA**

1)	Capacity at specified conditions.	: To suit the system requirement.
2)	Water flow rate	: To suit the system requirement.
3)	Design wet bulb temperature	: 25 Deg. C.
4)	Hot water inlet temperature	: To suit requirement.
5)	Cooled water temperature	: To suit requirement.
6)	Depth of sump Tank	: As per manufacturer's standard.

C. **MATERIAL**

1)	Sump tank & Casing	: FRP
2)	Louvers	: FRP/PVC/Aluminium.
3)	Type of fill	: Non-combustible PVC/Eq.
4)	Nozzles	: Brass with chrome plating/polypropylene.
5)	Ladder	: Hot dip galvanized steel ladder for each tower.
6)	Bird screen	: 25 mm square made of GI/SS wire mesh of 16 gauge.
7)	Fan impeller	: Cast Aluminium Alloy/FRP propeller type and multi-blade aerofoil construction with adjustable pitch..
8)	Supporting structure	: MS with spray galvanization of epoxy painting.
9)	Strainer	: Plant strainer made of GI/SS wire mesh of 16 gauge.

D. ACCESSORIES

1)	Make up connection	: Yes.

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2)	Quick fill connection	: Yes.
3)	Overflow & drain & blow down connection	: Yes.
4)	Access door in louvers/fan deck	: Yes (if applicable).
5)	Supports & supporting structure for mounting	: Yes.
6)	Level switch	: Yes.
7)	Rain protection for motor	: Yes (suitable Canopy by Bidder)
E.	ELECTRICAL DATA	
i)	Power supply	: 415 V± 10%/50 Hz ± 3%/3 phase.
ii)	Motor	: As per specification attached.
F.	INSPECTION & TESTING	: As per approved quality plan.

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STANDARD TECHNICAL SPECIFICATION
FOR
LOW PRESSURE AIR DISTRIBUTION SYSTEM

1. GENERAL

1.1 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 air conditioning system and ventilation system not involving localised exhaust.

2. CODES AND STANDARDS

2.1 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

2.2 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 Metal air ducts shall be either of galvanised steel sheets or aluminium sheets, as indicated in data sheet-A.

3.2 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 technical requirement refer to Section-C of Specific Technical Requirements.

3.3 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

4.1 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.

4.2 **RECTANGULAR DUCTS**

4.2.1

S.No.	Max Side	Sheet Thickness	Type of transverse	Bracings

		(mm) GI	(mm) Al	Joint connections	
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
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				

4.2.2 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.

4.2.3 The seams on duct cones shall be of Pittsburgh type. Longitudinal seams shall be smooth inside the ducts.

4.2.4 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

4.2.5 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.

4.2.6 MS angles used for bracings shall be tack welded to the ducts or rivetted at 125mm centres, as applicable.

4.3 **ROUND DUCTS**

4.3.1

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 (20G)	1.50	40x40x3mm girth MS angles at 2.0 meter centres
e)	1251 & above	1.25 (18G)	1.80	40x40x3mm girth MS angles at 1.2m centres

4.3.2 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.

4.3.3 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.

4.4 **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.

4.5 **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 9r (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.

4.6 **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.

4.7 **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.

4.8 **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.

4.9 **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.

4.10 **DAMPERS AND SPLITTERS**

4.10.1 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.

4.10.2 FIRE DAMPERS

Fire dampers 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.

4.10.3 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.

4.10.4 FLASHING

For the ducts penetrating roofs or outside walls, provision of flashing shall be made by the ducting vendor.

4.11 **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.

4.12 **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.

4.13 **ACCOUSTIC LINING**

The ducts shall be lined acoustically from inside as given in data- sheet A and/or section C of the specification.

4.14 **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.

4.15 **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**

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.

5.1.2 Galvanised sheets - Test certificate shall be furnished for visual check, coating thickness, adhesion test, sheet thickness, uniformity of coating.

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.

Description	Data
1. General (List of areas)	: As per Specification/Tender drawing.
2. GSS Duct Work	
a) Type	: GSS as per IS: 277 (Zinc coating as per Section-C of Specific Technical Requirements.)
b) Size	: As per Section-C of Specific Technical Requirements and bill of quantity.
3. Acoustic lining	: Up to 5m length from AHU Outlet.
4. Special painting	: Galvanised.
5. Thermal Insulation	: Required in supply air duct in AC entire length.
6. Diffusers (Circular/Square) 300 mm size 350 mm size 450 mm size 550 mm size 600 mm size Any other size	: Bidder to estimate as per drawings./specification. All grille frame and louvers shall be manufactured of at least 16 SWG Aluminium
7. SA grilles (for each size)	: To suit air flow as per System requirements / Tender Drawings.
8. RA grilles (for each size)	: -do-

NOTE:

1. Duct sheet thickness shall be as per IS-655
2. Opposed blade type volume control damper shall be provided at each supply air diffusers/grilles.
3. Bidder to provide suitable gasketing at each duct flange.
4. Fire damper shall be motor operated type, when otherwise specified under Section-C.
5. Access door in ducting system shall be provided as required.
6. MS Angle (painted) shall be used for duct supports etc.
7. Velocity thru duct shall normally not exceed 9.0 M/sec for Air conditioning system. Maximum velocity (outlet) for supply air diffuser shall not exceed 2.5 m/sec.

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8. All Grilles & diffusers shall be supported with frame. Frame etc. shall be supplied by bidder.

STANDARD TECHNICAL SPECIFICATION
FOR
CENTRIFUGAL PUMPS

1. GENERAL

1.1 This specification covers the design, material, constructional features, manufacture, assembly, inspection and testing at manufacturer's or his subcontractor's works, suitable painting requirements of centrifugal pumps and drives complete with all accessories as specified hereinafter.

2. 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):

2.1.1 IS-1520 : Horizontal centrifugal pumps for clear, cold and fresh water.

2.1.2 IS-5120 : Technical requirements - Rotodynamic special purpose pump.

2.1.3 IS-1710 : Vertical turbine pumps for clear, cold and fresh water.

2.1.4 BS - 599 : Method of testing Pumps.

2.1.5 PTC - '6' : Centrifugal Pumps Power test code

2.1.6 API - 610

2.1.7 Hydraulic Institute Standards of USA

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 engineering shall be final and binding.

3. 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. CONSTRUCTION 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 1.5 times 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 or plugged with threaded plugs as required.

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

4.2.1 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 checked for eccentricity and statically and dynamically balanced individually. The assembled rotor shall be dynamically balanced and checked for eccentricity. Supplier shall ensure during balancing that wall thickness of impeller vane, shroud etc is maintained above the minimum thickness requirement as per design.

4.3 WEARING RING

4.3.1 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**

4.4.1 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 **BEARING**

4.5.1 Bearings and hydraulic devices**,** of approved make, (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 BOX**

4.6.1 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. Tubings used for connections shall be flexible metallic type preferably SS-304/316. PVC/ rubber tubings are not acceptable.

4.7 **SHAFT COUPLING**

4.7.1 The pumps shall be directly coupled to their drives through heavy-duty flexible coupling. Suitable sturdy coupling guards of min. 1.5 mm MS sheet/ Aluminium sheet 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**

4.8.1 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. The external corners of the base plate shall be rounded to avoid sharp corners. Drilled holes shall have sufficient space around for proper seating of washer with nut. If required in the data specification sheet, steel sole plates shall be provided, below the base plate.

4.9 **PRIME MOVER**

4.9.1 The drive motor selected shall conform to the requirements of the enclosed motor specifications.

4.10 **LIFTING ARRANGEMENT**

4.10.1 Each pump and motor shall incorporate suitable lifting attachments e.g. lifting lugs or eye bolts etc., to facilitate erection and maintenance..

5. 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. 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. SCOPE OF INSPECTION AND TESTING

7.1 **CASTING**

7.1.1 The Witnessing pouring and thereafter physical testing of castings of 'Critical' nature such as casings, impellers, diffusers. Castings shall have 'as cast' heat numbers

unless they require overall machining. For partially machined components manufacturer shall ensure availability of as cast heat nos. on unmachined area.

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 Heat treatment charts (as applicable)

7.1.5 Castings may be required to meet NDT requirements such as Radiography, Magnetic Particle Testing or Dye-penetrant testing prior to Hydro-test as per requirements specified in Quality Plan.

7.1.6 Surface finish of Steel castings shall meet MSS SP-55.

7.2 **FORGING**

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 heat treatment charts (time temperature) (as applicable).

7.2.3 Forgings may be required to meet NDT requirements such as Radiography, Magnetic Particle Testing or Dye-penetrant testing prior to Hydro-test as per requirements specified in Quality Plan.

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 as per ASME Sec IX.

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 **Note:** For para 7.1.2, 7.2.1 and 7.3.1 above; in case correlating original test certificates are not available, material shall be identified by Main Vendor and test conducted at NABL approved Laboratory.

7.4 **IN PROCESS INSPECTION AND TESTING**

7.4.1 Identification 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. Permissible defects and acceptance norms need to be specified. 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. Probe shall be of min. 2 MHz frequency.

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.

a) Capacity V/s Head

b) Capacity V/s Power absorbed by pump

c) 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, noise level and temperature rise measurement. Noise level shall be within 85dB(A) at 1 metre distance. Vibration within satisfactory zone of VDI 2056 Group G machines. Temperature shall not exceed ambient + 40 deg. C.

7.5.4 Overall dimensions as per GA drawings. One pump/type/size assembly with job motor shall be mounted on base plate, provided the components are ordered on the same manufacturer.

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**

7.6.1 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**

7.7.1 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. CLEANING, PROTECTION , PAINTING & PACKING

8.1 Before shipment of the equipment to be supplied under this specification the necessary cleaning, flushing etc., as per manufacturers standard/ as specified for the contract in Data Sheet A/ elsewhere shall be done to remove all dirts, scales etc. Shop coats of rust inhibiting paints, lacquers etc., shall be applied to various parts as per manufacturers standard/ as specified for the contract in Data Sheet A/ elsewhere. Flanges, inlet and outlet pipe, etc shall be protected. Packing shall be done as per manufacturers standard/ as specified for the contract in Data Sheet A/ elsewhere.

9. 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:

a) Foundation base plate and sole plate details as applicable

b) Civil foundation and anchor bolts details and loading data

c) 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 and/ make 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. MANUFACTURERS NAME AND TAG. PLATES

10.1 Each pump shall have a permanently attached brass/ Stainless steel 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. DRAWINGS/DOCUMENT/DATA REQUIRED AFTER 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.

DESCRIPTION		DATA
1.	Designation	: Condenser water and Chilled Water pumps for AC plant.
2.	Type	: Horizontal, Centrifugal pump or vertical split type casing pump .
3.	Quantity	: Refer to section-C of Specific Technical Requirements
4.	Installation	: On floating type foundation.
5.	Fluid to be handled	: Water
6.	Temperature of fluid	: To suit.
7.	Capacity M3/hr and TDH at rated	: To suit system requirements but head shall not be less than 25 MWC.
8.	Duty	: Continuous (24 hours / day)
9.	Suction condition	: Flooded
10.	Type of drive	: Direct
11.	Prime Mover	: LV AC motor
12.	Maximum speed	: 1500 RPM
13.	Type of lubrication	: Grease Lubrication
14.	Material	
	a) Impeller	: Bronze to Grade IS: 318 Grade 2
	b) Pump shaft	: EN - 8 / Equivalent (Approved).
	c) Casing	: CAST IRON TO IS: 210 Grade - 260.
	d) Wearing ring	: Bronze to Grade IS:318 GR-2, Renewable type.
	e) Shaft Sleeve	: -do-
	f) Base plate	: Cast Iron to Grade FG-200 IS-210/M.S. fabricated.
	g) Bolt and nuts.	: MS
	h) Stuffing Box gland/bush case.	: Deep Bronze packing to be renewable with

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i) Stuffing box Packing. : Flexible Graphite or PTFE (Asbestos shall not be used)

j) Pump motor coupling. : Flexible.

15. **ACCESSORIES REQUIRED:-**

The following accessories shall be provided by the bidder for each pump:

a) Suction & Discharge pressure gauges. : Yes.

b) Vent connection : Yes.

c) Drain piping up to common drain point in plant room. : Yes

d) Companion flanges. : Yes

e) Common base plate. : Yes.

f) Suction strainer. : Yes

g) Isolating valve : Yes

h) NRV at pump outlet at inlet/outlet : Yes

i) Any special requirements : The Chilled Water pumps shall be suitably insulated as per spec.

j) Inspection & Testing : As per specification enclosed elsewhere.

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STANDARD TECHNICAL SPECIFICATION FOR PACKAGE CONDITIONING UNIT

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1 GENERAL

1.1 This specification covers the design, manufacture, inspection and testing at the manufacturer's works and suitable packing delivery and testing of the packaged air conditioning unit.

2 CODES AND STANDARDS

2.1 The design, manufacture, inspection, testing and performance of the packaged type air conditioning unit shall comply with all statutes, regulations and safety codes currently applicable in the locality where the equipment will be installed. The equipment shall also conform to the latest editions of the codes and standards specified herein under. Nothing in this specification shall be construed to relieve the vendor of this responsibility.

In particular, the packaged air conditioning Unit (max 7.5 TR capacity, ductable or non ductable type) or cassette type (up to 5 TR) shall conform to the latest editions of the following standards:

2.1.1 I.S.660 : Safety code for Mechanical Refrigeration.

2.1.2 I.S.5111 : Code of practice for measurement, and testing of refrigerant compressor.

2.1.3 I.S.659 : Safety code for air conditioning.

2.1.4 I.S.2494 : V Belt for industrial purpose.

2.1.5 I.S.3142 : V grooved pullies for V Belts.

2.1.6 I.S.4503 : Shell and tube type heat exchanger.

2.1.7 ARI 210 : Standard for/unitary air conditioning equipment

2.1.8 ARI 270 : Standard for application installation and servicing of unitary equipment.

2.1.9 ASHRAE-37 : Standard methods of testing for rating unitary air conditioning and heat pump / equipment.

2.1.10 ANSI-B9-1 : Safety code for mechanical refrigeration.

3 DESIGN AND CONSTRUCTIONAL REQUIREMENTS

3.1 Compressor

The compressor shall be hermatic or semi-hermatic or screw rotary type or scroll type. The same shall be suitable for R410A/R407C/R134A refrigerant. The compressor shall be mounted on anti-vibration spring/rubber pads and shall be positioned in such a way that it is freely accessable with sufficient space all around for easy maintenance. Safety controls like High and Low pressure cut-out overload and single phasing protection for the motors shall be provided. A crankcase heater shall also be provided, if considered necessary by the vendor.

3.2 **CONDENSING UNIT**

Shell and tube type water cooled condenser or air cooled condenser with adequate area shall be provided as specified in Data Sheet-A. The condensing unit shall be complete with

multipass heads and shall be fitted with the following:

3.2.1 Hot gas inlet and liquid outlet connection with shut off valve for liquid.

3.2.2 Drain plug, air vent and test valve.

3.2.3 Water inlet and outlet connection with thermowell and suitable cocks respectively.

3.2.4 Relief valve and air purge valve (Fusible plug in place of relief valve not acceptable)

3.2.5 Any other accessory as recommended by the manufacturer for proper functioning of the equipment.

3.3 AIR HANDLING FAN

The air handling fan shall be of the centrifugal type and with forward curved blades. This shall be driven by means of a three phase induction motor through V belt drive. The fan static pressure shall be selected for passing air through high efficiency absolute filters, if specified in Data Sheet-A.

3.4 FILTERS

Filters shall be of dry panel type and shall be cleanable. The velocity of air across the filters shall not exceed 1.75m/sec (350FPM).

3.5 COOLING COIL

The cooling coil shall be of direct expansion type and shall be made of heavy gauge copper with aluminium fins. The fins shall be bonded to the copper tubes under hydraulic pressure. A distributor shall be provided for feeding the refrigerant to different sections of the coil. Rows shall be staggered in the directions of airflow. The velocity of air across coil shall not exceed 2.5M/Sec. (500 FPM).

3.6 CONTROLS

All necessary controls and accessories like thermostatic expansion valve, refrigerant solenoid valve, distributor, filter drier in the liquid lines, shut off valves, HP/LP cut out for compressor, thermostat with adjustable settings, overload and single phasing preventer for motor etc. are to be provided. The microprocessor based control panel shall be provided outside the packaged unit on one side. The control panel shall generally be in line with the specification for control panels given elsewhere.

The control shall be so interlocked that the fan shall be started independently first, and then only the compressor. Tripping of the compressor by the thermostat or compressor cut outs shall not trip the fan. The thermostat setting shall be adjustable

3.7 REFRIGERANT PIPING

The refrigerant piping shall be either heavy gauge copper as furnished in Data Sheet-A. The piping shall be completely factory assembled, pressure tested, dehydrated and initially charged with FREON gas and compressor oil. The line accessories shall include liquid line shutoff valve dehydrator, strainer, flow indicator and distributor etc.

3.8 CABINET

All the equipments, except control panel, mentioned above shall be provided within a heavy gauge sheet metal cabinet, of floor/ wall mounted type. This shall be given two coats of anti-corrosive and rust proof paint, finished with two coats of final paint . Painting shall be as per manufacturers std unless specified otherwise in data sheet 'A'. The interior of the cabinet shall be provided with thermal and acoustic insulation of minimum 25mm thick. The insulating material shall be fire proof.

The front and back side of the cabinets shall be easily removable providing maintenance to all the interior parts.

All the electric wires within the cabinet shall run in flexible conduits and carry identification tags. The bottom side of the panel shall be specially ribbed to take care of the transportation.

3.9 **OTHER ACCESSORIES**

Each packaged air conditioner shall be provided with required number of neoprene rubber isolating pads.

4 CONTROL AND INTERLOCK REQUIREMENTS

The compressor shall have all protective devices like HP/LP cutouts, overload protection for the motor, single phasing preventor for motor etc.

The interlocking requirement shall be as indicated below:

4.1 The compressor shall not start, unless condenser water flow is achieved for water cooled condenser. The condenser flow shall be sensed by means of a flow switch.

4.2 The compressor shall not start unless the evaporator fan is started.

4.3 The tripping of compressor on HP/LP, overload or on thermostat shall not trip the fan.

4.4 Strip heater (if provided in the ducting system) shall not be switched on, unless the evaporator fan is started and airflow is established. For this purpose, an air stat on flow switch shall be used. The heater shall be separately controlled by humidistat/thermostat

4.5 A humidifying package, if specified in data sheet A, shall be controlled by humidistat.

5 TEST AND INPSECTION

5.1 Inspection and Testing at Manufacturer's Works

5.1.1 static and dynamic test for fans

5.1.2 Hydrostatic static test on condenser and cooling coil.

5.1.3 vacuum/pressure test for the complete refrigeration circuit.

5.1.4 Visual and Free running test of the packaged unit on test bed.

5.1.5 Free running test on compressor.

5.1.6 AIR CAPACITY WITH ANEMOMETER.

5.1.7 NOISE LEVEL- <=85 dB(A).

5.1.8 Other tests as per approved qualities plan/scope of inspection.

5.2 Inspection and Testing at Site

5.2.1 Performance testing of the packaged unit for 72 hours in summer / monsoon & 24-hours in winter. Up-to 3 TR (individual M/c capacity) inside room temperature (Dry & wet bulb) will be checked with all machines in the room operating.

The actual days of testing shall be mutually agreed. During the above testing, the following readings shall be taken to compare the same with guaranteed performance data.

5.2.1.1 Condenser inlet and outlet pressure and temperature

5.2.1.2 Entering and leaving air temperature of the cooling coil air filters.

5.2.1.3 Motor current for the compressor and blower.

5.2.1.4 Air quantity delivered by the fan. This shall be computed by adding air quantity leaving all the grilles entering the air filters.

Room temperature (Dry & wet bulb)

5.2.1.5 Test to ensure all controls and safety instruments are working properly.

During the above testing, noise level also will be checked to ensure that the same are within acceptable limits. Any undue vibration detected physically will be corrected.

All tools and instruments required for the above testing will be provided by the vendor.

6 PAINTING:

The packaged unit shall be given two coats of primer paint finished with two coats of finish paint as per Manufacturers std. unless specified otherwise elsewhere/ Data sheet 'A'. The colour of finish paint will be as specified in Data Sheet-A.

7 GUARANTEES

The package unit shall be guaranteed for performance measured in terms of the inside temperature maintained.

The packaged unit shall also be free from any manufacturing defects and shall be guaranteed as per contract after the first test as per 5.0 is successfully carried out, and the plant taken over by the purchaser.

8 NAME PLATES

Suitable Name plate as per Data Sheet 'A', depicting the equipment number as designated in Data Sheet A shall be provided for each packaged unit and screwed to a prominent position on the packaged unit.

9. DATA TO BE FURNISHED AFTER AWARD OF CONTRACT

9.1 Final technical data as per Data Sheet-B

9.2 G.A. and interior view of packaged unit

9.3 Electrical wiring diagram

9.4 Catalogues for all controls

9.5 O & M Manual

9.6 Erection Manual

DESCRIPTION		DATA
1)	Capacity of the unit at operating conditions.	: As specified
2)	Numbers required	: Refer to Section-C of Specific Technical Requirements
3)	Designation of the unit	: Package AC Unit
4)	Whether air cooled/water cooled	: Refer to Section-C of Specific Technical Requirements
5)	The plant shall be suitable for maximum- - ambient temp.	: Refer outdoor design condition as specified.
6)	Whether a plenum Chamber required	: Units shall be connected to fresh air ducts.
	OR	
	Whether to be connected duct system.	: Yes.
7)	Whether Humidifier required for humidity- -control.	: Refer to Section-C of Specific Technical Requirements
8)	Whether strip heaters required for winter heating.	: Refer to Section-C of Specific Technical Requirements
9)	Whether strip heater required for Humidity control.	: Refer to Section-C of Specific Technical Requirements
10)	Final painting colour shade stage.	: Subject to approval / during detail engineering
11)	Whether fan static pressure is to be designed for filters arrangement shown.	: Yes.
12)	Installation supporting structure/ drain piping, insulation.	: Required. Drain piping with insulation up to the nearest drain point.
13)	Controls & Instruments	: Yes (Lot)
14)	Isolation Switch	: Yes

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STANDARD TECHNICAL SPECIFICATION FOR 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 AUTOMATIC CLEANING FILTERS

This shall consist of a filter mat and drop eliminator, driven by a suitably rated geared motor unit being supported on a steel framework. The filter mat shall consist of an endless steel wire mat insets of steel mesh held between an upper & a lower shall drop eliminator shall consist of an endles steel wire without insets of steel mesh. The unit shall include a suitable oil pump, gladge raking mechanism and sludge container and tensioning device. Pressure drop shall be limited to 0.5 / mm WG when clean & 10 mm when dirty. Air velocity across filter shall not exceed 3 M/sec.

3.5 ABSOLUTE FILTERS

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.

3.6 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:

4.1 Dimensional inspection of frame & filter media.

4.2 Witnessing 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.

4.3 Verification of type test certificates for similar type & size of filters for sodium flame test as per BS-3928 (if applicable- refer data sheet).

5. DATA TO BE FURNISHED BY VENDOR AFTER AWARD OF CONTRACT

5.1 GA Drawing.

5.2 Drawing showing material/construction detail

5.3 Installation and\service manual

5.4 Rating curves/charts

5.5 Test certificates

5.6 Elect. diagrams (when automatic cleaning type)

DESCRIPTION		DATA
1)	**General**	
1.1	Service	: Air Conditioning.
1.2	Location	: Central Air conditioning plant, & package AC plant, fresh air fan system. Also for split AC.
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 pressue drop	: 2.5 mm & 6.5 mm in clean and dirty condition respectively for dry panel filters(prefilters). 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.

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STANDARD TECHNICAL SPECIFICATION
FOR
THERMAL INSULATION FOR COLD SURFACES

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 :-

IS:3069: GLOSSARY OF TERMS & SYMBOLS & UNITS RELATING TO THERMAL INSULATION

materials.

2.1 IS:4671 : Expanded polystyrene for thermal insulation purposes.

2.2 IS:3677 : Mineral wool for thermal insulation.

2.3 IS:8183 : Resin bonded mineral wool.

3. DESIGN REQUIREMENTS

3.1 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.

3.2 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.

3.3 The insulation material, density and thickness etc. Shall be as specified in DATA SHEET A.

4. APPLICATION DETAILS

4.1 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.

4.2 A layer of solvent free, anticorrosive paint shall be applied & allowed to dry.

4.3 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.

4.4 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.

4.5 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 3 mm (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

6.1 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.

6.2 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)

7.1 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 Pipe work having insulation & cladding shall be provided with color identification for the fluids handled and for indicating direction of flow.

8.2 Equipment surfaces having insulation and cladding shall also have identification numbers and any other relevant data provided on the insulated surface.

8.3 All painting for insulated surfaces shall conform to the requirement specified elsewhere.

9. DATA TO BE FURNISHED AFTER AWARD OF CONTRACT

9.1 Final version of data sheet 'B' incorporating changes if any along with design data.

9.2 Test certificates/reports giving result of insulation to ensure conformance to applicable codes & standards & in particular the following:-

a) Thermal conductivity test.

b) Sound absorption coefficient test.

c) Corrosion test.

d) Sulphur content, moisture content, shot content, moisture absorption etc.

e) Compressive strength & cross breaking strength test.

9.3 Sketches/technical literature/sectional drgs. indicating insulation materials finish and method of application etc.

9.4 Manual dealing with safety aspects & instructions for combating fire arising out of insulation work.

9.5 Instructions on maintenance of insulation work.

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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 duct insulation and 48 for acoustic lining.
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 10 ^{0}C	At least 15

Type of Insulation

S.No.	Surface	Insulation Material	Insulation Form	Thickness (mm)
i)	Supply & Return air duct for air-conditioning system	Resin bonded roll Mineral Wool (IS:8183)		25
ii)	Refrigerant Piping	a) Expanded Polystyrene	Pipe Section	75
		or		
		b) Mineral Wool	Pipe Section	75
iii)	AHU drain pipe	a) Expanded Polystyrene	Pipe Section	25
		or		
		b) Mineral Wool	Pipe Section	25
iv)	AHU drain pan coil section and fan section	a) Expanded Polystyrene	Slabs	25
		or		
		b) Mineral Wool	Slabs	25
v)	Chilled water piping, valves & specialties	a) Expanded Polystyrene	Pipe Section	75
		or		
		b) Mineral Wool	Pipe Section	75
vi)	Chiller	a) Expanded Polystyrene	Slabs	100
		or		
		b) Mineral Wool	Slabs	100
vii)	Chilled Water Pumps	a) Expanded Polystyrene	Slabs	50
		or		
		b) Mineral Wool	Slabs	50
viii)	Expansion tank with pipe	a) Expanded Polystyrene	Slabs/Pipe Section	50
		or		
		b) Mineral Wool	Slabs/Pipe Section	50

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ANNEXURE

ANNEXURE-I

LIST OF MAKES OF SUB-VENDOR ITEMS

SI. NO.	ITEM / EQUIPMENT	SUB SUPPLIER
1	SCREW CHILLER	YORK / TRANE / CARRIER / KIRLOSKAR / DUNHAM BUSH / MCQUAY (DAIKIN) / BLUE STAR / VOLTAS
2	VAPOUR ABSORBTION MACHINE	VOLTAS / THERMAX
3	PRECISION PACKAGE UNITS	STULZ / UNIFLAIR / EMERSON / BLUEBOX / CLIMADENTA
4	PACKAGE UNIT	VOLTAS / BLUE STAR / CARRIER
5	SPLIT AIR CONDITIONER	VOLTAS / BLUE STAR / CARRIER / HITACHI / LG
6	AIR HANDLING UNITS	VOLTAS / BLUE STAR / ZECO / CARRYAIRE(FLAKT) / EDGETECH / ETHOS / SYSTEM AIR / WAVES AIRCON
7	AHU FAN (CENTRIFUGAL FAN)	CB.DOCTOR / FLAKT / KRUGER / NICOTRA / COMEFRI / MARATHON / PATEL AIR
8	CHILLED & CONDENSER WATER PUMP	BEST & CROMPTON / JYOTI / SAM TURBO / KBL / KSB / M&P / VOLTAS / BEACON-WEIR / WORTHINGTON / FLOWMORE / SULZER / BHARAT PUMPS & COMPRESSORS LTD / FLOWSERVE INDIA CONTROL PVT LTD / V-FLOW PUMPS & SYSTEMS CO
9	COOLING TOWER	PAHARPUR / MIHIR / PCT / FLOWTECH / BELL
10	INDUCTION MOTORS (LT)	SIEMENS / ABB / CGL / MARATHON / KEC / BHARAT BIJLEE / NGEF /JYOTI / LHP
11	AIR FILTER	PUROLATOR / FMI / ANFILCO / TENACITY / JOHN FOWLER / SPECTRUM / AIR TECH / PUROMATIC
12	AXIAL FANS / F.A. FANS	FLAKT / KHAITAN / PATEL / NICOTRA / SARLA / KRUGER / MARATHON / C DOCTOR
13	INSULTATION MATERIAL	BEARDSHELL / K-FLEX / PARAMONT/ ARMAFLEX / SUPREME / LLOYDS / UP TWIGA
14	BALANCING VALVE	ADVANCE
15	BUTTERFLY VALVE	AUDCO / FOURESS / INTER VALVE / BDK / WEIR BDK / TYCO / CRANE PROCESS / KEYSTONE
16	NON RETURN VALVE	LEADER / H.SARKAR / FLUID LINE / HI -TECH / CRESENT / A V VALVES / BANKIM & COMPANY / SHIVADURGA
17	GATE/GLOBE VALVES	CRESENT / BDK / AUDCO / FOURESS / KIRLOSKAR / SANT / BOMBAY METAL & ALLOYS / BANKIM / LEADER / H SARKAR / AV VALVES / VENUS PUMPS AND ENGG
18	3 WAY MIXING VALVE WITH ACTUATING MOTOR	SIEMENS BUILDING TECHNOLOGY /JOHNSON / BELIMO / HONEYWELL / RAPID CONTROL / ALC
19	MOTORIZED BUTTERFLY VALVE	ANERGY / ADVANCE / BELIMO / JOHNSON / HONEYWELL / SIEMENS

20	Y / POT STRAINER	MULTITEX / GREAVES COTTON / JAYPEE / SANT / OTOKLIN / GRAND PRIX / GUJARAT OTOLIFT / DS ENGG / SAROJINI ENTERPRISE / BHATIA ENGINEERING / FILTERATION ENGINEERS INDIA PVT LTD / SUNGOV ENGINEERING
21	PIPING - ERW	SURYA ROSHNI / TISCO / DADU PIPES / INDUS TUBE / WELSPUN / TATA / BST / JINDAL / SAIL
22	PIPING - CS SEAMLESS (ASTM A 106)	ISMT / MAHARASHTRA SEAMLESS
23	GI SHEETS FOR DUCTING	TISCO / INDIAN IRON & STEEL CO LTD. / RASHITRYA ISPAT NIGAM LTD. / ESSAR/ ISPAT INDUSTRIES / JSW STEEL / LLOYDS STEEL / BHUSHAN / TATA / SAIL / JINDAL
24	FIRE DAMPER	TSC / CARRYAIRE / RAVISTAR (SYSTEM AIR)
25	GRILL/DIFFUSER/VOLUME CONTROL DAMPER	AIR FLOW/ TSC /AIR MASTER/ CARYAIRE/RAVI STAR (SYSTEM AIR)
26	STRIP HEATER	ESCORTS / RACOLD / DASPASS/ ALCO/ HEATCO / HOTSET
27	PAN HUMIDIFIER	RAPID COOL/ HOTSET /ALCO
28	RELIEF / PURGE VALVE	BRASSOMATIC
29	THERMOSTATS	HONEYWELL / RANCO / PENN / DANFOSS / INDFOSS / JHONSON CONTROL /RANUTROL
30	HUMID STAT	JHONSON CONTROL / HONEYWELL / PENN
31	ANTI FREEZE THERMOSTAT	RANCO / HONEYWELL / PENN / DANFOSS / INDFOSS
32	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
33	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)
34	LEVEL GAUGE	GENERAL INSTRUMENTS / CHEMTROLS / SBEM, PUNE/ AUTOMAT MUMBAI /SIGMA / TOSHNIWAL / TECHNOMATIC / TELACO /LEVCON / D K INSTRUMENTS / PUNE TECHTROL / FLOW STAR
35	PRESSURE SWITCH / DP SWITCHES	BELLS / DANFOSS / DK INSTRUMENTS/ DRESSER / SOR INC / VASU / SWITZER / INDFOSS / TRAFAG / GIC / ASHCROFT
36	TEMPERATURE SWITCH	INDFOSS/ SEIMENS / DANFOSS/ DK INSTRUMENTS/ SOR INC / VASU / DRESSER / TOSHNIWAL / SWITZER
37	FLOW SWITCH	SWITZER / LEVCON / DK INSTRUMENT / SBEM / V. AUTOMATE/ SIEMENS
38	LEVEL SWITCH	SBEM / BLISS ANAND / HI TECH / RAMAN INST / SIGMA / SOR INC / WAREE INST / LEVCON / DK INSTURMENT / V ATUOMATE /CHEMTROLS / SIMENS / FLOW STAR / TRAC

39	TRANSMITTERS	TAYLOR / ABB/BRISTOL BABCOCK / BIRLA KENT TAYLOR / BLISS ANAND /SBEM/ SMART INST / V AUTOMATION & INST / FISHER-ROSEMOUNT/ SIEMENS/ TATA HONEYWELL
40	SIGHT FLOW INDICATORS	SIGMA / LEVCON /V AUTOMAT / TELLACE /EUREKA / TATA HONEYWELL/BLISS
41	FLOW ELEMENT	BRISTOL BABCOCK / BALIGA /LIGHTING EQUIP /ENGINEERING SPECIALITIES /IL / MINCO/ MICRO PRECISION / STAR MECH
42	TEMPERATURE ELEMENT	GENERAL INST CONSORTIUM/ PYRO ELECTRIC /WAAREE INSTRUMENTS/ DETRIVE INST & ELECTRONICS / TOSHNIWAL
43	FLOW METER	EUREKA / INSTRUMENTATION ENGINEERS PVT LTD / PLACKA /TRAC / FLOW STAR/ SCIENTIFIC DEVICE
44	RH SENSOR/TEMP SENSOR	HONEY WELL /JOHNSON /SIEMENS / GENERAL INSTRUMENTS
45	PLC BASED PANEL	SIEMENS / SCHENIEDER / ROCKWELL / GE INTELLIGENT / HONEYWELL AUTOMATION / ABB
46	OWS / PC	HP / COMPAQ / DELL / HCL / IBM / LENOVO
47	PRINTER	HP / CANON / EPSON / XEROX / IBM / LEXMARK
48	UPS	HITACHI-HIREL / APC / DELTA / EMERSON / DB POWER / APLAB
49	FIBRE OPTIC CABLE	BIRLA ERICSON / FINOLEX / AKSH FIBRE
50	ANNUNCIATOR FOR PANEL	ICC / PECON/ PROCON
51	LT ADAPTER BOX FOR AL TO CU CABLE CONVERTOR	CONTROL DEVICE / SYSTEM POWER CONTROL / JACKSON / UNILEC / ELECTRIC ALLIED PRODUCT
52	METERING PUMP	SHAPO TOOLS / VK PUMPS
53	WATER SOFTENING PLANT	THERMAX / ION EXCHANGE / DOSI ION
54	PRESSURE TRANSMITTER	ABB / ENDRESS + HAUSER (INDIA) / MOORE / SIEMENS / SMART INSTRUMENT BRAZIL / SBEM / TOSHNIWAL / V. AUTOMAT / EMERSON / YOKOGAWA / HONEYWELL / FUJI
55	TEMPERATURE TRANSMITTER	ABB / ENDRESS + HAUSER (INDIA) / MOORE / SIEMENS / SMART INSTRUMENT BRAZIL / SBEM / TOSHNIWAL / V. AUTOMAT / EMERSON / YOKOGAWA / HONEYWELL
56	ROTAMETER	CHEMTROLS SAMIL / EUREKA IND / IL / TRANSDUCERS AND CONTROL
57	BATTERY CHARGER	AMARARAJA/ CHHABI ELECTRICAL / DUBAS ENGG. / HBL POWER SYSTEM / STATCON / CALDYNE
58	BATTERY (NI -Cd)	HBL POWER / AMCO SAFT / SAFT
NOTE		
	Above sub-vendor are also subjected to Customer approval during detailed engineering.	

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ANNEXURE-II

MANDATORY SPARE LIST

A. MECHANICAL

S.No.	Equipment / Package name	Qty. for TWO units
	AIR CONDITIONING SYSTEM	
1.	**Vapour Compression chiller**	
1.1	Oil filter "O" ring	1 set
1.2	Refrigerant filter	1 set
1.3	Master solenoid valve	1 No
1.4	Master solenoid valve coil	1 set
2.	**Screw compressors**	
2.1	Valve Head assembly	25 % of each type and rating
2.2	Bearings	25 % of each type and rating
2.3	Seal gasket and other wear out parts in sets	25 % of each type and rating
2.4	O' rings & oil seals	2 set of each rating of compressor
2.5	Crank case heater	1 no of each rating of compressor
2.6	Suction filter elements	4 set of each rating of compressor
2.7	Compressor shaft seal assembly	2 set of each rating of compressor
2.8	Oil pressure failure safety switch	1 set of each rating of compressor
3.	**Reciprocation compressor**	
3.1	Piston ring in sets	25% of each type and rating
3.2	Piston in sets	30% of each type and rating
3.3	Bearing in sets	25% of each type and rating
3.4	Seal gasket and other wear out parts in sets	25% of each type and rating
3.5	Valve Head assembly	25% of each type and rating
3.6	Crank shaft in sets	10% of each type and rating
3.7	Connecting rod in sets	10% of each type and rating
4.	**Pumps (condenser & chilling water pumps)**	
4.1	Pump Impeller	1 no of each type
4.2	Pump Bearing	1 set
4.3	Pump Motor Bearing	1 set
4.4	Shaft Sleeve	1 set
5.	**Cooling Towers**	
5.1	Nozzles for cooling towers	2 set
5.2	Float valve assembly	1 No
5.3	Fan Bearing	1 set

S.No.	Equipment / Package name	Qty. for TWO units
5.4	Motor Bearing	1 set
6.	**Packaged Air - conditioners**	
6.1	Filters	1 set
6.2	Expansion valve	1 set
6.3	Motor for compressor	1 set
7.	**Air Handling Unit**	
7.1	V-Belt for AHU blower	2 sets of each type
7.2	AHU blower bearing	1 sets of each type
7.3	Filters	2 sets of each type
7.4	Blower motor bearing	1 set
8.	**Tube axial fan**	
8.1	Bearing	1 set
8.2	Filter	1 set
8.3	Motor Bearing	1 set

B. ELECTRICAL

415 V Motors (Mandatory Spares)		
Sl no	**Name of spares**	**Quantity**
1.	Terminal plates	10 Nos. each for small motors upto 30 kW & 4 Nos. each for more than 30 kW
2.	Heaters	2 sets
3.	Greasing arrangements	4 sets 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. C&I

Sl no	Name of spares	Unit	Qty
(I)	Each type of lamps, PBs, ILPBs, fuse, MCB, MCCB used in the equipment/system.	Nos.	20 % of Installed of each type.
A	**Measuring Instruments**		
1	**Indicators, Recorders, Electrical Metering and Skid Mounted Instruments**		
a.	Indicators, recorders and meters offered from each model for the project. These instruments shall be supplied with three sets of blank scales.	Nos.	10 % of Installed of each type/Model or a minimum of one number for each model and type, whichever is more
b.	For skid mounted instruments	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
2	**Temperature Elements and Thermowells**		
a.	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.
b.	Thermowells	Nos.	10% for each type of temperature sensors or a minimum of one for each 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.**	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.
B	**DDCMIS/PLC system, Master slave clock system, Hart Management System, Vibration Monitoring system, CAAQMS, ERP/MIS/LAN/Simulator/ WAN, CCTV, Microprocessor based control system, and other Control System/Sub-systems/electronic system listed in NIT.**		
1	I/O cards		

Sl no	Name of spares	Unit	Qty
a.	Analog Input module	Nos.	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)
b.	Analog output module	Nos.	10% of qty Installed of each category/ model or at least 2 No. of each type/model (Whichever is more)
c.	RTD/TC cards/modules	Nos.	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)
d.	Digital input module	Nos.	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)
e.	Digital output module	Nos.	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)
2	All types of electronic modules, controllers, function modules, cards, terminal boards, relay boards, power supply cards etc for above mentioned system and other Control System/Sub- systems and any other type of PCB not covered above	Nos.	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)
3	Electronic Cards/modules	Nos.	10% of number for each type or minimum of 2 number for each type whichever is high.
4	Auto/Manual stations, set-point/bias stations etc	Nos.	10% of the number of stations offered for the project from each type or a minimum of 2 number from each model, whichever is more.
5	Control logic power supply fuses, MCB, MCCB, at each current rating required for the project.	Nos.	20% spare for each type/Model
6	Electronic cards of each type used for each type of Servers supplied with any control system	Nos.	Ten (10) percent or 2 no. (Whichever is more)
7	Electric to pneumatic converters of each type utilized with automatic control system using pneumatic drives	Nos.	Ten (10) percent of each type or a minimum of one of each type, whichever is more.
8	Plug-in type keyboard	Nos.	10 nos. of each type/model.

Sl no	Name of spares	Unit	Qty
9	Control OWS	Nos.	Two No. of each type with complete accessories & monitors.
10	Utility/Engineering OWS	Nos.	Two No. of each type with complete accessories & monitors.
11	DVD/CD	Nos.	10 boxes
12	Data highway cable with adequate connectors of each type	Set.	200 mts. each
13	Hard disc drive unit	Nos.	Five nos of each type
14	Prefab cable connectors	Nos.	10% or 5 nos (whichever is more) of each type of Installed
15	Cubicle power supply power supply modules	Nos.	Ten (10) percent or 5 nos (whichever is more) of Installed of each type and rating
16	Interposing/coupling relays.	Nos.	Ten (10) percent Installed of each type and rating
17	Ethernet Switches, Routers & other communication hardware	Nos.	10% of qty Installed of each type or a minimum of 2 numbers from each model, whichever is more.
18	Sensors with special cables, Power supply modules, Relay, Interface Module, and electronic modules used for vibration monitoring system.	Nos.	10% of qty installed or Five no. (Whichever is more) of each type)
19	Printer toners for all printers	Nos.	Ten (10) percent of qty installed or 3 no. (whichever is more)
20	DMP printer head of the total quantity	Nos.	2 nos. of 132 colums of each type
21	Drum for A3 sized scanner cum copies, printer	Nos.	2 nos. of each type
22	24“ LED monitor,	Nos.	3 nos.
23	29” LED monitor	Nos.	1 no
24	22” LED monitors.	Nos.	5 nos
25	RJ 45 connector with box of each type	Nos.	Twenty (20) percent or 2 no. (Whichever is more)
26	Hooters, Buzzers, Cooling fans of each type.	Nos.	Ten (10) percent or 2 no. (Whichever is more)
27	Interface cables	Set	2 sets of each type/model
28	Power supply modules (AC to DC convertors)	Nos.	10% or Five no. (Whichever is more) of each type/model
29	DVD/CD drive unit of each type	Nos.	5 nos.

Sl no	Name of spares	Unit	Qty
30	Mouse	Nos.	20 nos. of each type/model.
C	**Relay based Control Panels**		
1	LEDs for indicating lights	Nos.	10% of qty installed.
2	Control circuit fuses/MCB/MCCB/ Semiconductor Fuses	Nos.	300% of installed of each type, current rating.
3	Relays modules & contactors.	Nos.	20% spare of qty Installed of each type & rating.
D	**Alarm Annunciation System**		
1	logic modules, group card modules, power supply modules, Hooters and any other electronic module.	Nos.	20% spares of each type installed
2	un-engraved window boxes complete with LED etc.	Nos.	5% spares of each size installed
3	LEDs for annunciation facia windows and LEDs box assemblies offered for the project.	Nos.	20% of qty installed
4	Annunciator hooter	Nos.	One (1) No. of each type
E	**Un-interrupted Power Supply System and DC Control Power Supply System**		
1	As per Manufacturer's Recommendation for Three Years Continuous Operation or minimum quantities indicated as below (whichever is more)		
2	Fuses/Semiconductor Fuses	Nos.	300% of installed of each type, current rating with each panel /board
3	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 (whichever is more) of each type
4	Battery cells complete with contactor, cover plates etc.	Nos.	10% of qty installed
5	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
6	Miniature Circuit breakers for AC and DC supply.	Nos.	20 % of installed or 10 Nos of each type (whichever is more) for ACDB and DCDB.
7	Digital/analog panel meters/indicators	Nos.	5% or 2 no. of each type (whichever is more)
8	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)

Sl no	Name of spares	Unit	Qty
9	Cooling Fans in UPS & 24 V DC charger panels	Nos.	10% or 2 nos. of each type and rating, (whichever is more)
10	Following accessory equipment for the battery shall be furnished :	Set	Two sets
	a) Cell lifting facilities		
	b) Assembly wrenches		
	c) Vent plug hydrometer thermometer		
	d) Vent plug		
	e) Supply of corrosion-preventive grease.		
	f) 10% spare cells.		
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, stabilizer etc. as per approved BOM.
12	MCCB for UPS & 24 V DC charger panels, ACDB, DCDB.	Nos.	20 % of installed or 5 Nos of each type (whichever is more)
F	**Erection hardware**		
1	Instrument valves	Nos.	Ten (10) percent of each type & Size installed
2	Condensate pots of each type & Size installed	Nos.	Ten (10) percent of total number of Installed or four numbers whichever is higher
3	Manifold	Nos.	Ten (10) percent of each type & Size installed
4	Fittings	Nos.	Ten (10) percent of each type & Size installed
G	**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.		

Sl no	Name of spares	Unit	Qty
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.		
H	**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.		

NOTE:

1. These spares shall be considered as per the applicable items in main supply of AC system package.
2. Spares shall be considered as unit wise except for any item/equipment supplied as common for both unit.

ANNEXURE-III

PAINTING & COLOUR SCHEME

(ALREADY COVERED UNDER SECTION C2-C PAINTING SPECIFICATION)

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ANNEXURE-IV

LIST OF TOOLS & TACKLES

SL NO	ITEM DESCRIPTION	UNIT	QTY
1	FLAT D WRENCH - 6 MM TO 32 MM (12 Pcs)	SET	1
2	BOX WRENCHES - 6 MM TO 22 MM (14 Pcs)	SET	1
3	RING SPANNER - 6 MM TO 32 MM (12 Pcs)	SET	1
4	ALLEN KEYS - 2 MM TO 10 MM	SET	1
5	CRESCENT SCREW SPANNER	NO.	1
6	SCREW DRIVER	NO.	1
7	OFFSET SCREW DRIVER	NO.	1
8	INSULATED PLIER	NO.	1
9	TORCH LIGHT FOR 2 CELL	NO.	1
10	HAMMER 1 LB	NO.	1
11	OIL CAN	NO.	1
12	POCKET THERMOMETER - 0 TO 50 DEG. C)	NO.	1
13	INSULATION TAPE ROLL	NO.	1
14	STEEL FOOT RULE - 12"	NO.	1
15	FEELER GAUGE 9 BLADES	NO.	1
16	PIPE WRENCH	NO.	1
17	FLARE NUT (1/4")	NOS.	6
18	FLARING TOOL	NO.	1
19	TUBE CUTTER	NO.	1
20	GAS CHARGING PIPE	NO.	1
21	NITOGEN CHARGING ADAPTER	NO.	1
22	FREON PRESSURE GAUGE (2 1/2" DIA DIAL)) 0 - 300 MM PSI	NO.	1
23	FREON PRESSURE GAUGE (2 1/2" DIA DIAL)) 30 - 150 MM PSI	NO.	1
24	PSYCHRO METER	NO.	1
25	LOCK WITH KEY FOR TOOL BOX	NO.	1
26	RATCHET 1/4"	NO.	1
27	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-V0-412-553-A001	INSPECTION CATEGORISATION PLAN	4
2	PE-V0-412-553-A002	QAP OF SCREW CHILLER PACKAGE/VAM	14
3	PE-V0-412-553-A003	QAP OF AIR HANDILING UNIT	14
4	PE-V0-412-553-A004	QAP OF PUMPS	15
5	PE-V0-412-553-A005	QAP OF COOLING TOWER	15
6	PE-V0-412-553-A006	QAP OF MOTORS	15
7	PE-V0-412-553-A007	QAP OF PLC BASED PANEL	20
8	PE-V0-412-553-A101	HEAT LOAD CALCULATION FOR MAIN PLANT, ESP / VFD CONTROL ROOMS , SERVICE BUIDLING AND ADMIN BUILDING ETC	4
9	PE-V0-412-553-A102	OPERATION & CONTROL PHILOSPHY FOR AIR CONDITIONING SYSTEM	12
10	PE-V0-412-553-A103	PRESSURE DROP CALCULATIONS FOR CHILLED AND CONDENSER WATER PIPING	10
11	PE-V0-412-553-A201	TDS AND GA OF SCREW CHILLER ALONG WITH FOUNDATION DETAILS	16
12	PE-V0-412-553-A202	TDS AND GA OF COOLING TOWER ALONG WITH FOUNDATION DETAILS	15
13	PE-V0-412-553-A203	TDS AND GA OF AIR HANDLING UNITS ALONG WITH FOUNDATION DETAILS	14
14	PE-V0-412-553-A204	TDS AND GA OF CONDENSER AND CHILLED WATER PUMPS ALONG WITH FOUNDATION DETAILS	15
15	PE-V0-412-553-A205	TDS AND GA OF PAC / SPLIT AIR CONDITIONER	12
16	PE-V0-412-553-A206	TDS AND GA OF MOTOR (PUMP, COOLING TOWER, AHU)	15
17	PE-V0-412-553-A207	TDS OF INSULATION MATERIAL (DUCT INSULATION, DUCT LINING, PIPE INSULATION)	12
18	PE-V0-412-553-A208	TDS AND GA OF FRESH AIR FANS	12
19	PE-V0-412-553-A209	TDS AND GA OF ONLINE NON CHEMICAL SCALE PREVENTER	16
20	PE-V0-412-553-A210	TDS AND GA OF WATER COOLED PACKAGE AC UNITS ALONG WITH FOUNDATION DETAILS	12
21	PE-V0-412-553-A211	TDS AND GA OF HEATERS AND HUMIDIFIER	7
22	PE-V0-412-553-A212	TDS AND GA OF FIRE DAMPER WITH ACTUATOR	10
23	PE-V0-412-553-A213	TDS AND GA OF FOR 3-WAY MIXING VALVE	8
24	PE-V0-412-553-A214	TDS AND GA OF VALVEES (BALANCING VALVE, GATE VALVE, CHECK VALVE , Y ATRAINER)	9
25	PE-V0-412-553-A215	TDS AND GA OF SUPPLY / RETURN AIR DIFFUSER/GRILL	8
26	PE-V0-412-553-A216	TDS OF GI SHEET	5
27	PE-V0-412-553-A217	TDS OF PIPES	5

S. NO.	DRAWING NO	DRG./ DOC. TITLE	SCH. WEEK (FROM DATE OF LOI)
28	PE-V0-412-553-A218	TDS AND GA OF EXPANSION TANK, MAKEUP WATER AND SOFT WATER TANK	5
29	PE-V0-412-553-A219	TDS AND GA OF FILTERS	10
30	PE-V0-412-553-A220	TDS FOR INSTRUMENTS (PRESSURE GAUGE, TEMPERATURE GAUGE, LEVEL GAUGE, PRESSURE SWITCH, TEMPERATURE SWITCH, LEVEL SWITCH, DP SWITCH, TEMPERATURE AND HUMIDITY SENSORS ETC)	12
31	PE-V0-412-553-A501	PID FOR MAIN PLANT, SERVICE BUILDING,ADMIN BUILDING, ESP ETC	8
32	PE-V0-412-553-A502	TYPICAL DETAILS DUCT FABRICATION DRAWING /SUPPORT/ERECTION. INSULATION OF DUCTING / PIPING & EQUIPMENTS CHILLED AND CONDENSER WATER PIPE ERECTION	7
33	PE-V0-412-553-A503	AC DUCT LAYOUT DRAWING FOR CONTROL ROOM ARES AT 17M ALONG WITH AHU ROOM LAYOUT WITH FOUNDATION DETAILS	16
34	PE-V0-412-553-A504	AC DUCT & AHU ROOM LAYOUT WITH FOUNDATION DETAIL FOR UPS BATTERY CHARGER ROOM AT 8.5M AND SWAS ROOM AT 0 M	17
35	PE-V0-412-553-A505	AC DUCT LAYOUT DRAWING FOR ESP CONTROL ROOM ARES ALONGWITH AHU/PU ROOM LAYOUT WITH FOUNDATION DETAILS FOR INDOOR AND OUTDOOR UNITS	18
36	PE-V0-412-553-A506	AC DUCT LAYOUT DRAWING FOR SERVICE BUILDING WITH AHU ROOM LAYOUT AND FOUNDATION DETAILS	18
37	PE-V0-412-553-A507	AC DUCT LAYOUT DRAWING FOR ADMIN BUILDING WITH AHU ROOM LAYOUT AND FOUNDATION DETAILS	18
38	PE-V0-412-553-A508	AC PLANT ROOM LAYOUT & COOLING TOWER AREA LAYOUT WITH COMPLETE FOUNDATION DETAIL OF ALL EQUIPMENT	15
39	PE-V0-412-553-A509	CHILLED & CONDENSER WATER PIPING LAYOUT WITHIN PLANT ROON & UPTO VARIOUS AHU ROOMS, & COOLING TOWER AREA.	20
40	PE-V0-412-553-A510	SPLIT AC SCHEDULE ALONGWITH HEAT LOAD CALCULATION FOR AUXILIARY BUILDING	22

S. NO.	DRAWING NO	DRG./ DOC. TITLE	SCH. WEEK (FROM DATE OF LOI)
41	PE-V0-412-553-A701	TDS OF PLC WITH CONFIGURATION DIAGRAM, BILL OF MATERIAL, GA &INTERNAL WIRING DIAGRAM, LOGIC FLOW DIAGRAM, IO WIRING DIAGRAM , PLC ROOM LAYOUT	20
42	PE-V0-412-553-A702	I/O LIST FOR AC SYSTEM	20
43	PE-V0-412-553-A751	ELECTRICAL FEEDER LIST	18
44	PE-V0-412-553-A752	CABLE SCHEDULE	22
45	PE-V0-412-553-A901	PG TEST PROCEDURE	12
46	PE-V0-412-553-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 &				

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Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
	bigger sizes are to be attached in the last)				
3.7	Single line/wiring diagrams				
3.8	Control philosophy /control write-ups				
4.0	**COMMISSIONING ACTIVITIES (IF NOT COVERED IN SEPARATE DOCUMENT I.E. ERECTION MANUAL, COMMISSIONING MANUAL)**				
4.1	Pre-Commissioning Checks				
4.2	handling of items at site				
4.3	Storage at site				
4.4	Unpacking & Installation procedure				
5.0	**OPERATION GUIDELINES FOR PLANT PERSONAL/USER/OPERATOR**				
5. 1	Interlock & Protection logic along with the limiting values of protection settings for the equipment along with brief philosophy behind the logic, drawings etc. to be provided.				
5. 2	Start up, normal operation and shut down procedure for equipments along with the associated systems in step by step mode. Valve sequence chart, step list, interlocks etc. with Equipment isolating procedures to be mentioned.				
5. 3	Do's & Don't of the equipments.				
5. 4	Safety precautions to be taken during normal operation. Safety symbols, Emergency instructions on total power failure condition/lubrication failure/any other condition				
5. 5	Parameters to be monitored with normal values and limiting values				
5. 6	Trouble shooting with causes and remedial measures				
5. 7	Routine operational checks, recommended logs & records				
5. 8	Changeover schedule if more than one auxiliary for the same purpose is given				
5. 9	Painting requirement and schedule				
5. 10	Inspection, repair , Testing and calibration procedures				

Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
6.0	**MAINTENANCE GUIDELINES FOR PLANT PERSONAL**				
6.1	List of Special Tools and Tackles required for Overhaul/Trouble shooting including special testing equipment required for calibration etc.				
6.2	Stepwise dismantling and re-assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained, clearances etc. to be mentioned. Tolerances for fitment of various components to be given.				
6.3	Preventive Maintenance & Overhauling schedules linked with running hours/calendar period along with checks to be given				
6.4	Long term maintenance schedules especially for structural, foundations etc.				
6.5	Consumable list along with the estimated quantity required during commissioning, normal running and during maintenance like Preventive Maintenances and Overhaul. Storage/handling requirement of consumables/self-life.				
6.6	List of lubricants with their Indian equivalent, Lubrication Schedule, Quantity required for each equipment for complete replacement is to be given				
6.7	List of vendors & Sub-vendors with their latest addresses, service centres ,Telephone Nos., Fax Nos., Mobile Nos., e-mail IDs etc.				
6.8	List of mandatory and recommended spare parts list				
6.9	Tentative Lead time required for ordering of spares from the equipment supplier				
6.10	Guarantee and warranty clauses				
7.0	**Statutory and other specific requirements considerations.**				
8.0	**List of reference documents**				
9.0	**Binding as per requirement**				

ANNEXURE-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	

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	

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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	

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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.		

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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.

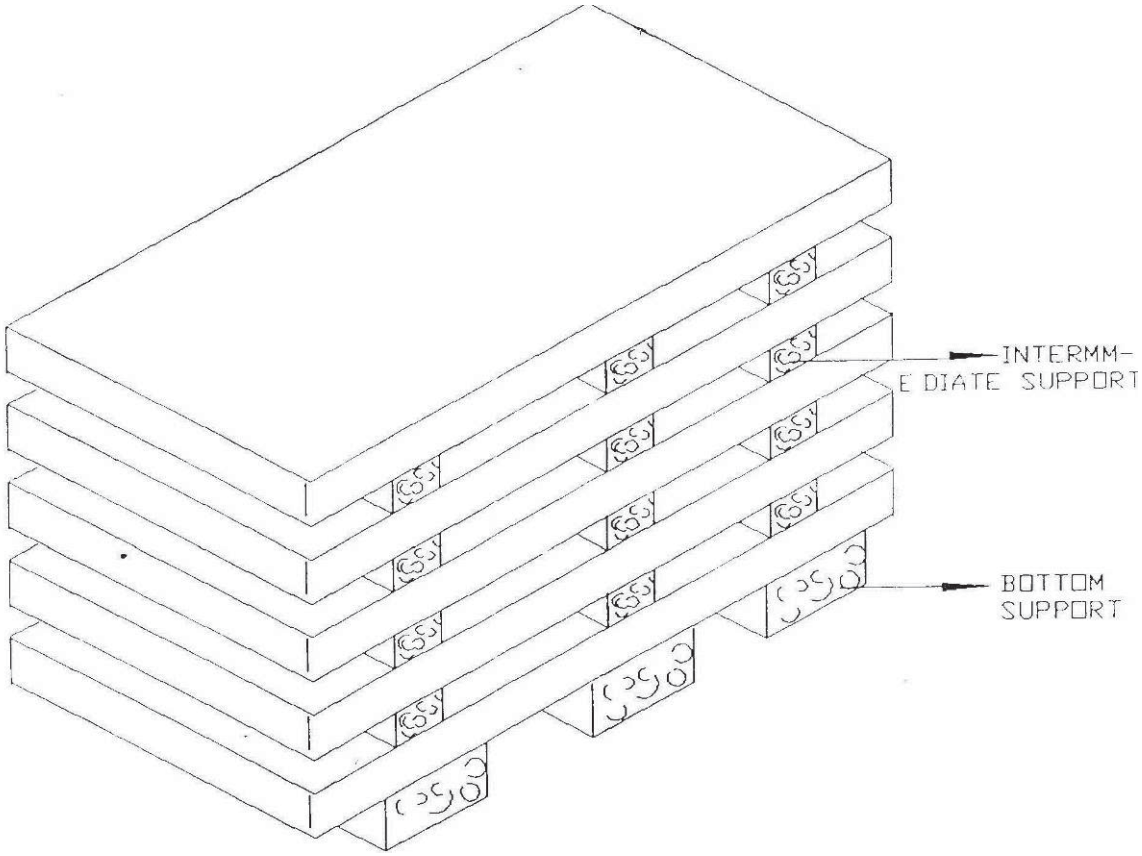


Figure – 1 – PLATE STACKING ARRANGEMENT

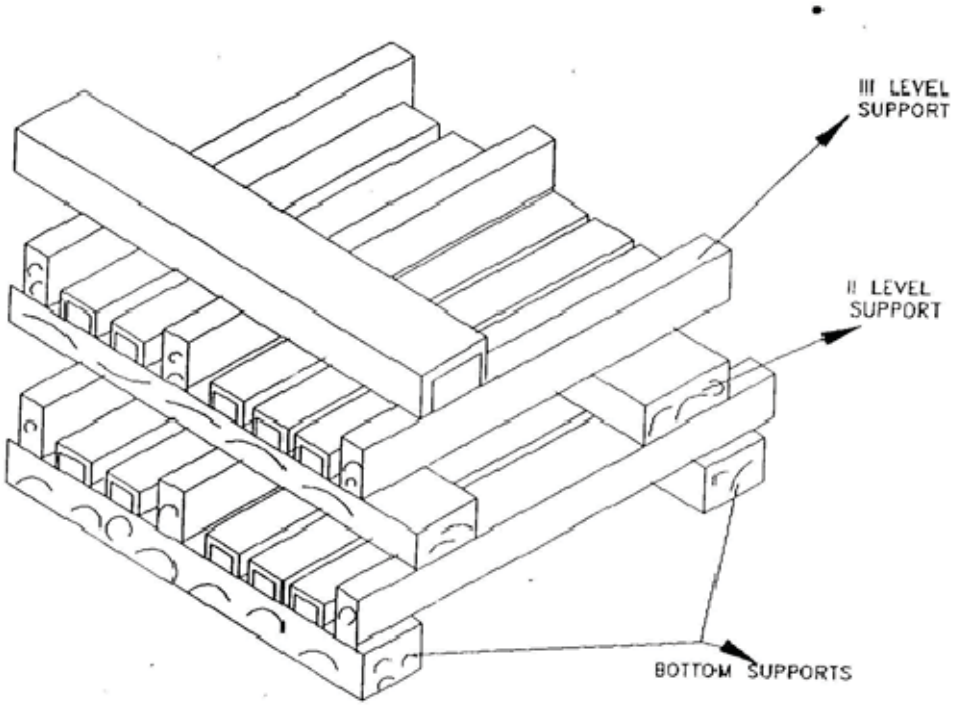


Figure – 2 – STRUCTURAL STEEL STACKING ARRANGEMENT

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 envelop.
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 AIR CONDITIONING SYSTEM GAURANTEE POWER CONSUMPTION	SPECIFICATION No: PE-TS-412-553-A001
		VOLUME: III
		SECTION: 5
		REV. NO. 00 | DATE: April 2015
		SHEET: 1 OF 3

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	**AC-Plant-1: (CENTRAL CHILLED WATER SYSTEM FOR MAIN CR AREAS COMMON FOR UNIT-1&2.)**					
1.1	Water chilling machine -Screw chiller	1	1		1	**0**
1.2	AHUs for Common control room areas, CER, computer room etc	2	2		1	**0**
1.3	AHUs for 8.5 m battery charger & UPS room	1	1		1	**0**
1.4	Cooling tower fans for AC plant	1	1		1	**0**
1.5	Condenser water pumps for AC plant	1	1		1	**0**
1.6	Chilled water pumps for AC plant	1	1		1	**0**
1.7	Fresh air fans for above AHU rooms	4	0		1	**0**
2	**AC PLANT-2 (ESP Building-UNIT- 1)**					
2.1	Water cooled DX condensing machine -Screw	1	1		1	**0**
2.2	AHUs for ESP control room	1	1		1	**0**
2.3	Cooling tower fans for AC plant	1	1		1	**0**
2.4	Condenser water pumps for AC plant	1	1		1	**0**
2.5	Fresh air fans for above AHU rooms	2	0		1	**0**
3	**AC PLANT-3 (ESP Building-UNIT- 2)**					
3.1	Water cooled DX condensing machine -Screw	1	1		1	**0**
3.2	AHUs for ESP control room	1	1		1	**0**

Anshul S A Khan Praveen Kishore

	2x660MW ENNORE STPP AIR CONDITIONING SYSTEM GAURANTEE POWER CONSUMPTION	SPECIFICATION No: PE-TS-412-553-A001
		VOLUME: III
		SECTION: 5
		REV. NO. 00 | DATE: April 2015
		SHEET: 2 OF 3

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
3.3	Cooling tower fans for AC plant	1	1		1	**0**
3.4	Condenser water pumps for AC plant	1	1		1	**0**
3.5	Fresh air fans for above AHU rooms	2	0		1	**0**
4	**AC PLANT-4 (Service Building)**					
4.1	Water cooled package AC (20TR)	9	9		1	**0**
4.2	Water cooled package AC (15TR)	4	4		1	**0**
4.3	Fresh air fans for above PAC room.	16	0		1	**0**
4.4	Cooling tower fans for AC plant	1	1		1	**0**
4.5	Condenser water pumps for AC plant	1	1		1	**0**
5	**AC PLANT-5 (Admin Building)**					
5.1	Water cooled package AC (20TR)	3	3		1	**0**
5.2	Water cooled package AC (15TR)	3	3		1	**0**
5.3	Fresh air fans for above PAC room.	8	0		1	**0**
5.4	Cooling tower fans for AC plant	1	1		1	**0**
5.5	Condenser water pumps for AC plant	1	1		1	**0**
				TOTAL (KW)		**1120**

NOTES:	
1	Estimated power consumption (EPC) figure for the system (for working drives only) has been considered as **1120** 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 2,00,000/- per KW of additional power over EPC up to 1151 KW. In case the bidders quoted GPC is higher than 1151 KW, the technical loading over this figure(1151KW) shall be @ **Rs 64,92,703/-** per KW.

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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
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, there shall be penalty @Rs 2,00,000/- per KW of additional power up to 1151 KW. In case the power consumption is higher than 1151 KW, the penalty over this figure (1151KW) shall be @ **Rs 64,92,703/-** per KW shall be levied on vendor.					

Anshul S A Khan Praveen Kishore

SUGGESTIVE PRICE FORMAT

AC 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 of 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, submission of operation and maintenance manual, carrying out acceptance tests at site, and final painting of complete AC System on turnkey basis as per specification **PE-TS-412-553-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.													
A	**AC-Plant-1: CENTRAL CHILLED WATER SYSTEM FOR MAIN CR AREAS.**													
1	Microprocessor controlled, water cooled chiller package each of minimum capacity **300TR** consisting of Hermeticaly sealed Screw type refrigerant compressor operating on R134a / R407C refrigerant complete with motor, unit mounted starter, complete with suction and discharge shut off valves, HP / LP cutouts, oil pressure failure switch, gauge panel, automatic capacity control; Condenser, relief valve, chiller, controls such as thermostatic/electronic expansion valve, cooling thermostat, antifreeze thermostat, water flow switch, integral refrigerant pipes & fittings, strainer, sight glass, isolating valves, chiller drain valve, chiller insulation, refrigerant piping insulation, first charge of gas and oil, base frames, vibration isolators, integral wiring, unit mounted isolator / fuse switch and other accessories as specified.	2	NO											
2	Sheet metal cabinet type air handling units (double skin as per specification) consisting of chilled water cooling coil, centrifugal blower, TEFC sq cage induction motor, VFD drive set , filters (pre filter), 3 way motorised mixing valve with thermostatic controls and other accessories as per specifications to meet the AC load of the main Control Room areas of **power house building** at **17.0m and kept at 19 M floor level as per specification.** Fine filter and HEPA Filters shall be provided in Common discharge plenum .	4	NO											
3	Sheet metal cabinet type air handling units (double skin as per specification) consisting of chilled water cooling coil, centrifugal blower, TEFC sq cage induction motor, VFD drive set, filters (pre filter), 3 way motorised mixing valve with thermostatic controls and other accessories as per specifications to meet the AC load of the UPS & Battery charger areas of **Unit 1 & 2** at **8.5m.** Fine Filters in Common discharge plenum for AHUs shall also be included.	2	NO											
4	Fibreglass reinforced plastic (FRP) construction cooling towers complete with fan, motor, FRP basin, nozzles, make-up water & quick fill water connection, Level Switch, drains, piping, valves, strainers, ladder & all accessories as specified.	2	NO											
5	Centrifugal pump sets for condenser water recirculation complete with TEFC motor & all accessories as specified.	2	NO											
6	Centrifugal pump sets for chilled water recirculation complete with TEFC motor & all accessories, as specified.	2	NO											
7	Make up water FRP Storage tank to cooling towers with level switch, pr switch and other accessories as required. Capacity of each tank 8 m3 .	2	NO											
8	FRP Expansion Tank (insulated) for chilled water with all accessories as required, capacity 1 m3.	1	NO											
9	Online chemical scale preventer, with all accessories as required to meet system requirements	1	NO											

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AC 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)
10	Condenser water piping with necessary fittings, strainers, valves including piping from soft water storage tank to pan humidifiers of AHU room as specified.	1	LOT											
11	Chilled water piping from AC plant to AHU rooms within power house building complete with valves supports, fittings, strainers, PUF section insulation with finish as per specification.	1	LOT											
12	MS medium class drain piping upto nearest drain point with and without insulation	1	LOT											
13	Monsoon reheating/ winter heating kit comprising strip heaters, safety controls, air-stat, contactors, frame work, thermostat & humidistat/ sensors etc.	1	LOT											
14	Pan type humidifier for each AHU room.	1	LOT											
15	Fresh air fan (axial flow type), complete with motor, inlet cone, air filters (pre and fine), dampers etc.	1	LOT											
B	**AC Plant -2 & 3 : WATER COOLED DX SYSTEM (ESP building) Unit-1 & 2**													
1	DX type water cooled condensing unit of minimum **30TR** capacity. The refrigerant compressor shall be hermetically sealed Srew type operating on R-134a / R-407c refrigerant complete with motor, unit mounted starter, complete with suction and discharge shut off valves, HP / LP cutouts, oil pressure failure switch, gauge panel, automatic capacity control, condenser, relief valve, chiller, controls such as thermostatic/electronic expansion valve, cooling thermostat, antifreeze thermostat, water flow switch, integral refrigerant pipes & fittings, strainer, sight glass, isolating valves, chiller drain valve, chiller insulation, refrigerant piping insulation, first charge of gas and oil, base frames, vibration isolators, integral wiring, unit mounted isolator / fuse switch and other accessories as specified.	4	NOs											
2	Sheet metal cabinet type air handling units (double skin as per specification) consisting of Dampers, Filters (pre filter and fine filters), DX- cooling coil, and Fan section with fan & TEFC sq cage induction motor, VFD drive set, face and bypass damper with modulating motor, condensate drain pan, thermostatic controls and other accessories to meet the AC load of control room area, complete with all accessories as per specification.	4	NOs											
3	Fibreglass reinforced plastic (FRP) construction cooling towers complete with fan, motor, FRP basin, nozzles, make-up water & quick fill water connection, Level Switch, drains, piping, valves, strainers, ladder & all accessories as specified.	4	NOs											
4	Centrifugal pump sets for condenser water recirculation complete with TEFC motor & all accessories as specified.	4	NOs											
5	Make up water FRP Storage tank to cooling towers with level switch, pr switch and other accessories as required. Capacity of each tank2m3 .	4	NOs											
6	FRP Expansion Tank (insulated) for chilled water with all accessories as required, capacity 1 m3.	2	NOs											
7	Online non - chemical scale preventer, with all accessories as required to meet system requirements	2	NOs											
8	Condenser water piping with necessary fittings, strainers, valves including piping from soft water storage tank to pan humidifiers of AHU room as specified.	2	LOT											
9	MS medium class drain piping upto nearest drain point with and without insulation	2	LOT											
10	Monsoon reheating/ winter heating kit comprising strip heaters, safety controls, air-stat, contactors, frame work, thermostat & humidistat/ sensors etc.	2	LOT											
11	Pan type humidifier for each AHU room.	2	LOT											
12	Fresh air fan (axial flow type), complete with motor, inlet cone, air filters (pre and fine), dampers etc.	2	LOT											
C	**AC-Plant-4: WATER COOLED PACKAGED AC FOR SERVICE BUILDING AREAS**													

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AC 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*	Water cooled packages, each of following capacity consisting of water cooled condenser & evaporating unit including complete refrigerant piping / unit with insulation, controls, complete drain piping to nearest drain and all other accessories as per specifications.													
a*	20TR (Actual)	18	NO*											
b*	15 TR (Actual)	8	NO*											
2	Fibreglass reinforced plastic (FRP) construction cooling towers complete with fan, motor, FRP basin, nozzles, make-up water & quick fill water connection, Level switch, drains, piping, valves, strainers, ladder & all accessories as specified. The capacity of each cooling tower shall be equal to the working capacituy of the plant for service building.	2	NO											
3	Centrifugal pump sets for condenser water recirculation complete with TEFC with TEFC motor & all accessories as specified.	2	NO											
4	Make up water FRP Storage tank to cooling towers with level switch, pr switch and other accessories as required. Capacity of each tank 8 m3 .	2	NO											
5	FRP Expansion Tank (insulated) for chilled water with all accessories as required, capacity 1 m3.	1	NO											
6	Online non - chemical scale preventer, with all accessories as required to meet system requirements	1	NO											
7	Condenser water piping with necessary fittings, strainers, valves including piping from soft water storage tank to pan humidifiers of AHU room as specified.	1	LOT											
8	MS medium class drain piping upto nearest drain point with and without insulation	1	LOT											
9	Fresh air fan (axial flow type), complete with motor, inlet cone, air filters (pre and fine), dampers etc.	1	LOT											
D	**AC-Plant-5: WATER COOLED PACKAGED AC FOR ADMINISTRATIVE BUILDING AREAS.**													
1*	Water cooled packages, each of following capacity consisting of water cooled condenser & evaporating unit including complete refrigerant piping / unit with insulation, controls, complete drain piping to nearest drain and all other accessories as per specifications.													
a*	20TR (Actual)	6	NO*											
b*	15 TR (Actual)	6	NO*											
2	Fibreglass reinforced plastic (FRP) construction cooling towers complete with fan, motor, FRP basin, nozzles, make-up water & quick fill water connection, Level switch, drains, piping, valves, strainers, ladder & all accessories as specified. The capacity of each cooling tower shall be equal to the working capacituy of the plant for administration building.	2	NO											
3	Centrifugal pump sets for condenser water recirculation complete with TEFC with TEFC motor & all accessories as specified.	2	NO											
4	Make up water FRP Storage tank to cooling towers with level switch, pr switch and other accessories as required. Capacity of each tank 8 m3 .	2	NO											
5	FRP Expansion Tank (insulated) for chilled water with all accessories as required, capacity 1 m3.	1	NO											
6	Online non - chemical scale preventer, with all accessories as required to meet system requirements	1	NO											
7	Condenser water piping with necessary fittings, strainers, valves including piping from soft water storage tank to pan humidifiers of AHU room as specified.	1	LOT											
8	MS medium class drain piping upto nearest drain point with and without insulation	1	LOT											
9	Fresh air fan (axial flow type), complete with motor, inlet cone, air filters (pre and fine), dampers etc.	1	LOT											
E	**ITEMS COMMON TO ALL AC PLANTS**													

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AC 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*	FAN COIL UNIT consisting of chilled water cooling coil, blower, motor, driveset, filters (prefilter), 3way motorised mixing valve with thermostatic controls and other accessories as per specifications													
a*	3 TR	4	NO*											
b*	2TR	1	NO*											
c*	1.5 TR	1	NO*											
2*	**Fire damper.**													
a*	Fire damper with auto resetting, limit switches, indication lamps etc.	30	SQM*											
b*	Motorized actuator with single phase power supply for the above fire damper.	40	NO*											
3*	GSS zinc coating **275** gms/ m^2 ducting complete with hangers/ supports, dampers, grilles, diffusers (with & without VCD) etc.													
a*	18G.	1500	SQM*											
b*	20G.	3000	SQM*											
c*	22G.	3500	SQM*											
d*	24G.	5000	SQM*											
e*	Supply air diffuser with VCD (Extruded Aluminium).	75	SQM*											
f*	Return air diffuser without VCD (Extruded Aluminium).	90	SQM*											
g*	GI Volume control dampers for Duct	20	SQM*											
4	Acoustic insulation of the first 6 of ducting from AHU outlets.	1	LOT											
5*	Acoustic insulation of walls of AHU / PU room as per specifications.	2000	SQM*											
6*	Thermal insulation of supply air duct & return air duct with finish as specified.	13000	SQM*											
7	Field instruments like pressure gauge, temperature gauge, pressure switch, differential pressure switch, flow switch, flow meters, velocity sensor, static pressure sensors and other required instruments as per specifications, including necessary control panel form hook up with main DDCMIS as per specifications	1	LOT											
8	PLC control system complete with PLC panels , RIO panels and all accessories as specified in the specification.	1	LOT											
9*	Fibre optic cable.	400	Rmt*											
F	**AC System for Aux. building for unit#1 & 2)**													
1*	Air Cooled PAC-Unit complete with all accessories as specified The package unit shall be complete with all accessories like duct hetaers, pan humidifier, filters, acoustic insulation of duct for 5m from PU, drain piping with insulation upto nearest drain, required instrumentation etc													
(a)*	10 TR net capacity	1	No*											
(b)*	15 TR net capacity	1	No*											
2*	Air-cooled split type AC units consisting of condensing unit & evaporating unit including refrigerant pipes & fittings with insulation etc. (Minimum BEE Rating 5 Star for non ductable units).													
(a)*	5.0 TR capacity (ductable type, 415 V, 3 phase with isolation switch).	2	NO*											
(b)*	2.0 TR capacity (non-ductable type, 240 V, 1 phase isolation switch) with isolation switch , i.e MCB of suitable rating as specified.	30	NO*											
(c)*	1.5 TR capacity (non-ductable type, 240 V, 1 phase isolation switch) with isolation switch , i.e MCB of suitable rating as specified.	70	NO*											
3	Manually operated, platform trolley of 1 Ton capacity with base area 2m x 1.5m	4	No											
4	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											

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AC 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)
5	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											
6	Total lumpsum price for Mandatory Spare for air conditioning inclusive of packing forwarding, transportation up to site, etc. (Bidder to submit item-wise price break-up).	1	LOT											
7	Any other item not indicated above, but required to make the system complete in all respects.	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

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AC 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**													
1	**Vapour Compression chiller**													
1.1	Oil filter “O” ring	1	set											
1.2	Refrigerant filter	1	set											
1.3	Master solenoid valve	1	no											
1.4	Master solenoid valve coil	1	set											
2	**Screw compressors**													
2.1	Valve Head assembly	25%	of each type and rating											
2.2	Bearings	25%	of each type and rating											
2.3	Seal gasket and other wear out parts in sets	25%	of each type and rating											
2.4	O' rings & oil seals	2	set of each rating of compressor											
2.5	Crank case heater	1	no of each rating of compressor											
2.6	Suction filter elements	4	set of each rating of compressor											
2.7	Compressor shaft seal assembly	2	set of each rating of compressor											
2.8	Oil pressure failure safety switch	1	set of each rating of compressor											
3	**Reciprocation compressor**													
3.1	Piston ring in sets	25%	of each type and rating											
3.2	Piston in sets	30%	of each type and rating											
3.3	Bearing in sets	25%	of each type and rating											
3.4	Seal gasket and other wear out parts in sets	25%	of each type and rating											
3.5	Valve Head assembly	25%	of each type and rating											
3.6	Crank shaft in sets	10%	of each type and rating											
3.7	Connecting rod in sets	10%	of each type and rating											
4	**Pumps (condenser & chilling water pumps)**													
4.1	Pump Impeller	1	no of each type											
4.2	Pump Bearing	1	set											

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AC SYSTEM FOR 2 x 660 MW ENNORE SEZ STPP ---MANDATORY SPARES SUGGESTIVE PRICE FORMAT														
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				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)
4.3	Pump Motor Bearing	1	set											
4.4	Shaft Sleeve	1	set											
5	**Cooling Towers**													
5.1	Nozzles for cooling towers	2	set											
5.2	Float valve assembly	1	no											
5.3	Fan Bearing	1	set											
5.4	Motor Bearing	1	set											
6	**Packaged Air - conditioners**													
6.1	Filters	1	set											
6.2	Expansion valve	1	set											
6.3	Motor for compressor	1	set											
7	**Air Handling Unit**													
7.1	V-Belt for AHU blower	2	sets of each type											
7.2	AHU blower bearing	1	sets of each type											
7.3	Filters	2	sets of each type											
7.4	Blower motor bearing	1	set											
8	**Tube axial fan**													
8.1	Bearing	1	set											
8.2	Filter	1	set											
8.3	Motor Bearing	1	set											
B	**ELECTRICAL SPARES**													
1	Terminal plates													
a	For motors upto 30 KW	10	nos											
b	For motors above 30 KW	4	nos											
2	Heaters	2	sets											
3	Greasing arrangements	4	sets of each type of motor											
4	Motor of each type and rating	10%	of installed quantity or minimum 1 number whichever be higher.											
5	Bearings (DE and NDE) for each type and rating of motor	4	sets											
C	**C&I SPARES**													

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AC SYSTEM FOR 2 x 660 MW ENNORE SEZ STPP ---MANDATORY SPARES SUGGESTIVE PRICE FORMAT															
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				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)	
	Each type of lamps, PBs, ILPBs, fuse, MCB, MCCB used in the equipment/system.	20%	of Installed of each type.												
a)	**Measuring Instruments**														
1	Indicators, Recorders, Electrical Metering and Skid Mounted Instruments														
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												

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AC SYSTEM FOR 2 x 660 MW ENNORE SEZ STPP ---MANDATORY SPARES SUGGESTIVE PRICE FORMAT															
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				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)
b)	**DDCMIS/PLC system, Master slave clock system, Hart Management System, Vibration Monitoring system, CAAQMS, ERP/MIS/LAN/Simulator/ WAN, CCTV, Microprocessor based control system, and other Control System/Sub-systems/electronic system listed in NIT.**													
1	I/O cards	10%	of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)											
1.1	Analog Input module	10%	of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)											
1.2	Analog output module	10%	of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)											
1.3	RTD/TC cards/modules	10%	of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)											
1.4	Digital input module	10%	of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)											
1.5	Digital output module	10%	of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)											
2	All types of electronic modules, controllers, function modules, cards, terminal boards, relay boards, power supply cards etc for above mentioned system and other Control System/Sub- systems and any other type of PCB not covered above	10%	of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)											

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AC SYSTEM FOR 2 x 660 MW ENNORE SEZ STPP ---MANDATORY SPARES SUGGESTIVE PRICE FORMAT															
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3	Electronic Cards/modules	10%	of number for each type or minimum of 2 number for each type whichever is high.											
4	Auto/Manual stations, set-point/bias stations etc	10%	of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)											
5	Control logic power supply fuses, MCB,MCCB, at each current rating required for the project.	20%	spare for each type/Model.											
6	Electronic cards of each type used for each type of Servers supplied with any control system	10%	or 2 no. (Whichever is more)											
7	Electric to pneumatic converters of each type utilized with automatic control system using pneumatic drives	10%	of each type or a minimum of one of each type, whichever is more.											
8	Plug-in type keyboard	10%	nos for each type/Model.											
9	Control OWS	2	of each type with complete accessories &											
10	Utility/Engineering OWS	2	of each type with complete accessories & monitors.											
11	DVD/CD	10	boxes											
12	Data highway cable with adequate connectors of each type	200	mts each											
13	Hard disc drive unit	5	nos of each type											
14	Prefab cable connectors	10%	5 nos (whichever is more) of each type of Installed											
15	Cubicle power supply power supply modules	10%	5 nos (whichever is more) of Installed of each type and rating											
16	Interposing/coupling relays.	10%	Installed of each type and rating											
17	Ethernet Switches, Routers & other communication hardware	10%	Installed of each type or a minimum of 2 numbers from each model, whichever is more											

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AC SYSTEM FOR 2 x 660 MW ENNORE SEZ STPP ---MANDATORY SPARES SUGGESTIVE PRICE FORMAT														
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18	Sensors with special cables, Power supply modules, Relay, Interface Module, and electronic modules used for vibration monitoring system.	10%	of qty installed or Five no. (Whichever is more) of each type											
19	Printer toners for all printers	10%	of qty installed or 3 no. (whichever is more)											
20	DMP printer head of the total quantity	2	nos. of 132 colums of each type											
21	Drum for A3 sized scanner cum copies, printer	2	nos. of each type											
22	24“ LED monitor,	3	nos											
23	29” LED monitor	1	nos											
24	22” LED monitors.	5	nos											
25	RJ 45 connector with box of each type	20%	or 2 no. (Whichever is more)											
26	Hooters, Buzzers, Cooling fans of each type.	10%	2 no. (Whichever is more)											
27	Interface cables	2	sets of each type/model											
28	Power supply modules (AC to DC convertors)	10%	or Five no. (Whichever is more) of each type/model											
29	DVD/CD drive unit of each type	5	nos											
30	Mouse	20	nos. of each type/model.											
c)	**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											
d)	**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	1	One (1) No. of each type											
e)	**Un-interrupted Power Supply System and DC Control Power Supply System**													

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AC SYSTEM FOR 2 x 660 MW ENNORE SEZ STPP ---MANDATORY SPARES SUGGESTIVE PRICE FORMAT														
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1	As per Manufacturer's Recommendation for Three Years Continuous Operation or minimum quantities indicated as below (whichever is more)													
2	Fuses/Semiconductor Fuses	300%	of installed of each type, current rating with each panel /board											
3	Miscellaneous parts for the power supplies such as SCRS, transistors, resistors, diodes, light bulbs, static switches , blocking diodes etc	10%	Minimum of 10% or atleast two (which ever is more) of each type											
4	Battery cells complete with contactor,cover plates etc	10%	of qty installed											
5	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.	1	1 Set of each type & rating											
6	Miniature Circuit breakers for AC and DC supply.	20%	of installed or 10 Nos of each type (which ever is more) for ACDB and DCDB.											
7	Digital/analog panel meters/indicators	5%	or 2 no. of each type (whichever is more)											
8	CT's, CVT's VT's chokes, AC/DC isolators, contactors, timers, relays.	10%	or 2 nos. of each type and rating, (whichever is more)											
9	Cooling Fans in UPS & 24 V DC charger panels	10%	or 2 nos. of each type and rating, (whichever is more)											
10	Following accessory equipment for the battery shall be furnished :	2	sets											
10.1	Cell lifting facilities													
10.2	Assembly wrenches													
10.3	Vent plug hydrometer thermometer													
10.4	Vent plug													
10.5	Supply of corrosion-preventive grease.													
10.6	10% spare cells.													

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AC SYSTEM FOR 2 x 660 MW ENNORE SEZ STPP ---MANDATORY SPARES SUGGESTIVE PRICE FORMAT															
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11	Electronic modules of each type & rating for UPS and DC control power supply system.	1	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.											
12	MCCB for UPS & 24 V DC charger panels, ACDB, DCDB.	20%	of installed or 5 Nos of each type (which ever is more)											
f)	**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											
g)	**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.													

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AC SYSTEM FOR 2 x 660 MW ENNORE SEZ STPP ---MANDATORY SPARES SUGGESTIVE PRICE FORMAT															
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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.													
h)	**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.													

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 ENNORE STPP		
PACKAGE : AIR CONDITIONING 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 air conditioning system on turnkey basis as per specification PE-TS-412-553-A001 including special tool & tackels for maintenance, commissioning spares, all taxes, duties etc. (Without mandatory spare - Sr. No. 2.10 of suggestive price	**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 air conditioning system and as defined in the technical specification (PE-TS-412-553-A001)	**80%**
2.1	Erection & commissioning, carrying out acceptance tests at site, final painting and handing over to customer the complete AC system on turnkey basis as per specification PE-TS-412-553-A001 including 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	Water Chilling machine - Screw Chiller - (Item no A-1 & B- 1of Suggestive price format)	**9.89%**
3.2	Air handling units (Item Nos A- 2 & 3 and B- 2of Suggestive price format)	**7.43%**
3.3	Cooling Towers (Item no A-4 , B - 3, C - 2 & D - 2 of Suggestive price format)	**2.96%**
3.4	Pumps (Item no A-5 & 6 , B -4 , C - 3 & D - 3 of Suggestive price format)	**1.95%**
3.5	Tanks (Item no A-7 & 8 , B- 5&6 ,C-4&5 and D-4&5 of Suggestive price format)	**2.34%**
3.6	Water treatment equipment (Item no A-9 , B - 7 , C-6 & D-6 of Suggestive price format)	**1.34%**
3.7	Condenser water piping (Item Nos A- 10,B- 8 , C-7& D- 7 of Suggestive price format)	**12.95%**
3.8	Chilled & Drain water piping (Item Nos A- 11,12,B- 9 , C-8& D- 8 of Suggestive price format)	**6.78%**
3.9	Heaters and humidifiers (Item Nos A- 13,14 & B- 10 , 11 of Suggestive price format)	**4.15%**
3.10	Fresh air Fans and Fresh air arrangement (Item Nos A- 15 , B- 12 , C-9 & D- 9 of Suggestive price format)	**0.90%**
3.11	Water cooled Package AC - (Item no C-1 & D- 1 of Suggestive price format)	**14.64%**
3.12	Air cooled PAC units (Item no F-1 of Suggestive price format)	**0.51%**
3.13	Air cooled split type AC units (Item no F-2 of Suggestive price format)	**3.55%**
3.14	Fan coil units (Item no E-1 of Suggestive price format)	**0.28%**
3.15	Fire Dampers (Item no E-2 of Suggestive price format)	**0.93%**
3.16	GSS Duct work with airline accessories (Item no E-3 of Suggestive price format)	**10.26%**
3.17	Acoustic insulation (Item no E-4 &5 of Suggestive price format)	**3.44%**
3.18	Thermal Insulation (Item no E-6 of Suggestive price format)	**9.20%**
3.19	Field instruments - (Item no E-7 of Suggestive price format)	**2.44%**
3.20	PLC including cable (Item no E-8 & 9 of Suggestive price format)	**3.68%**
3.21	Handling Arrangment (Item no F -3 of Suggestive price format)	**0.27%**
3.22	Special Tools tackles & Commissioning Spares (Item no F-4 & 5 of Suggestive price format)	**0.11%**

Anshul S A Khan Praveen Kishore

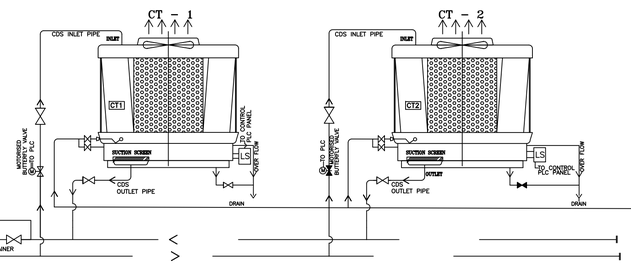
DRAWING NO. PE-DG-412-100-M003

FIRST ANGLE PROJECTION — ALL DIMENSIONS ARE IN MM

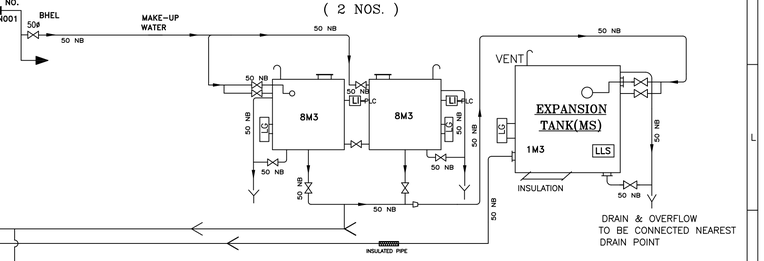
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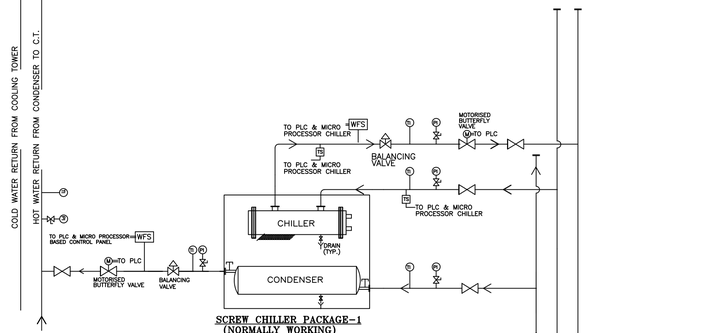
INDUCED DRAFT COOLING TOWER (1 WORKING & 1 STANDBY)

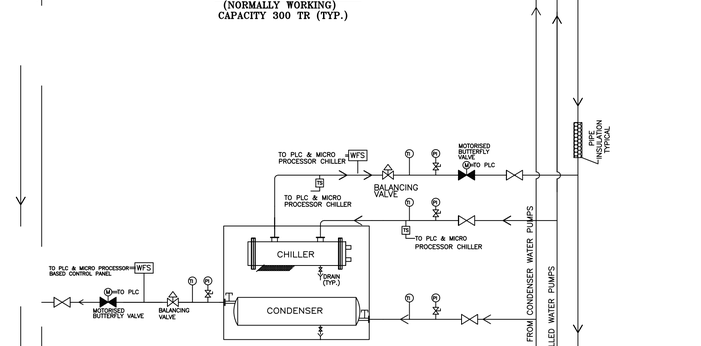


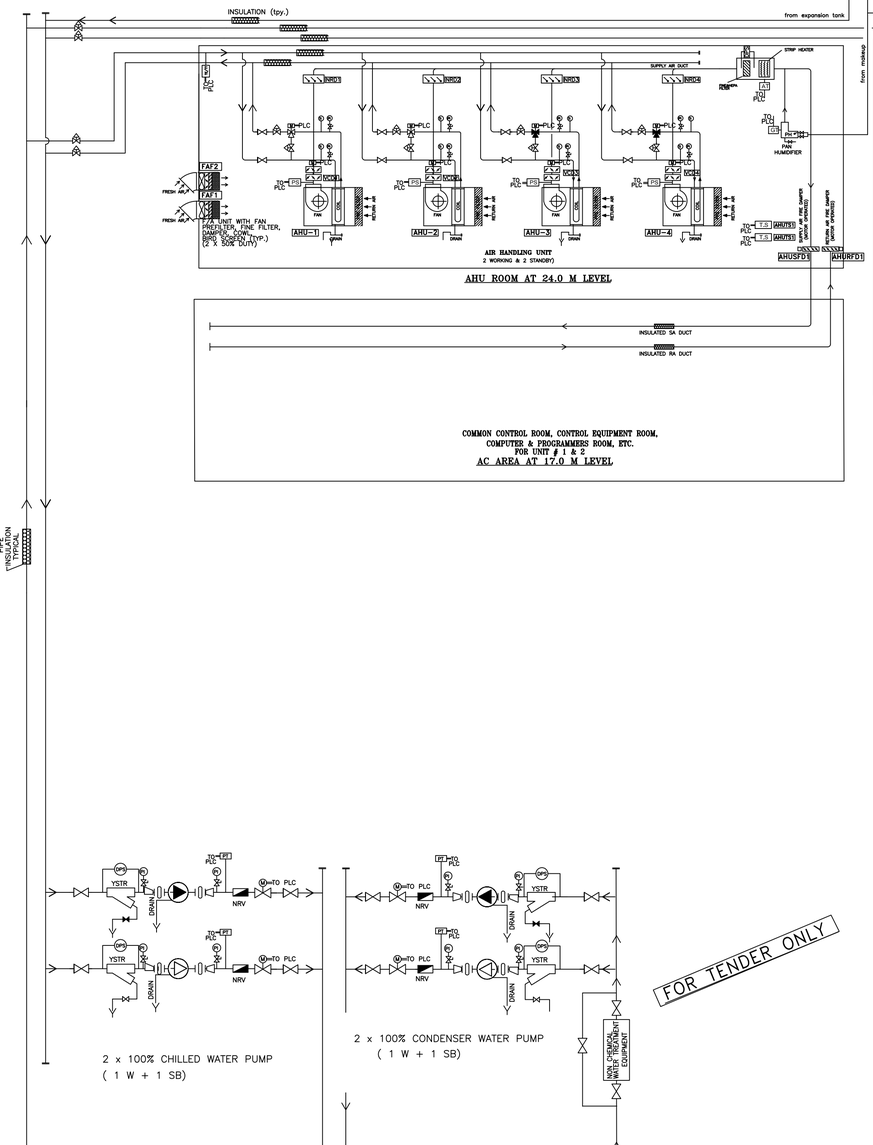
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FRP STORAGE TANKS (2 NOS.)







FOR TENDER ONLY

LEGEND :-

	EXPANSION BELLOW
TE/TT	TEMPERATURE WITH TRANSMITTER
PT	PRESSURE TRANSMITTER
WFS	WATER FLOW SWITCH
PS	PRESSURE SWITCH
AT	AIR STAT
GT	GYSERSTAT
	STRIP HEATER
	DUCT
	FINE FILTER
	PRE FILTER
VCD	VOLUME CONTROLDAMPER
LT	LEVEL GAUGE
LS	LEVEL SWITCH
	NON RETURN DAMPER
	PUMP
	PIPE
	PIPE
TI	TEMP.GAUGE,
PI	PRESSURE GAUGE,
TS	TEMP.SENSOR
R.H.S	R.H.SENSOR
PAN HUMIDIFIER	PAN HUMIDIFIER
	FIRE DAMPER(SOL)
	Y- STRAINER
	FLOAT VALVE
	NON RETURN VALVE
	3-WAY-4XNG.VALVE
	BALANCING VALVE
	GATE VALVE
M	MOTORISED BUTTER FLY VALVE
FT	FLOW TRANSMITTER
	ORIFICE PLATE
	POT STRAINER

GENERAL: –

1. THIS DRG. SHALL BE CONSIDERED AS MINIMUM TENDER REQUIREMENT . FINAL DRAWING SHALL BE AS PER CUSTOMER APPROVAL. THE EQUIPMENT/ INSTRUMENTS MAY CHANGE DURING DETAIL ENGINEERING.

NOTES :-

1 PIPING FOR CHILLED WATER AND CONDENSER WATER SHALL BE MS CONFORMING TO IS-1239,PART I HEAVY GRADE OR IS-3589 (DEPENDING UPON PIPE SIZE) AS PER TECHNICAL SPECIFICATION.
2 ALL CHILLED WATER PIPING SHALL BE INSULATED AS PER TECHINICAL SPECIFICATION.
3 ALL EQUIPMENT DRAIN SHALL BE CONNECTED TO NEAREST BUILDING/ PLANT ROOM DRAIN (BY AC SUPPLIER)
4 THE STANDBY CONDENSER WATER PUMPS, CHILLED WATER PUMPS & AHU'S SHALL BE STARTED AUTOMATICALLY WHEN THE WORKING EQUIPMENT ARE STOPPED / TRIPPED.

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	AG		21.04.2015
	DESN	AG		21.04.2015
	CHD	SAK		21.04.2015
	APPD	PK		21.04.2015

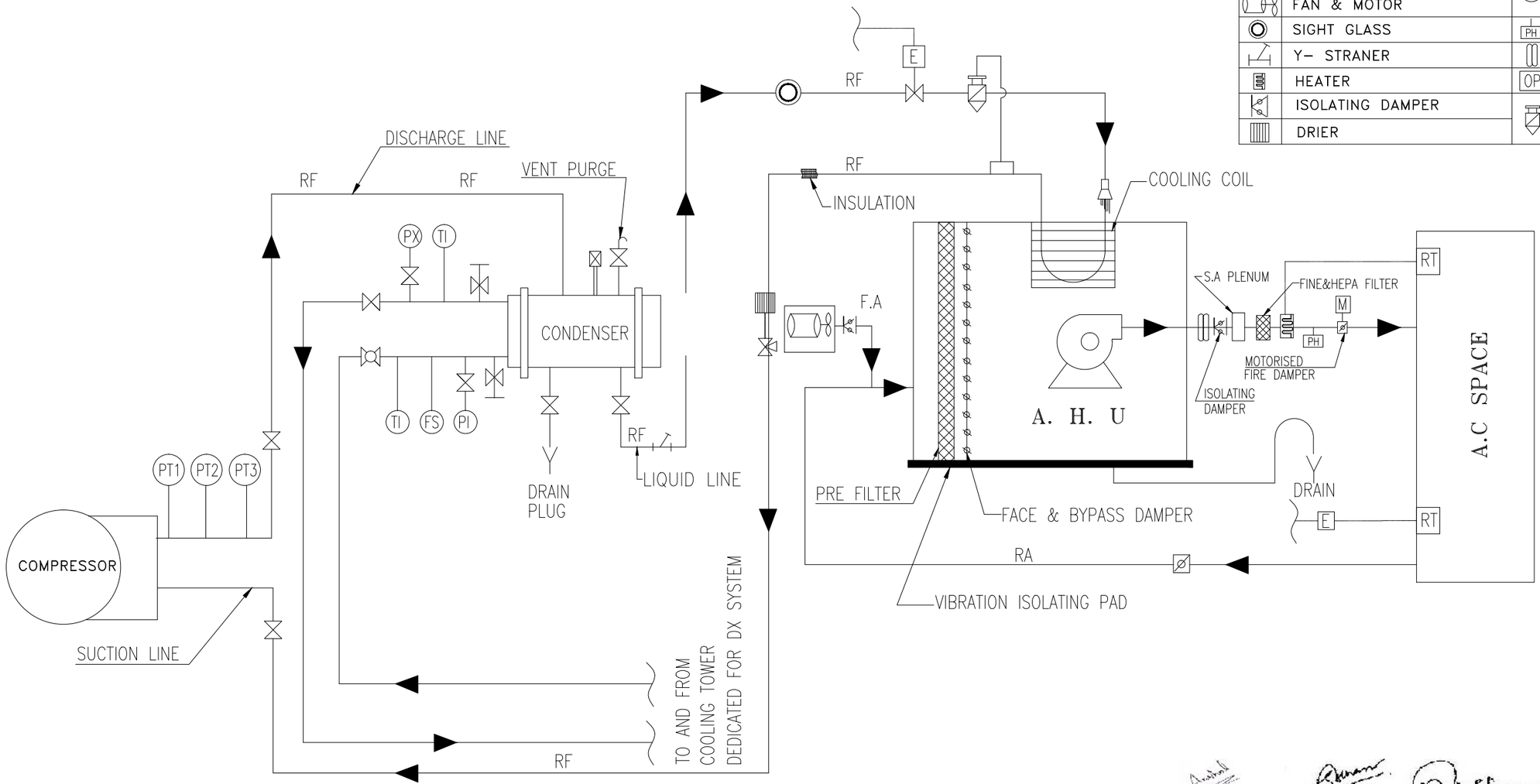
TITLE

DEPT. | SCALE: 1:300 | DRAWING NO. PE-DG-412-553-A001
SIGN
DATE
SHEET 1 OF 1 | REV. R0

FORMAT SIZE A0

LEGEND:–

⋈	GATE VALVE	(PX)	PRESSURE TEST PORT
⋈	GLOBE VALVE	(TI)	TEMPERATURE INDICATOR
⋈	PRESSURE RELIEF VALVE	(PI)	PRESSURE INDICATOR
⋈	ANGLE VALVE	(FS)	FLOW SWITCH
⋈	STOP VALVE	FA	FRESH AIR
E ⋈	SOLENOID VALVE	SA	SUPPLY AIR
		RA	RETURN AIR
RT	ROOM THERMOSTAD	RF	REFRIGERANT LINE
▨	AIR FILTER	(PT)	PRESSURE TRANSDUCER FOR HP,LP & OP
⊂⊃	FAN & MOTOR		
◎	SIGHT GLASS	PH	PAN HUMIDIFIER
⋈	Y– STRANER	▯	FLEXIBLE CONNECTION
▤	HEATER	OP	ROOM THERMOSTAT
⋈	ISOLATING DAMPER	▽	THERMOSTATIC EXPANSION VALVE
▥	DRIER		



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	REVISIONS	DATE	CIVIL	MECH.	ELEC.	C&I	H.O.D.
	0	FOR BID PURPOSE ONLY	04.05.13					

APPROVED

SELF – RELIANCE IN ENGINEERING

DESEIN

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**

DX TYPE AIR CONDITIONING SYSTEM

	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–4023

DWG.No. 111–15–6202 REV. 0

Sheet No. of

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it must not be used directly or indirectly in any way detrimental to the interest of the company.

COMPUTER FILE NAME:

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 & PAN HUMIDIFIER SHALL BE IN BIDDER'S SCOPE.
6. MAKE-UP WATER REQUIREMENT IS CONTINUOUS.

Anshul
S A Khan
Praveen Kishore

APPD	REV	DATE	ALTD	CHD	APPD	

I NO. 412
STATUS CONTRACT
DISTRIBUTION
TO
No.

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

CONTRACTOR
BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

DEPT CODE		NAME	SIGN	DATE
N	DRN	AG	SD	15.01.15
	DESN	AG	SD	15.01.15
	CHD	SAK	SD	15.01.15
	APPD	PK	SD	15.01.15

TITLE
SCHEMATIC DAIAGRAM FOR HVAC MAKE UP

DEPT.
SCALE
SIGN
DATE
DRAWING NO. PE-DG-412-553-A055.
SHEET 1 OF 1 REV 01

 SIZE-A0

DRAWING NO. PE-DG-412-100-M001

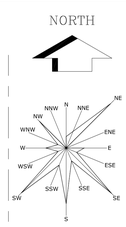
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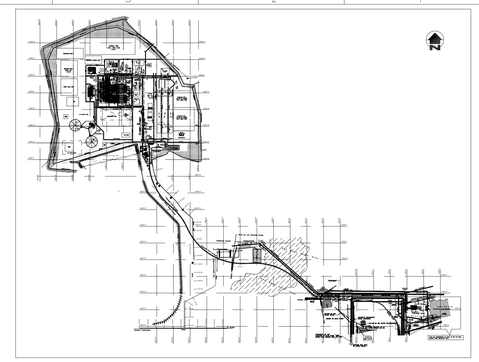
ALL DIMENSIONS ARE IN MM

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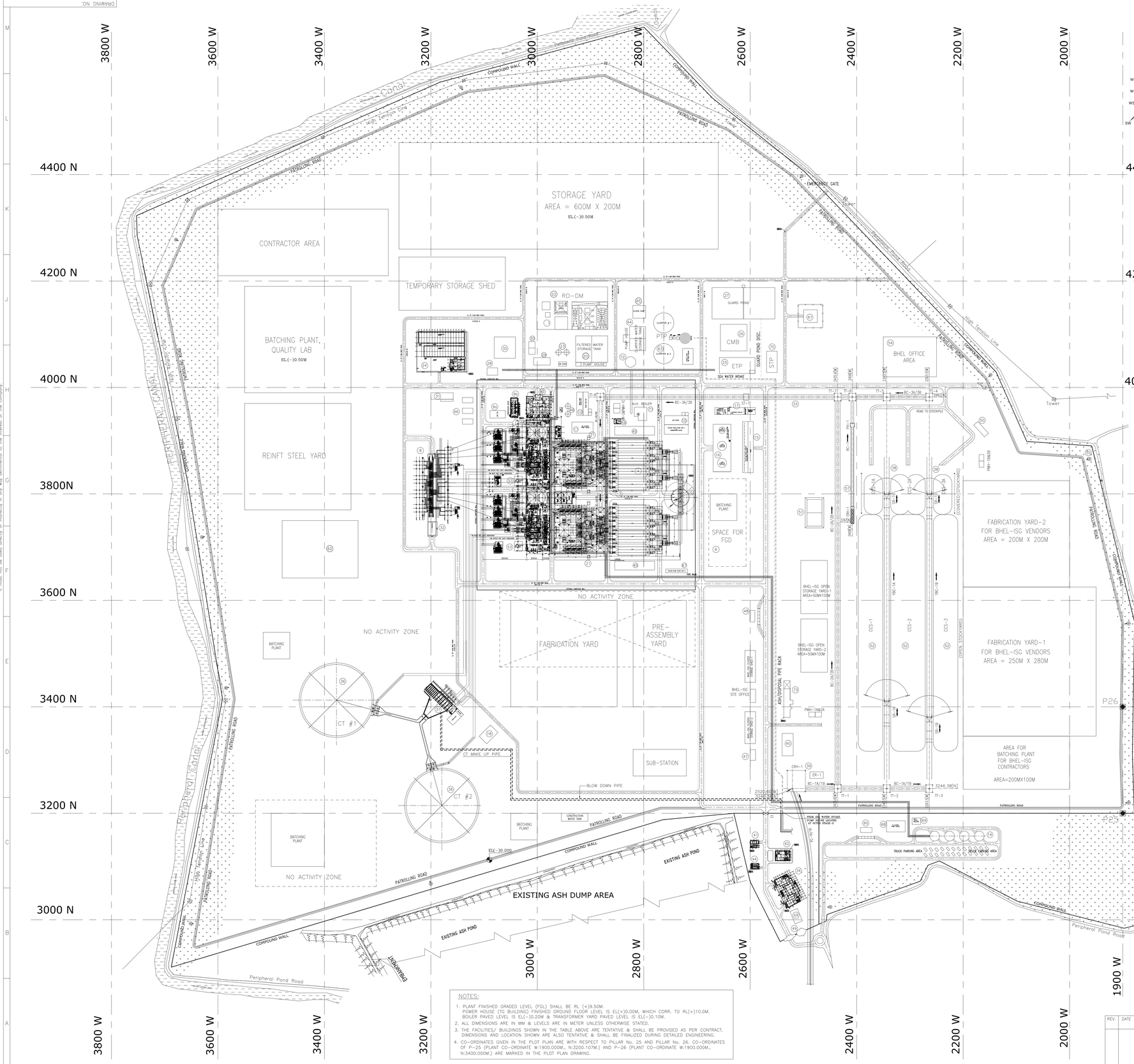
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NORTH





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.

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.

JOB NO. 412
STATUS CONTRACT
DISTRIBUTION

REV.	DATE	ALTD	CHD	APPD
01	20.02.15	SD	SK	JJ

01 DRAWING GENERALLY REVISED BASED ON CUSTOMER'S COMMENTS.

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

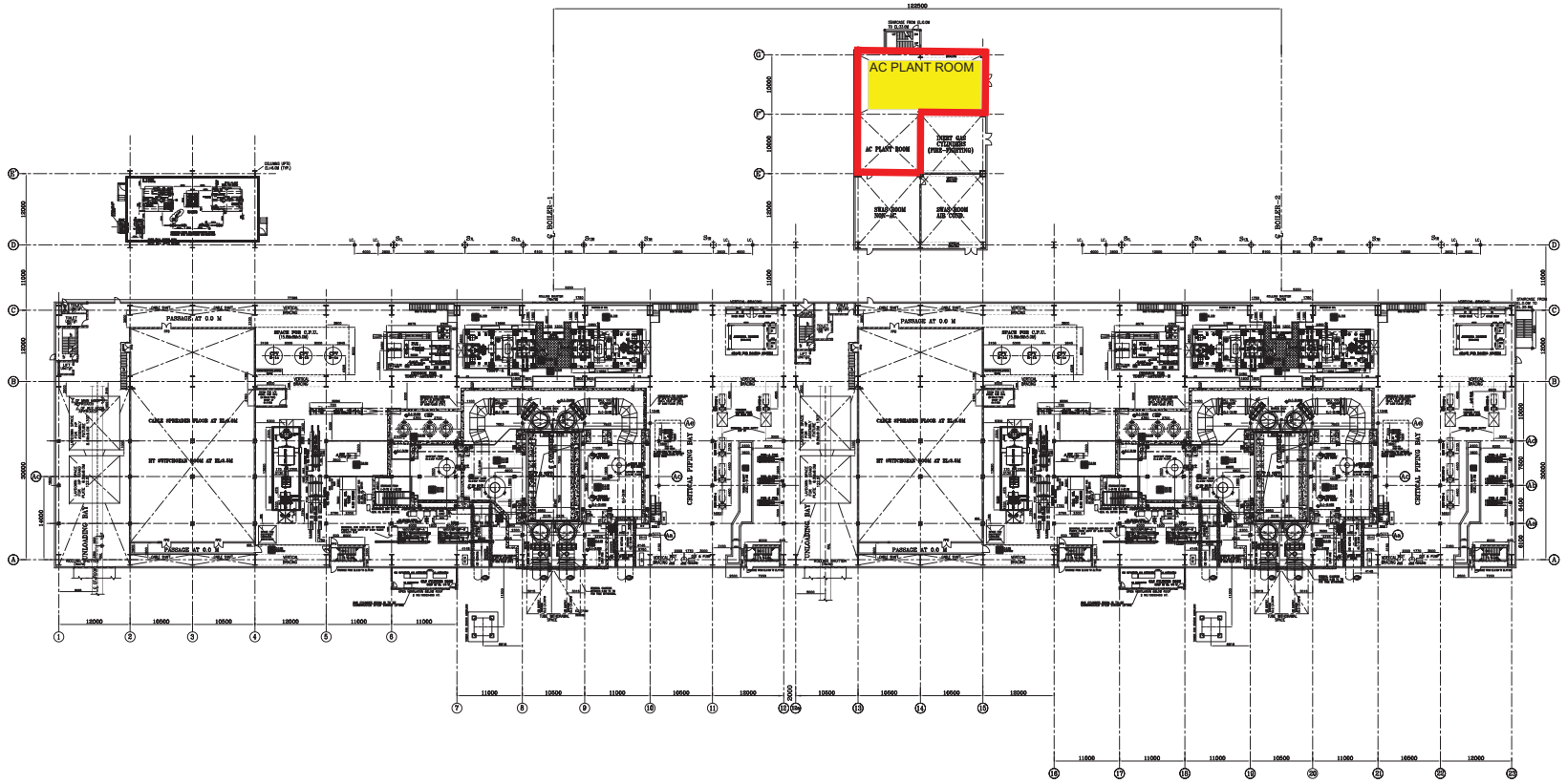
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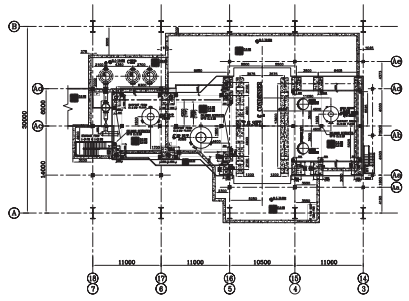
PLOT PLAN

DEPT. | SCALE: 1:2500 | DRAWING NO. PE-DG-412-100-M001
SIGN
DATE
SHEET 1 OF 1 | REV. 01

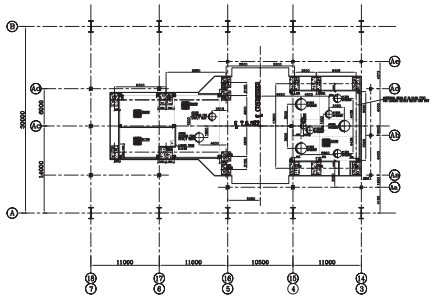
FORMAT SIZE A0

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PLATFORM AT EL.0.0M & EL.2.2M LEVEL
**(PLATFORM BEAMS/EC BEAMS TO BE RESTRICTED TO DEPTH OF 300MM)



PLATFORM AT EL.7.5M/EL.8.0M/EL.8.5M LEVEL
**(PLATFORM BEAMS/EC BEAMS TO BE RESTRICTED TO DEPTH OF 500MM)

NOTES:-
1. ALL DIMENSIONS ARE IN MMTS AND LEVELS ARE IN METRES.
2. ALL ELEVATIONS MENTIONED IN THE DWG. ARE W.R.T. POWER HOUSE GROUND FLOOR ELEVATION AS 0.00M, WHICH CORRESPONDS TO EL.(+)13.0M.
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-M004
2.	EQUIPMENT PLAN AT 17.0M	PE-DG-412-100-M005
3.	EQUIPMENT PLAN AT 24.0M/29.0M	PE-DG-412-100-M006
4.	CROSS SECTION OF BMN PLANT	PE-DG-412-100-M007
5.	CONDENSER ASSEMBLY (S.A.)	0100X70707/C008 (HBR)
6.	TG FOUNDATION ARRANGEMENT	--- (HBR)
7.	GLAND STEAM CONDENSER	--- (HBR)
8.	FOUNDATION DETAILS OF GEN. AUXILIARY EQUIPMENTS	--- (HBR)
9.	FOUNDATION ARRANGEMENT OF CEP	--- (HYD)
10.	GENERAL ARRANGEMENT OF DRAIN COOLER	--- (HYD)
11.	FOUNDATION DETAILS OF HPSU (VPRP VALVE)	--- (SH)
12.	VACUUM PUMP	--- (HBR)
13.	GA OF DOT & PUMP	--- (HBR)
14.	GA OF MOT	--- (HBR)
15.	PLOT PLAN OF TDBFP	--- (HYD)
16.	GA OF UP 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.	MIMIC & ADD. OF OIL UNLOADING VESSEL	--- (BPL)
23.	CPU SYSTEM	--- (PSN)
24.	GA OF CENTRAL OIL PURIFIER	--- (HBR)
25.	GA OF DOSING SKID	--- (PSN)
26.	PLOT PLAN OF MDBFP	--- (HYD)
27.	GA OF CELOCS	--- (PSN)
28.	GA OF PHCs	--- (PSN)
29.	GA OF CMDE PUMPS	--- (PSN)
30.	TURBINE JB LOT & LAYOUT	--- (HBR)

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

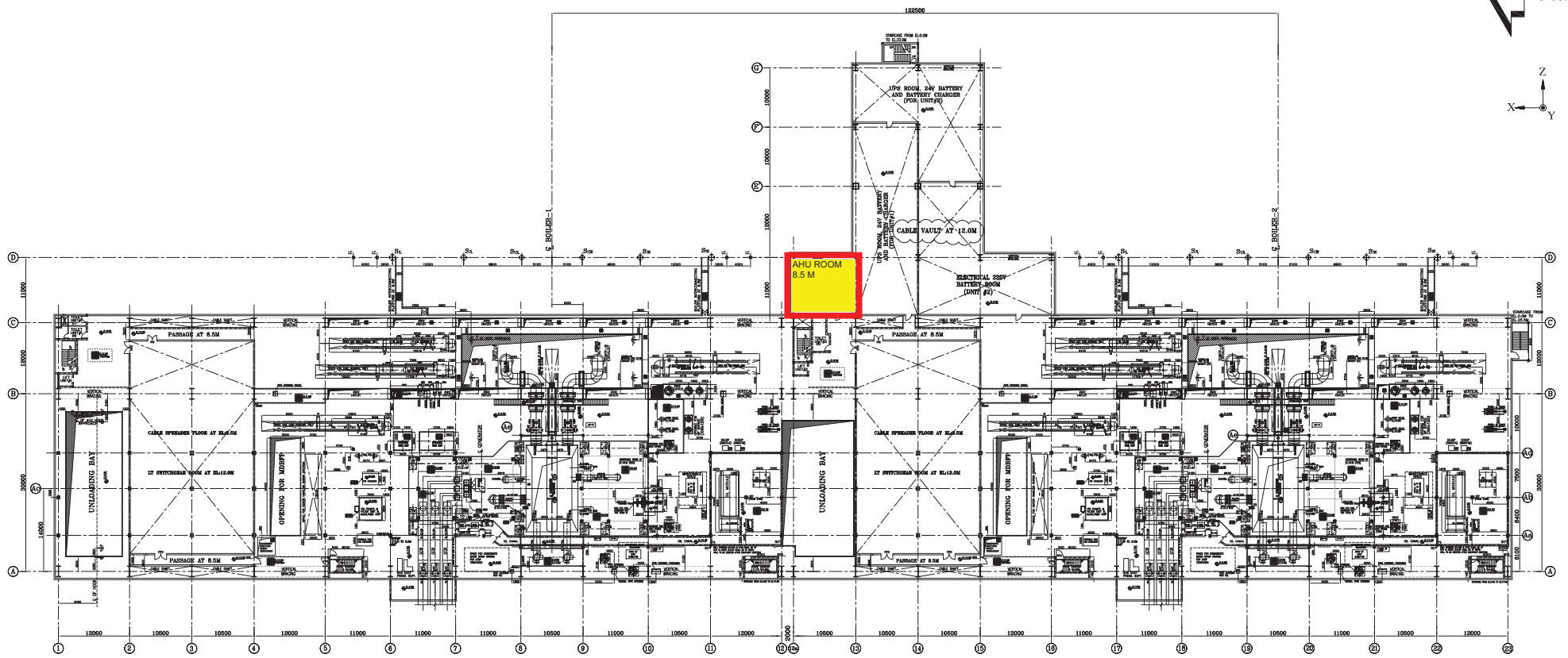
PROJECT: 2x660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI
CUSTOMER: TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
CONSULTANT: DESEIN PRIVATE LIMITED, DESEIN HOUSE, GREATER KAILASH-II, NEW DELHI
BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR, PROJECT ENGINEERING MANAGEMENT, NEW DELHI

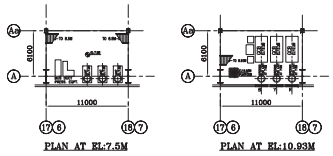
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DRN	SD	sd/--	04.12.2014
DES	TD	sd/--	04.12.2014
CHD	SK	sd/--	04.12.2014
APPD	JJ	sd/--	04.12.2014

TITLE: T.G. EQUIPMENT LAYOUT PLAN AT EL. 0.0M
SCALE: 1:300
DRAWING NO. PE-DG-412-100-M003
SHEET 1 OF 1
REV. R0
FORMAT SIZE A0

ELECTRONIC FILE NAME: 412_100_M003_R0.DWG

FIRST ANGLE PROJECTION | ALL DIMENSIONS ARE IN MM





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+110.0M.
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 (S.A.)	01601070070C208 (HHK)
6	GENERATOR OUTLINE	— (HHK)
7.	OIL ROOM ARRANGEMENT	— (HHK)
8	FOUNDATION DETAILS OF GEN. AUXILIARY EQUIPMENTS	— (HHK)
9.	LP BYPASS VALVE ARRANGEMENT	— (HHK)
10.	GENERAL ARRANGEMENT OF LP HEATER No.-1	— (HHK)
		HYD
		HYD
		HYD
		HYD
		HHK
		HHK
		HHK

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

	NAME	SIGN	DATE
DRN	SD	sd/—	04.12.2014
DES	TD	sd/—	04.12.2014
CHD	SK	sd/—	04.12.2014
APPD	JJ	sd/—	04.12.2014

TITLE: T.G. EQUIPMENT LAYOUT PLAN AT EL. 8.50M

SCALE: 1:250 | DRAWING NO. PE-DG-412-100-M004 | SHEET 1 OF 1 | REV. R0

FORMAT SIZE A0

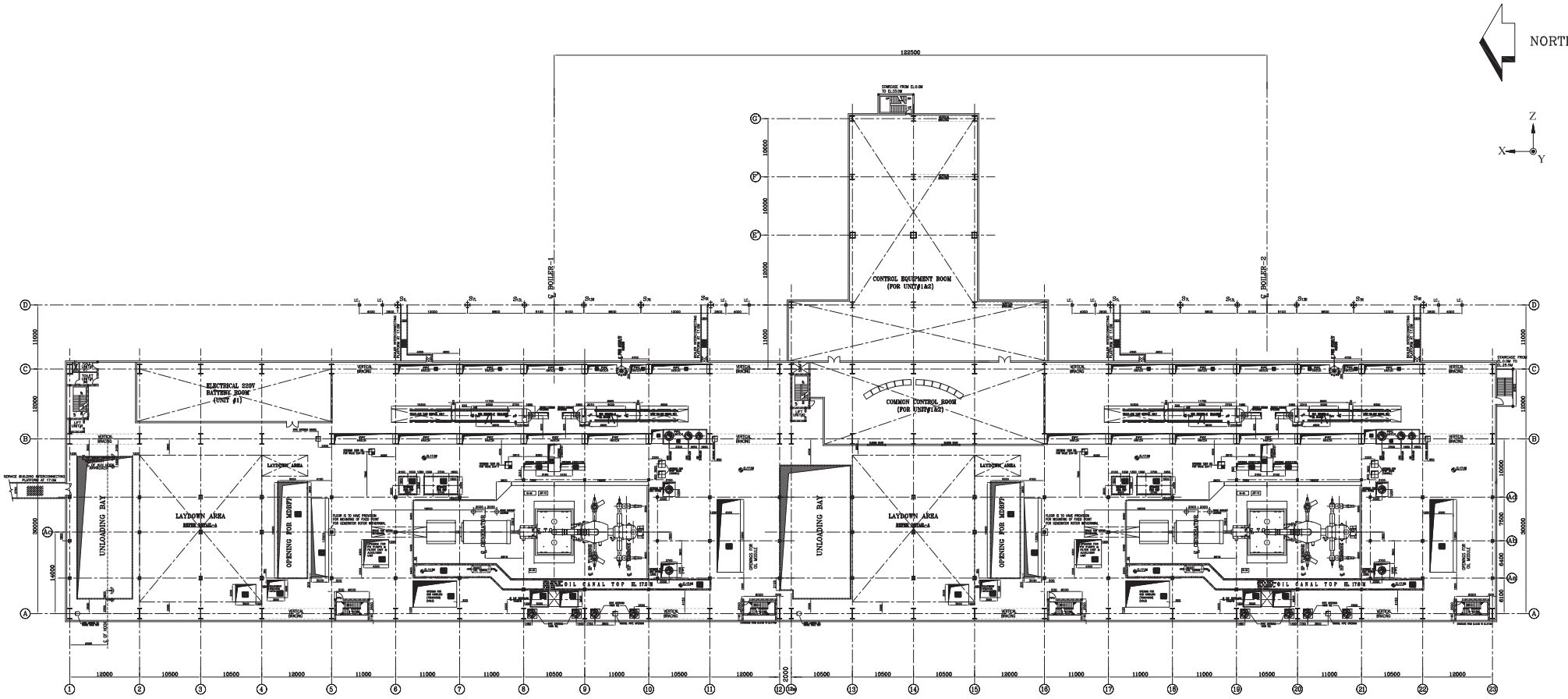
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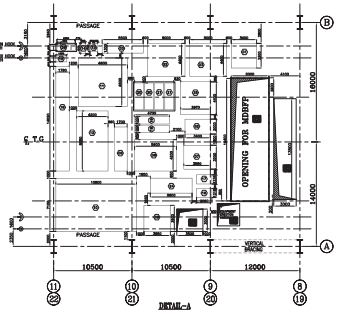
ELECTRONIC FILE NAME: 412_100_M004_R0.DWG

FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN MM

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DETAIL-A
LAY-DOWN SPACE FOR TG COMPONENTS

MODE OF LAY-DOWN SPACE FOR TG COMPONENTS

SYM	DESCRIPTION	WEIGHT (Kg)	SIZE (mm)
(1)	HP OUTER CASING (BOTTOM PART)	45000	5.0 X 3.0
(2)	HP INNER CASING UPPER HALF	17000	3.0 X 3.0
(3)	HP SHAFT	20000	6.0 X 1.5
(4)	HP STEAM PLATE (LOCATED AT 5.0M FLOOR)	120000	8.0 X 8.0
(5)	HP ASSEMBLY PIPEWORK (LOCATED AT 5.0M FLOOR)	120000	8.0 X 8.0
(6)	IPT OUTER CASING UPPER HALF	35000	8.0 X 4.0
(7)	IPT INNER CASING UPPER HALF	35000	3.00 X 3.0
(8)	IPT INNER CASING LOWER HALF	35000	3.00 X 3.0
(9)	IP SHAFT	32000	8.0 X 1.7
(10)	LP OUTER CASING UPPER HALF	40000	10.0 X 7.1
(11)	LP INNER CASING UPPER HALF	55000	8.0 X 8.0
(12)	LP SHAFT	120000	8.00 X 4.0
(13)	LP SHAFT WITH COUPLING (TG & GEN)	100 x 2	0.400 X 1.0
(14)	PEDESTAL UNDER-HP(BEARING CASING HP FRONT)	500	1.200 X 0.80
(15)	PEDESTAL UNDER-HP+IP(BEARING CASING HP REAR)	1000	1.40 X 0.70
(16)	PEDESTAL UNDER-IP+LP(BEARING CASING IP REAR)	2000	2.00 X 1.200
(17)	PEDESTAL UNDER-LP+GENERATOR(BEARING LP REAR)	2000	2.00 X 1.200
(18)	TURBINE FRONT PEDESTAL UNDER HP & IP BEARING (F-2)	7000 x 2	4.7 X 1.0
(19)	GENERATOR ROTOR WITH RIGID COUPLING	80000	14.000 X 1.70
(20)	GEN SHELLS UPPER & LOWER HALF (DE)	8000 x 2	1.0 X 3.0
(21)	GEN SHELLS UPPER & LOWER HALF (TE)	8000 x 2	1.0 X 3.0
(22)	HYDROGEN COOLER (2 NOS. TWIN TYPE)	10000 x 2	3.0 X 1.0
(23)	HYDROGEN COOLER HOUSING	15000	5.0 X 4.0
(24)	EXCITER	35000	6.0 X 3.0
(25)	EXCITER HOUSING	3000	4.0 X 3.0
(26)	BEARING SHELLS (TRIAD-UPPER & LOWER HALF)	800 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-00-412-100-M003
2.	EQUIPMENT PLAN AT 8.5M	PE-00-412-100-M004
3.	EQUIPMENT PLAN AT 24.0M/25.5M	PE-00-412-100-M006
4.	CROSS SECTION OF MAIN PLANT	PE-00-412-100-M007
5.	GENERAL ARRANGEMENT OF HP HEATER NO.–7	--- (VHT)
6.	GENERAL ARRANGEMENT OF HP HEATER NO.–8	--- (VHT)
7.	TG FOUNDATION PLAN	--- (VHR)
8.	GA OF FRSHG 7/T	--- (BPL)
9.	OIL CANAL DETAIL	--- (VHR)
10.	LAYDOWN SPACE FOR GENERATOR COMPONENTS	--- (VHR)
11.	LAYDOWN SPACE FOR STEAM TURBINE COMPONENTS	--- (VHR)
12.	OIL ROOM ARRANGEMENT	--- (VHR)
13.	LP BYPASS ARRANGEMENT	--- (VHR)
14.	CCR/ CER ROOM LAYOUT	--- (PCM)

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
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POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI

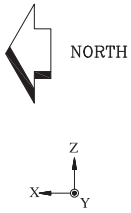
DEPT CODE	NAME	SIGN	DATE
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DES	TD	sd/–	04.12.2014
CHD	SK	sd/–	04.12.2014
APPD	JJ	sd/–	04.12.2014

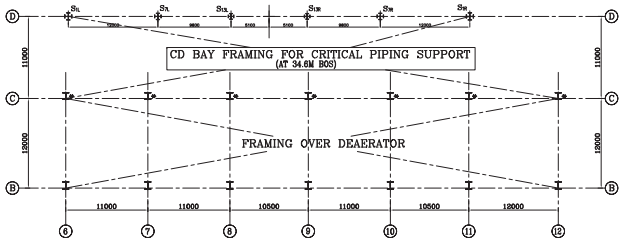
TITLE: T.G. EQUIPMENT LAYOUT PLAN AT EL. 17.0M

SCALE: 1:250
DRAWING NO. PE–DG–412–100–M005
SHEET 1 OF 1
REV. R0
FORMAT SIZE A0

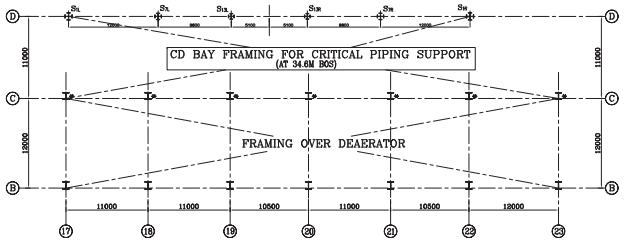
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FIRST ANGLE PROJECTION
ALL DIMENSIONS ARE IN MM

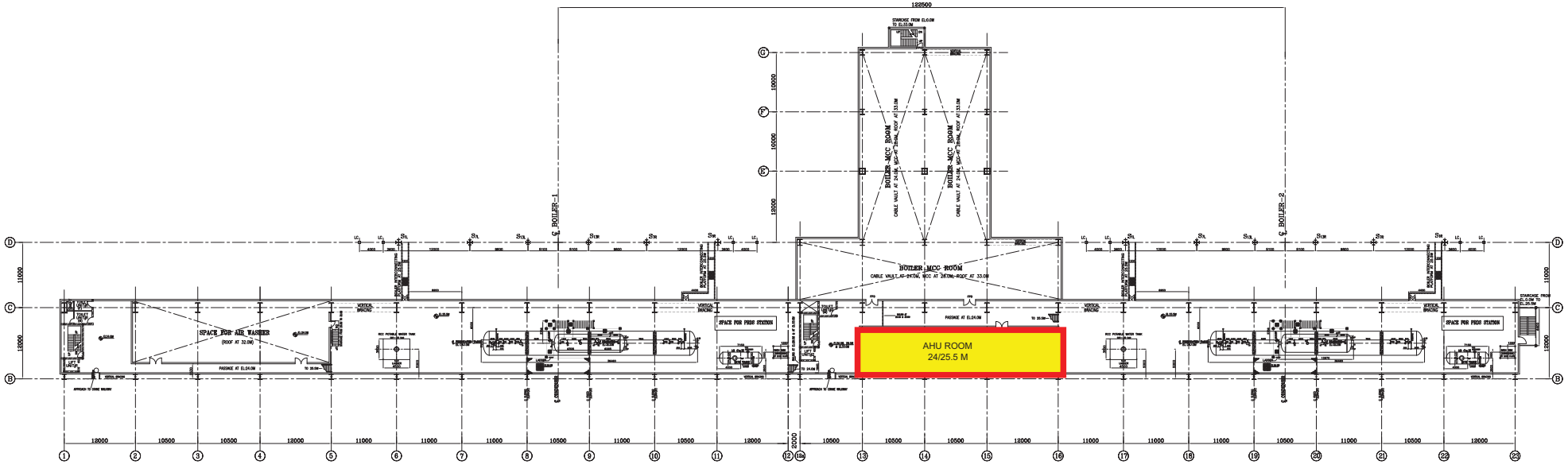




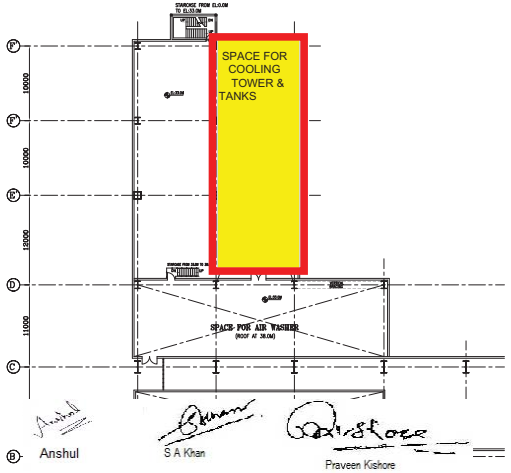
PLAN AT EL:37.5M (TOS)



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)

Anshul S A Khan Praveen Kishore

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

REV.	DATE	ALTD	CHD	APPD

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI

	NAME	SIGN	DATE
DRN	SD		04.12.2014
DES	TD		04.12.2014
CHD	SK		04.12.2014
APPD	JJ		04.12.2014

TITLE: T.G. EQUIPMENT LAYOUT PLAN AT EL. 24.0M/ 25.5M

SCALE: 1:250
DRAWING NO. PE-DG-412-100-M006
SHEET 1 OF 1
REV. R0
FORMAT SIZE A0

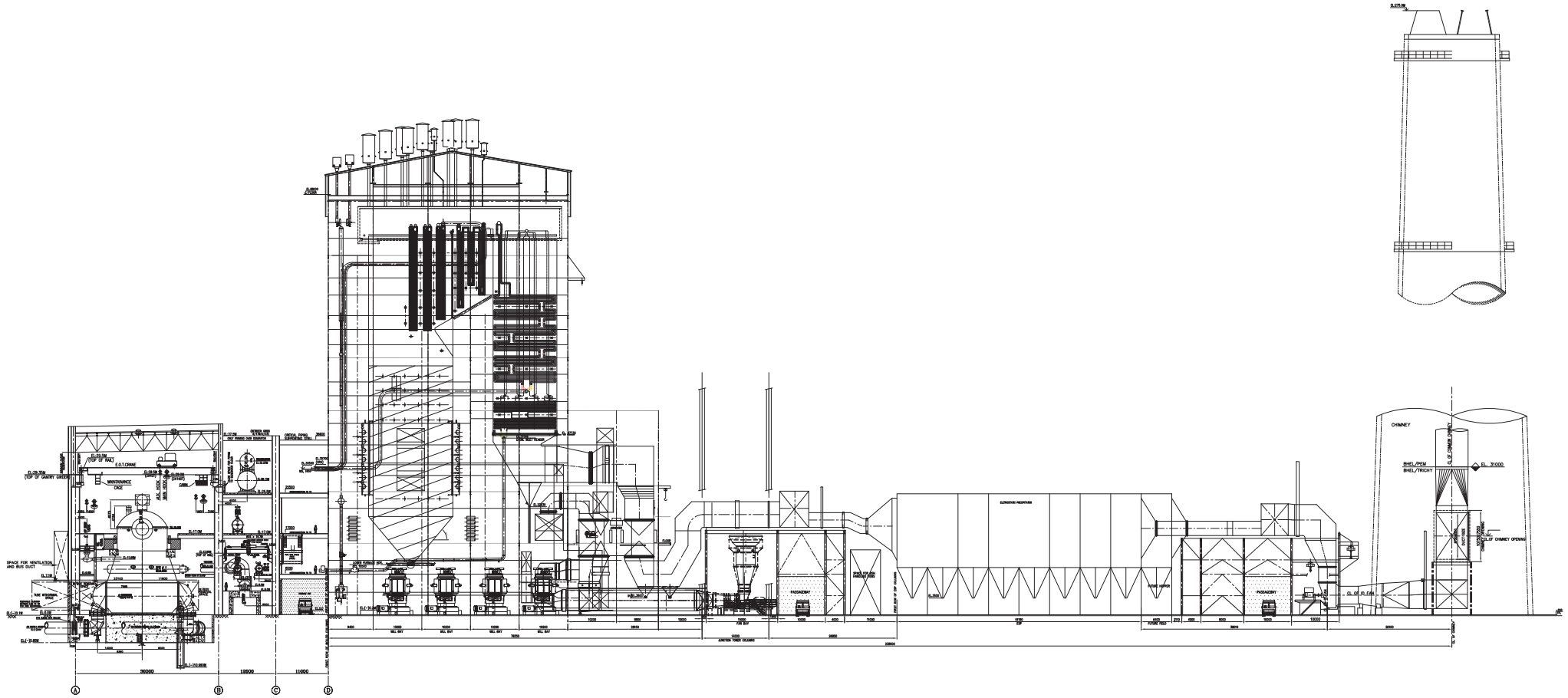
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ELECTRONIC FILE NAME: 412_100_M006_R0.DWG

FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN MM

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REFERENCE DRAWINGS:

1.	MAIN EQUIPMENT PLAN LAYOUT	PE-DG-412-100-M002
2.	EQUIPMENT PLAN AT 0.0M	PE-DG-412-100-M003
3.	EQUIPMENT PLAN AT 8.5M	PE-DG-412-100-M004
4.	EQUIPMENT PLAN AT 17.0M	PE-DG-412-100-M005
5.	EQUIPMENT PLAN AT 24.0M/ 25.5M	PE-DG-412-100-M006
6.	GA OF BOILER SECTIONAL SIDE ELEVATION	--- (TRY)
7.	GA OF ID SYSTEM SIDE ELEVATION	--- (TRY)
8.	GA OF CHIMNEYS	412/100/DG/M008 (NEW)

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(+)10.00M.
3. EQUIPMENT SIZES SHOWN IN THIS DRAWING ARE INDICATIVE ONLY, THE SAME SHALL BE FINALIZED DURING DETAILED ENGINEERING.

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

	CODE	NAME	SIGN	DATE
DRN	SD		sd/--	04.12.2014
DES'N	TM		sd/--	04.12.2014
CHD	SK		sd/--	04.12.2014
APPD	JJ		sd/--	04.12.2014

TITLE: CROSS SECTION OF MAIN PLANT

SCALE: 1:300

DRAWING NO. PE-DG-412-100-M007

SIGN

DATE

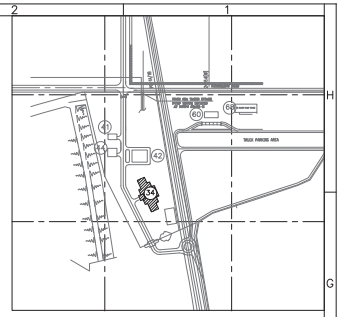
SHEET 1 OF 1

REV. R0

FORMAT SIZE A0

ELECTRONIC FILE NAME: 412_100_M007_R0.DWG

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FIRST ANGLE PROJECTION
ALL DIMENSIONS ARE IN MM
DRAWING NO. PE-DG-412-641-C001



KEY PLAN

PACKAGE AC ROOM

PACKAGE AC ROOM

1000MM WIDE PLINTH PROTECTION ALLROUND

WALL/LINTEL TO BE DONE AFTER INSTALLATION OF EQUIPMENTS

13NO EQ. RISERS
12NO TRADES@250

14NO EQ. RISERS
13NO TRADES@300

LIBRARY A/C

CONFERENCE ROOM A/C

FIRST AID ROOM A/C

RECEPTION

PRINTER ROOM 3435X3385 A/C

LADIES TOILET

GENTS' TOILET

SAFETY AND WELFARE CELL

TOILET

ATM 2395X3655

PANTRY 2795X3655

BANK EXTENSION COUNTER A/C

TELECOMMUNICATION/ EPBAX ROOM A/C

A T R I U M
EL(−)0.165M.

1000 MM HIGH RAILING AS PER SPECIFICATION (TYP)

SECURITY ROOM 3770X5470

LOBBY

ENTRANCE

OFFICE SPACE FFL(±)0.00 A/C

STORE 3155X5770

PANTRY

MCC ROOM

POST OFFICE FFL(±)0.00 A/C

PORCH

115THK BRICK WORK UPTO 4.25M

160mm ø HDPE RAIN WATER PIPE (TYP)

600 MM HIGH BRICK WALL(TYP) PLANTER

PLANTATION EL(−)0.50M

450 HIGH BRICK WORK

RAMP SLOPE 1:10

450MM WIDE SUNSHADE (TYP)

750MM WIDE SUNSHADE (TYP)

350 MM THK. BRICK WORK UP TO 450 MM HEIGHT ON EITHER SIDE OF RAMP

ENTRY
EL(−)0.500M.

EL(−)0.330M.

EL(−)0.165M.

EL(−)0.500M.

NOTES

1. ALL DIMENSIONS ARE IN MILIMETERS AND ELEVATIONS IN METERS UNLESS NOTED.
2. ALL ELEVATIONS ARE REFERRED TO THE FINISHED GROUND FLOOR LEVEL OF POWER HOUSE BUILDING AS EL. 0.00 M WHICH CORRESPONDS TO RL. +10.00 M.
3. UNLESS NOTED OTHERWISE WINDOW / DOOR/ ROLLING SHUTTER LOCATION SHALL BE AT CENTER BETWEEN GRIDS.
4. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH CONTRACT TERMS AND CONDITIONS, SPECIFICATION AND SCHEDULE OF ITEMS.

REFERENCE DRAWINGS:-

1. FOR GENERAL NOTES REFER DRAWING NO. ---PE-DG-412-611-C031
2. PLOT PLAN ---------- PE-DG-412-100-M001
3. ARCH. PLAN AT EL+4.25M ---------- PE-DG-412-641-C002
4. ARCH. PLAN AT EL+8.50M ---------- PE-DG-412-641-C003
5. FINISHING DETAILS ---------- PE-DG-412-641-C011

GROUND FLOOR PLAN AT EL(±)0.00M

(*)=DOORS MARKED WITH (*) ARE PART OF ALUMINIUM PARTITION

BHEL-PROJECT ENGINEERING MANAGEMENT(CIVIL)			
THIS DRAWING MARKED(✓) IS RELEASED FOR			
☐ COMMENTS/APPROVAL			
☐ PLANNING/INFORMATION			
☐ CONSTRUCTION			
STAMP ALL PREVIOUS REVISION AS SUPERSEDED			
ISSUED BY			
NAME	S.PANDIT		
SIGNATURE			
DATE			

JOB NO.	412
STATUS	CONTRACT
DISTRIBUTION	
TO	
No. OF	

PROJECT: 2x660 MW ENNORE SEZ SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI

OWNER: TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED

CONSULTANT: DESEIN PRIVATE LIMITED, DESEIN HOUSE, NEW DELHI

BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR, PROJECT ENGINEERING MANAGEMENT, NEW DELHI

DEPT CODE		NAME	SIGN	DATE
C	DRN	USHA		04.02.2015
	DESN	SB		04.02.2015
	CHD	S.PANDIT		04.02.2015
	APPD	A.NARAYAN		04.02.2015

TITLE: ADMINISTRATIVE BUILDING ARCHITECTURAL PLAN AT EL(±)0.00M

DRAWING NO. PE-DG-412-641-C001

SHEET 1 OF 1 REV. 0

REV.	DATE	ALTD	CHD	APPD

Anshul | S A Khan | Praveen Kishore

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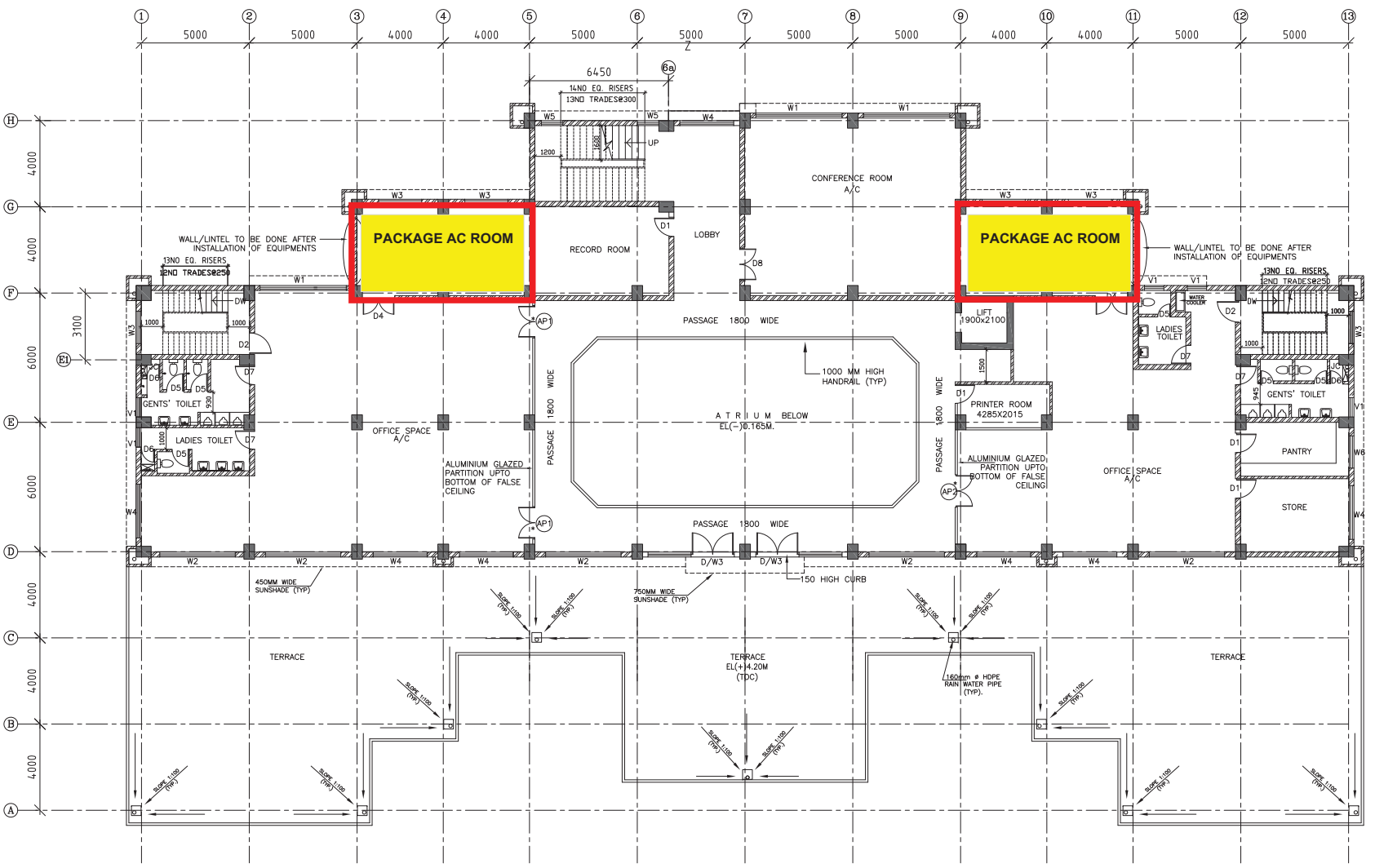
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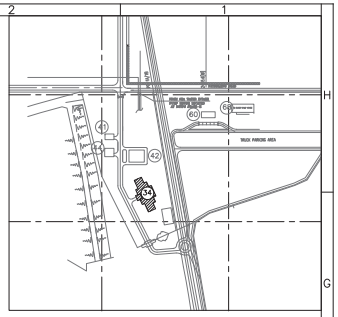
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FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN MM

DRAWING NO. PE-DG-412-641-C002





KEY PLAN

REFERENCE DRAWINGS:-

1. FOR GENERAL NOTES REFER DRAWING NO. ----PE-DG-412-611-C031
2. PLOT PLAN ---------- PE-DG-412-100-M001
3. ARCH. PLAN AT EL+0.00M ---------- PE-DG-412-641-C001
4. ARCH. PLAN AT EL+8.50M ---------- PE-DG-412-641-C003
5. FINISHING DETAILS ---------- PE-DG-412-641-C011

FIRST FLOOR PLAN AT EL(+) 4.25M

(*)=DOORS MARKED WITH (*) ARE PART OF ALUMINIUM PARTITION

BHEL-PROJECT ENGINEERING MANAGEMENT(CIVIL)

THIS DRAWING MARKED (✓) IS RELEASED FOR
- ☐ COMMENTS/APPROVAL
- ☐ PLANNING/INFORMATION
- ☐ CONSTRUCTION

STAMP ALL PREVIOUS REVISION AS SUPERSEDED

ISSUED BY	
NAME	S.PANDIT
SIGNATURE	
DATE	

PROJECT: 2x660 MW ENNORE SEZ SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI

OWNER: TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED

CONSULTANT: DESEIN PRIVATE LIMITED, DESEIN HOUSE, NEW DELHI

BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR, PROJECT ENGINEERING MANAGEMENT, NEW DELHI

DEPT CODE		NAME	SIGN	DATE
C	DRN	USHA		04.02.2015
	DESN	SB		04.02.2015
	CHD	S.PANDIT		04.02.2015
	APPD	A.NARAYAN		04.02.2015

JOB NO. 412

STATUS CONTRACT

DISTRIBUTION

TO

No. OF

REV.	DATE	ALTD	CHD	APPD

Anshul | S A Khan | Praveen Kishore

TITLE: ADMINISTRATIVE BUILDING ARCHITECTURAL PLAN AT EL(+) 4.25M

DEPT. | SCALE: | DRAWING NO. PE-DG-412-641-C002

SIGN | DATE | SHEET 1 OF 1 | REV. 0

FORMAT SIZE A1

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PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT
FIRST ANGLE PROJECTION
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DRAWING NO. PE-DG-412-641-C003

PLANT NORTH

SPACE FOR COOLING TOWER & TANKS

MACHINE ROOM EL(+)9.05M FFL

CAGE LADDER

LIFT

TRAP DOOR 1200 X 2000

450MM WIDE SUNSHADE (TYP)

760MM WIDE SUNSHADE (TYP)

EL(+)9.25M (FFL)

4NO EQ. RISER TREADS @ - 250

SPACE FOR SERVICE WATER TANK 1X1000 lt.

SHAFT

DETAIL-A

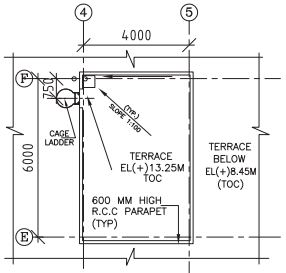
TERRACE EL(+)11.5M (TOC)

1000 MM HIGH R.C.C PARAPET (TYP)

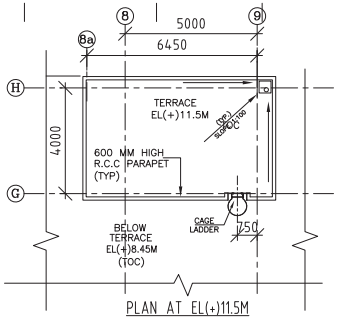
LOW TERRACE EL(+)4.20M (TOC)

160mm ø HDPE RAIN WATER PIPE (TYP).

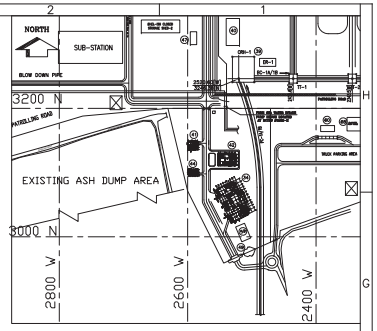
ROOF PLAN AT EL(+)8.45M



PLAN AT EL(+)13.25M
(FOR MACHINE ROOM ROOF)



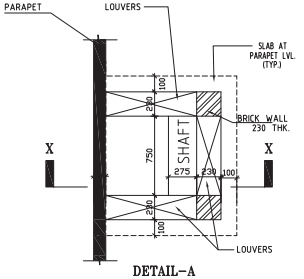
PLAN AT EL(+)11.5M
(FOR STAIRCASE ROOF)



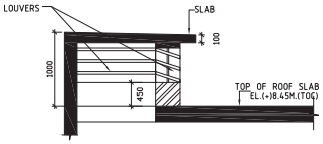
KEY PLAN

REFERENCE DRAWINGS:-

1. FOR GENERAL NOTES REFER DRAWING NO. ---PE-DG-412-611-C031
2. PLOT PLAN ---------- PE-DG-412-100-M001
3. ARCH. PLAN AT EL+0.00M ---------- PE-DG-412-641-C001
4. ARCH. PLAN AT EL+4.25M ---------- PE-DG-412-641-C002
5. FINISHING DETAILS ---------- PE-DG-412-641-C011



DETAIL-A



SECTION X-X

BHEL-PROJECT ENGINEERING MANAGEMENT(CIVIL)
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☐ PLANNING/INFORMATION
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NAME S.PANDIT
SIGNATURE
DATE

PROJECT: 2x660 MW ENNORE SEZ SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI

OWNER: TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED

CONSULTANT: DESEIN PRIVATE LIMITED, DESEIN HOUSE, 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
C	DRN	USHA		11.03.2015
	DESN	SB		11.03.2015
	CHD	S.PANDIT		11.03.2015
	APPD	A.NARAYAN		11.03.2015

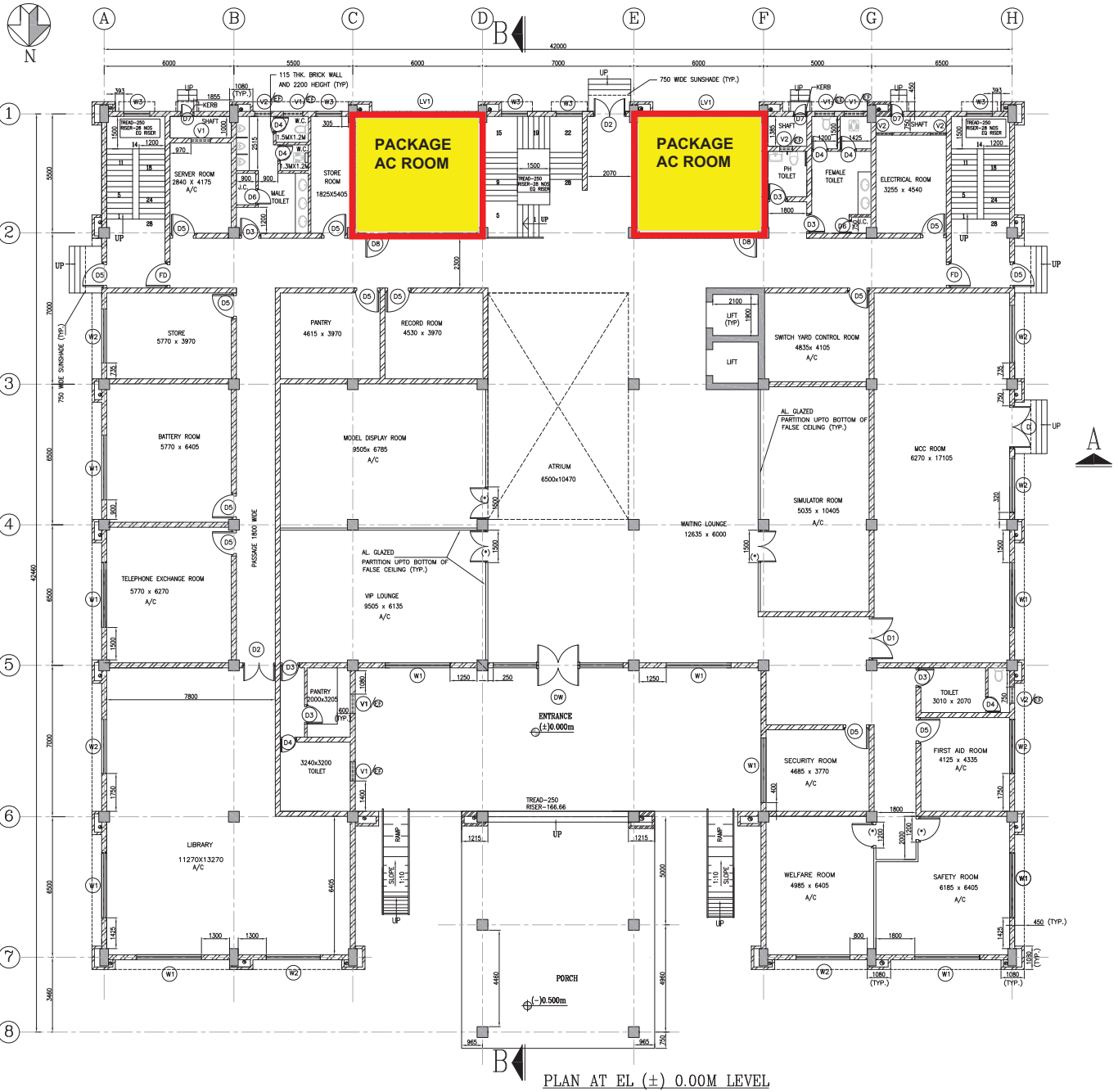
TITLE: ADMINISTRATIVE BUILDING
ROOF PLAN AT EL (+) 8.45M

DEPT. | SCALE: | DRAWING NO. PE-DG-412-641-C003
SIGN | DATE | SHEET 1 OF 1 | REV. 0

REV.	DATE	ALTD	CHD	APPD
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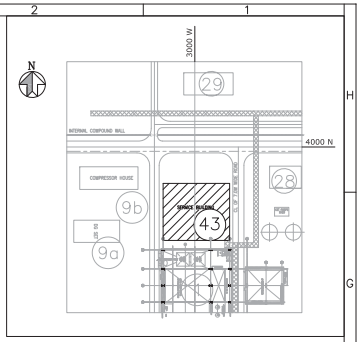
Anshul | S A Khan | Praveen Kishore

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FORMAT SIZE A1



PLAN AT EL (±) 0.00M LEVEL

(*)= DOORS MARKED WITH (*) ARE PART OF ALUMINIUM PARTITION



KEY PLAN

NOTES

1. ALL DIMENSIONS ARE IN MILIMETERS AND ELEVATIONS IN METERS UNLESS NOTED.
2. ALL ELEVATIONS ARE REFERRED TO THE FINISHED GROUND FLOOR LEVEL OF POWER HOUSE BUILDING AS EL. 0.00 M WHICH CORRESPONDS TO RL. +10.00 M.
3. UNLESS NOTED OTHERWISE WINDOW / DOOR/ ROLLING SHUTTER LOCATION SHALL BE AT CENTER BETWEEN GRIDS.
4. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH CONTRACT TERMS AND CONDITIONS, SPECIFICATION AND SCHEDULE OF ITEMS.
5. ALUMINIUM GRILL SHOULD BE PROVIDED TO ALL WINDOWS AT GROUND FLOOR

ARCH. REF. DWG.

1. PLOT PLAN ---------- PE-DG-412-100-M001
2. ARCH. PLAN AT EL+4.250M ---------- PE-DG-412-640-C002
3. ARCH. PLAN AT EL+8.500M ---------- PE-DG-412-640-C003
4. ARCH. PLAN AT EL+12.750M ---------- PE-DG-412-640-C004
5. ARCH. PLAN AT EL+17.000M ---------- PE-DG-412-640-C005
6. DOOR WINDOWS AND FINISHING SCHEDULE --- PE-DG-412-640-C006
7. WINDOWS DETAILS ---------- PE-DG-412-640-C013
8. DOOR AND PARTITION DETAILS ---------- PE-DG-412-640-C014
9. TOILET DETAILS ---------- PE-DG-412-640-C015
10. FOR GENERAL NOTES REFER DRAWING NO. – PE-DG-412-611-C031

LEGENDS

1. J.C -------JANITOR CLOSET
2. T.O.C ------TOP OF CONCRETE
3. F.G.L ------FINISHED GROUND LEVEL
4. B.O.L ------BOTTOM OF LINTEL
5. F.F.L ------FINISHED FLOOR LEVEL
6. TYP -------TYPICAL
7. THK.--------THICK
8. LVL --------LEVEL
9. EX --------EXHAUST FAN
10. P.H -------PHYSICALLY HANDICAPPED

BHEL-PROJECT ENGINEERING MANAGEMENT(CIVIL)	
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SIGNATURE	
DATE	02.02.2015

REV.	DATE	ALTD	CHD	APPD
A				

Anshul — S A Khan — Praveen Kishore

JOB NO.	412
STATUS	CONTRACT
DISTRIBUTION	
TO	
No. OF	

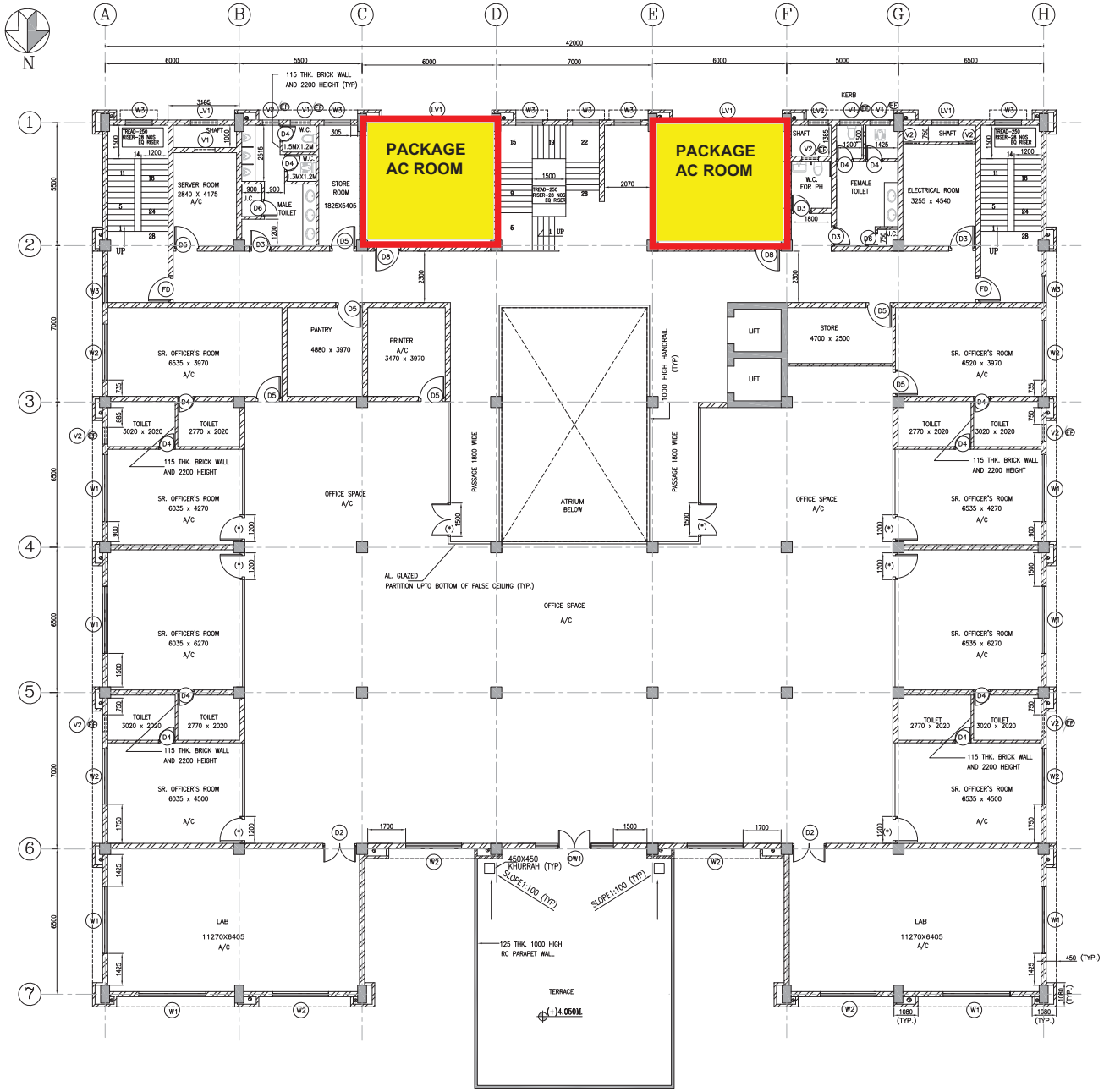
PROJECT	2x660 MW ENNORE SEZ SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI
OWNER:	TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED
OWNER'S CONSULTANT:	DESEIN PRIVATE LIMITED DESEIN HOUSE, NEW DELHI
	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NEW DELHI

DEPT CODE		NAME	SIGN	DATE
C	DRN	OM		02.02.2015
	DESN	SB		02.02.2015
	CHD	S. PANDIT		02.02.2015
	APPD	A. NARAYAN		02.02.2015

TITLE: SERVICE BUILDING
ARCHITECTURAL PLAN AT EL (±) 0.000M LEVEL

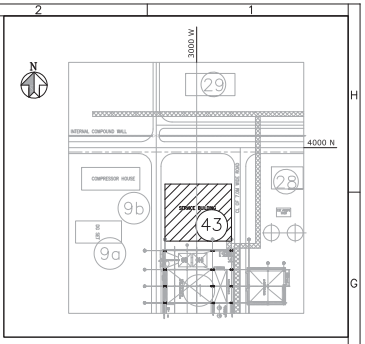
DEPT.	SCALE:	DRAWING NO.
SIGN		PE-DG-412-640-C001
DATE	SHEET 1 OF 1	REV. 0

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PLAN AT EL (+) 4.25M LEVEL

(*)= DOORS MARKED WITH (*) ARE PART OF ALUMINIUM PARTITION



KEY PLAN

NOTES

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4. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH CONTRACT TERMS AND CONDITIONS, SPECIFICATION AND SCHEDULE OF ITEMS.

ARCH. REF. DWG.

1. PLOT PLAN ---------- PE-DG-412-100-M001
2. ARCH. PLAN AT EL+0.000M ---------- PE-DG-412-640-C001
3. ARCH. PLAN AT EL+8.500M ---------- PE-DG-412-640-C003
4. ARCH. PLAN AT EL+12.750M ---------- PE-DG-412-640-C004
5. ARCH. PLAN AT EL+17.000M ---------- PE-DG-412-640-C005
6. DOOR WINDOWS AND FINISHING SCHEDULE ---- PE-DG-412-640-C006
7. WINDOWS DETAILS ---------- PE-DG-412-640-C013
8. DOOR AND PARTITION DETAILS ---------- PE-DG-412-640-C014
9. TOILET DETAILS ---------- PE-DG-412-640-C015
10. FOR GENERAL NOTES REFER DRAWING NO. – PE-DG-412-611-C031

LEGENDS

1. J.C ------JANITOR CLOSET
2. T.O.C -----TOP OF CONCRETE
3. F.G.L -----FINISHED GROUND LEVEL
4. B.O.L -----BOTTOM OF LINTEL
5. F.F.L -----FINISHED FLOOR LEVEL
6. TYP -------TYPICAL
7. THK.--------THICK
8. LVL --------LEVEL
9. EX --------EXHAUST FAN
10. P.H -------PHYSICALLY HANDICAPPED

BHEL–PROJECT ENGINEERING MANAGEMENT(CIVIL)		
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SIGNATURE		
DATE	02.02.2015	

REV.	DATE	ALTD	CHD	APPD
A				

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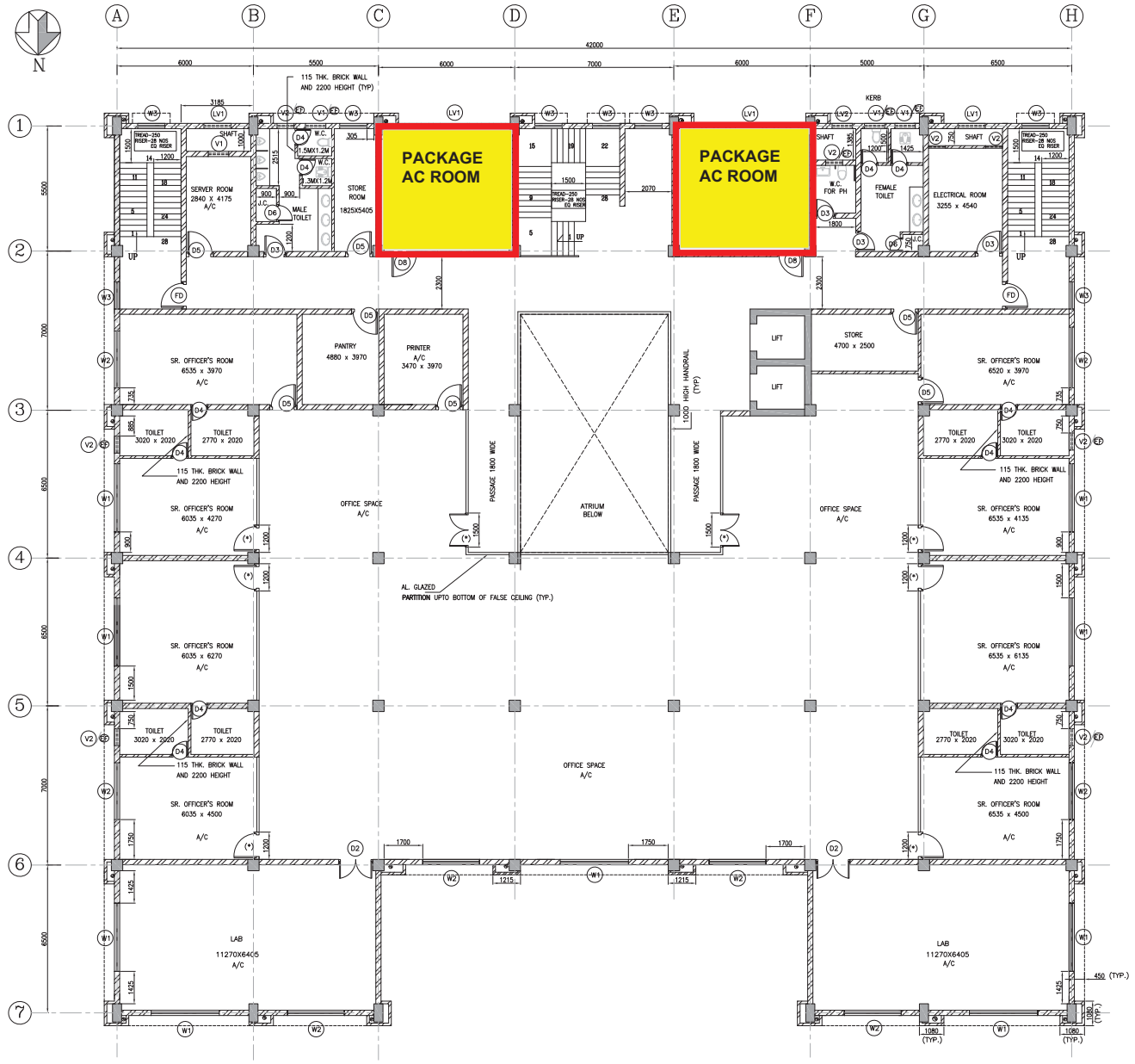
JOB NO.	412
STATUS	CONTRACT
DISTRIBUTION	
TO	
No. OF	

PROJECT	2x660 MW 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
	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NEW DELHI
TITLE	SERVICE BUILDING ARCHITECTURAL PLAN AT EL (+) 4.250M LEVEL
DRAWING NO.	PE–DG–412–640–C002
SHEET	1 OF 1
REV.	0

DEPT CODE		NAME	SIGN	DATE
C	DRN	OM		02.02.2015
	DESN	SB		02.02.2015
	CHD	S. PANDIT		02.02.2015
	APPD	A. NARAYAN		02.02.2015

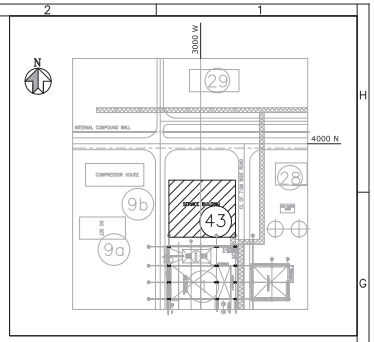
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PLAN AT EL (+) 8.500M LEVEL

(*)= DOORS MARKED WITH (*) ARE PART OF ALUMINUM PARTITION



KEY PLAN

NOTES

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4. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH CONTRACT TERMS AND CONDITIONS, SPECIFICATION AND SCHEDULE OF ITEMS.

ARCH. REF. DWG.

1. PLOT PLAN ---------- PE-DG-412-100-M001
2. ARCH. PLAN AT EL+0.000M ---------- PE-DG-412-640-C001
3. ARCH. PLAN AT EL+4.250M ---------- PE-DG-412-640-C002
4. ARCH. PLAN AT EL+12.750M ---------- PE-DG-412-640-C004
5. ARCH. PLAN AT EL+17.000M ---------- PE-DG-412-640-C005
6. DOOR WINDOWS AND FINISHING SCHEDULE --- PE-DG-412-640-C006
7. WINDOWS DETAILS ---------- PE-DG-412-640-C013
8. DOOR AND PARTITION DETAILS ---------- PE-DG-412-640-C014
9. TOILET DETAILS ---------- PE-DG-412-640-C015
10. FOR GENERAL NOTES REFER DRAWING NO. – PE-DG-412-611-C031

LEGENDS

1. J.C --------JANITOR CLOSET
2. T.O.C ------TOP OF CONCRETE
3. F.G.L ------FINISHED GROUND LEVEL
4. B.O.L -------BOTTOM OF LINTEL
5. F.F.L ------FINISHED FLOOR LEVEL
6. TYP --------TYPICAL
7. THK.---------THICK
8. LVL ---------LEVEL
9. EX ---------EXHAUST FAN
10. P.H -------PHYSICALLY HANDICAPPED

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DATE	02.02.2015

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JOB NO.	412
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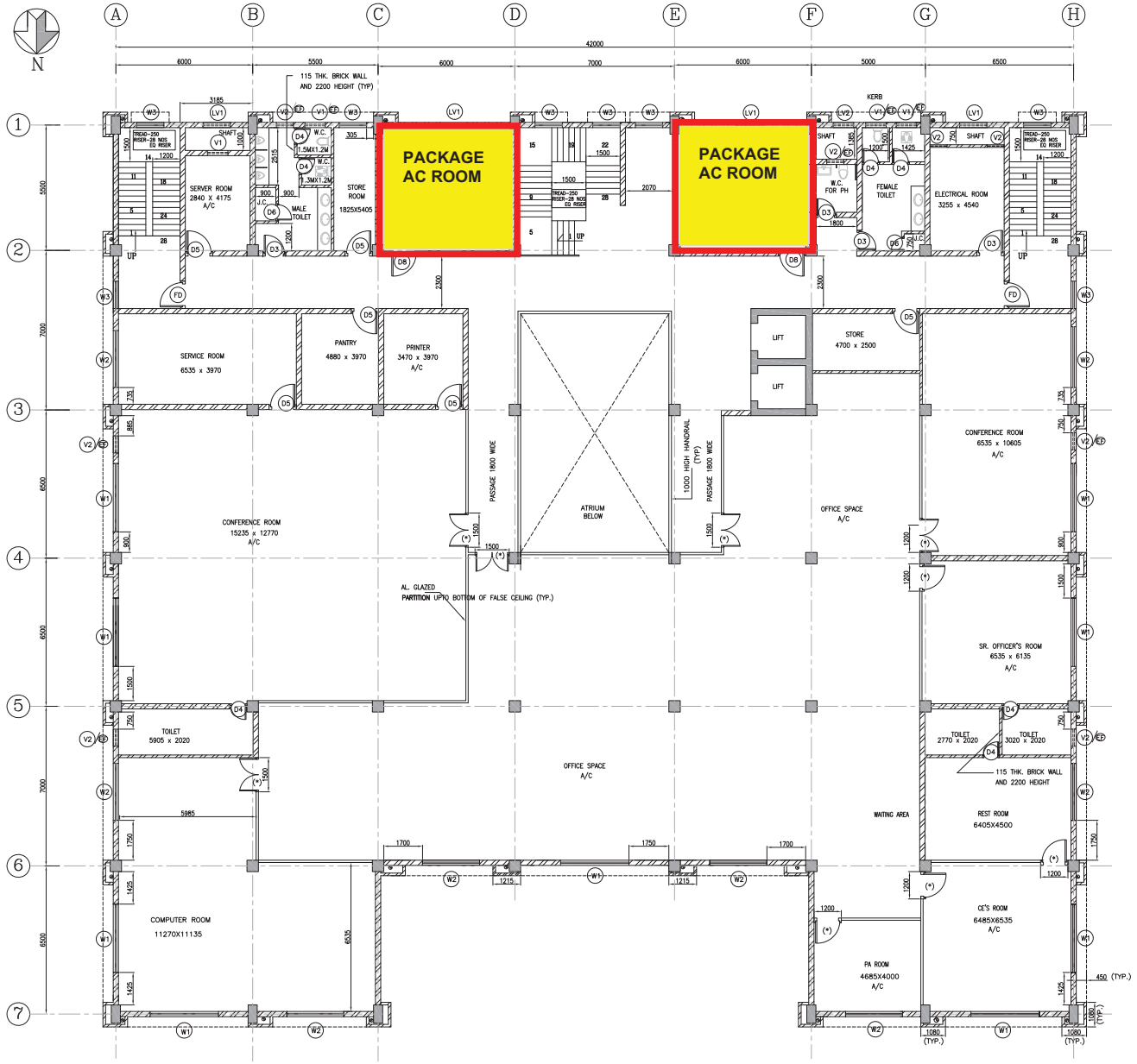
PROJECT	2x660 MW ENNORE SEZ SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI
OWNER:	TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED
OWNER'S CONSULTANT:	DESEIN PRIVATE LIMITED DESEIN HOUSE, NEW DELHI
	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NEW DELHI

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	DESN	SB		02.02.2015
	CHD	S. PANDIT		02.02.2015
	APPD	A. NARAYAN		02.02.2015

TITLE: SERVICE BUILDING
ARCHITECTURAL PLAN AT EL (+) 8.500M LEVEL

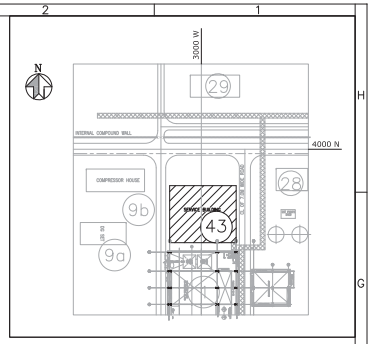
DEPT. | SCALE: | DRAWING NO. PE-DG-412-640-C003

SIGN | DATE | SHEET 1 OF 1 | REV. 0



PLAN AT EL (+) 12.750M LEVEL

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KEY PLAN

NOTES

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ARCH. REF. DWG.

1. PLOT PLAN ---------- PE-DG-412-100-M001
2. ARCH. PLAN AT EL+0.000M ---------- PE-DG-412-640-C001
3. ARCH. PLAN AT EL+4.250M ---------- PE-DG-412-640-C002
4. ARCH. PLAN AT EL+8.500M ---------- PE-DG-412-640-C003
5. ARCH. PLAN AT EL+17.000M ---------- PE-DG-412-640-C005
6. DOOR WINDOWS AND FINISHING SCHEDULE --- PE-DG-412-640-C006
7. WINDOWS DETAILS ---------- PE-DG-412-640-C013
8. DOOR AND PARTITION DETAILS ---------- PE-DG-412-640-C014
9. TOILET DETAILS ---------- PE-DG-412-640-C015
10. FOR GENERAL NOTES REFER DRAWING NO. – PE-DG-412-611-C031

LEGENDS

1. J.C -------JANITOR CLOSET
2. T.O.C -----TOP OF CONCRETE
3. F.G.L -----FINISHED GROUND LEVEL
4. B.O.L -----BOTTOM OF LINTEL
5. F.F.L -----FINISHED FLOOR LEVEL
6. TYP -------TYPICAL
7. THK.-------THICK
8. LVL -------LEVEL
9. EX --------EXHAUST FAN
10. P.H -------PHYSICALLY HANDICAPPED

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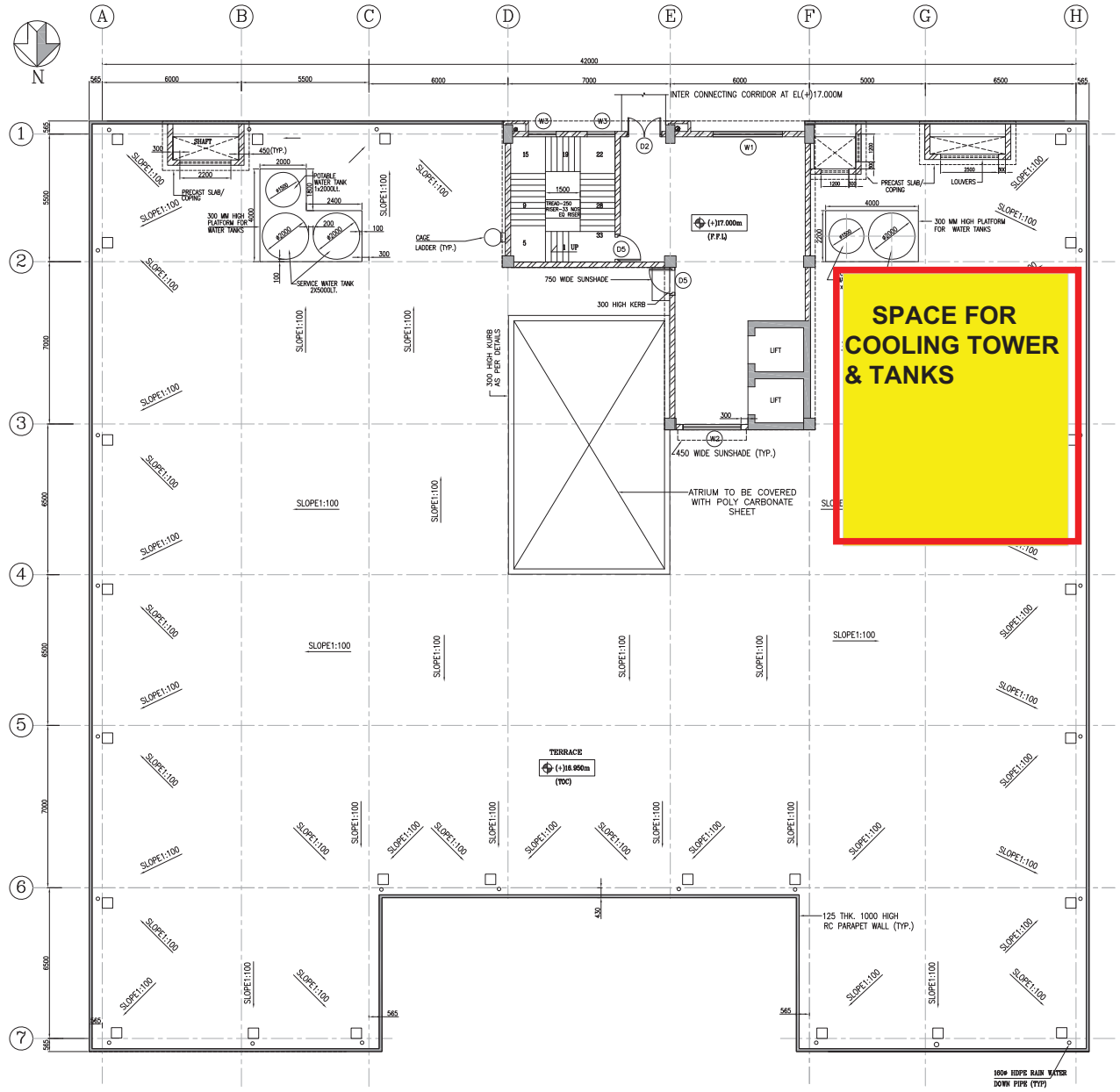
JOB NO.	412
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PROJECT	2x660 MW ENNORE SEZ SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI
OWNER:	TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED
OWNER'S CONSULTANT:	DESEIN PRIVATE LIMITED DESEIN HOUSE, NEW DELHI
	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NEW DELHI
TITLE	SERVICE BUILDING ARCHITECTURAL PLAN AT EL (+) 12.750M LEVEL
DRAWING NO.	PE-DG-412-640-C004
REV.	0

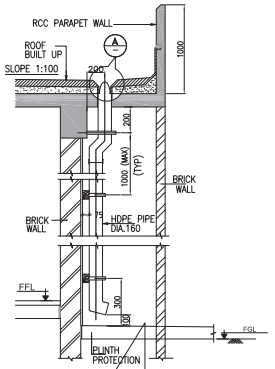
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	DESN	SB		02.02.2015
	CHD	S. PANDIT		02.02.2015
	APPD	A. NARAYAN		02.02.2015

DEPT. SCALE: SHEET 1 OF 1

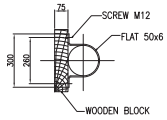
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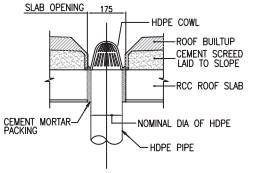
ROOF PLAN AT EL (+)17.000m



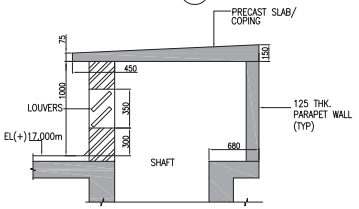
FIXING DETAILS OF RAIN WATER DOWN TAKE PIPE (NTS)



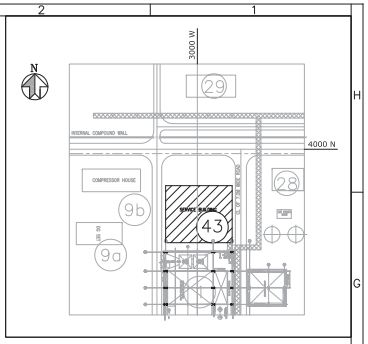
FIXTURE DETAIL (NTS)



HDPE INLET & CATCH BASIN DETAILS



TYPICAL SHAFT DETAILS (NTS)



KEY PLAN

NOTES

1. ALL DIMENSIONS ARE IN MILIMETERS AND ELEVATIONS IN METERS UNLESS NOTED.
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ARCH. REF. DWG.

1. PLOT PLAN ---------- PE-DG-412-100-M001
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9. TOILET DETAILS ---------- PE-DG-412-640-C015
10. FOR GENERAL NOTES REFER DRAWING NO. – PE-DG-412-611-C031

LEGENDS

1. T.O.C ------TOP OF CONCRETE
2. F.G.L ------FINISHED GROUND LEVEL
3. B.O.L ------BOTTOM OF LINTEL
4. F.F.L ------FINISHED FLOOR LEVEL
5. TYP --------TYPICAL
6. THK.--------THICK
7. LVL --------LEVEL

BHEL-PROJECT ENGINEERING MANAGEMENT(CIVIL)	
THIS DRAWING MARKED(✓) IS RELEASED FOR	
☐ COMMENTS/APPROVAL	
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☐ CONSTRUCTION	
STAMP ALL PREVIOUS REVISION AS SUPERSEDED	
ISSUED BY	
NAME	S.PANDIT
SIGNATURE	
DATE	02.02.2015

REV.	DATE	ALTD	CHD	APPD
A		Anshul	S A Khan	Praveen Kishore

JOB NO.	412
STATUS	CONTRACT
DISTRIBUTION	
TO	
No. OF	

PROJECT: 2x660 MW 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

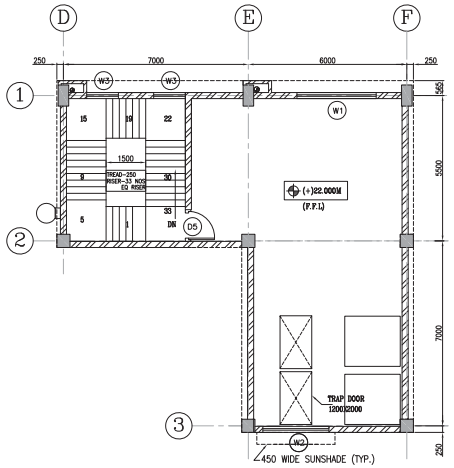
BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR, PROJECT ENGINEERING MANAGEMENT, NEW DELHI

DEPT CODE		NAME	SIGN	DATE
C	DRN	OM		02.02.2015
	DESN	SB		02.02.2015
	CHD	S. PANDIT		02.02.2015
	APPD	A. NARAYAN		02.02.2015

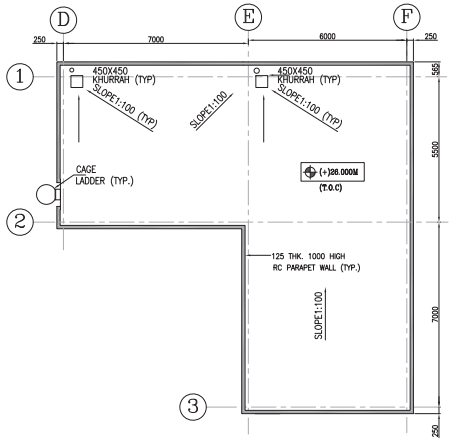
TITLE: SERVICE BUILDING
ARCHITECTURAL PLAN AT EL (+) 17.000M LEVEL

DEPT. | SCALE: | DRAWING NO. PE-DG-412-640-C005
SIGN | DATE | SHEET 1 OF 1 | REV. 0

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ROOF PLAN AT EL (+)22.000m



ROOF PLAN AT EL (+)26.000m

DOOR SCHEDULE

FLOOR	SYMBOL	WIDTH	HEIGHT	SILL AT EL (FROM F.F.L)	LINTEL AT EL (FROM F.F.L)	REMARKS
GROUND FLOOR EL(±)0.00M	DW	6000	2550/1950	--/600	2550	ANODIZED ALUMINIUM GLAZED DOOR WITH 6MM THK. FLOAT GLASS
	D	2000	3000	--	3000	HOLLOW METAL STEEL FLUSH DOOR WITH 900 HIGH REMOVABLE TRANSOM
	D1	2000	2100	--	2100	HOLLOW METAL STEEL FLUSH DOOR
	D2	1500	2100	--	2100	ANODIZED ALUMINIUM GLAZED DOOR WITH 6MM THK. FLOAT GLASS
	D3	900	2100	--	2100	ANODIZED ALUMINIUM FRAMED DOOR WITH PRELAMINATED PARTICLE BOARD
	D4	750	2100	--	2100	PVC DOOR AS PER SPEC
	D5	1200	2100	--	2100	ANODIZED ALUMINIUM GLAZED DOOR WITH 6MM THK. FLOAT GLASS
	D6	600	2100	--	2100	PVC DOOR AS PER SPEC
	D7	600	2100	--	2100	HOLLOW METAL STEEL FLUSH DOOR
	D8	1200	2100	--	2100	HOLLOW METAL STEEL FLUSH DOOR
	FD	1200	2100	--	2100	FIRE PROOF DOOR AS PER SPEC
FIRST FLOOR EL(+)4.25M	DW1	3500	2100/1500	--/600	2100	ANODIZED ALUMINIUM GLAZED DOOR WITH 6MM THK. FLOAT GLASS
	D2	1500	2100	--	2100	ANODIZED ALUMINIUM GLAZED DOOR WITH 6MM THK. FLOAT GLASS
	D3	900	2100	--	2100	ANODIZED ALUMINIUM FRAMED DOOR WITH PRELAMINATED PARTICLE BOARD
	D4	750	2100	--	2100	PVC DOOR AS PER SPEC
	D5	1200	2100	--	2100	ANODIZED ALUMINIUM GLAZED DOOR WITH 6MM THK. FLOAT GLASS
	D6	600	2100	--	2100	PVC DOOR AS PER SPEC
	D8	1200	2100	--	2100	HOLLOW METAL STEEL FLUSH DOOR
	FD	1200	2100	--	2100	FIRE PROOF DOOR AS PER SPEC
SECOND FLOOR EL(+)8.50M & THIRD FLOOR EL(+)12.75M	D2	1500	2100	--	2100	ANODIZED ALUMINIUM GLAZED DOOR WITH 6MM THK. FLOAT GLASS
	D3	900	2100	--	2100	ANODIZED ALUMINIUM FRAMED DOOR WITH PRELAMINATED PARTICLE BOARD
	D4	750	2100	--	2100	PVC DOOR AS PER SPEC
	D5	1200	2100	--	2100	ANODIZED ALUMINIUM GLAZED DOOR WITH 6MM THK. FLOAT GLASS
	D6	600	2100	--	2100	PVC DOOR AS PER SPEC
	D8	1200	2100	--	2100	HOLLOW METAL STEEL FLUSH DOOR
	FD	1200	2100	--	2100	FIRE PROOF DOOR AS PER SPEC
FLOOR PLAN EL(+)17.00M & EL(+)22.00M	D2	1500	2100	--	2100	ANODIZED ALUMINIUM GLAZED DOOR WITH 6MM THK. FLOAT GLASS
	D5	1200	2100	--	2100	ANODIZED ALUMINIUM GLAZED DOOR WITH 6MM THK. FLOAT GLASS

WINDOW SCHEDULE

FLOOR	SYMBOL	WIDTH	HEIGHT	SILL AT EL (FROM F.F.L)	LINTEL AT EL (FROM F.F.L)	REMARKS
ALL FLOOR (*)	W1	3000	1200	900	2100	ANODIZED ALUMINIUM GLAZED WINDOW PARTLY SLIDING PARTLY FIXED WITH 4MM THK. SHEET GLASS.
	W2	2500	1200	900	2100	ANODIZED ALUMINIUM GLAZED WINDOW PARTLY SLIDING PARTLY FIXED WITH 4MM THK. SHEET GLASS.
(**)	W3	1200	1200	900	2100	ANODIZED ALUMINIUM GLAZED SLIDING WINDOW WITH 4MM THK. SHEET GLASS.
	V1	900	600	1500	2100	ANODISED ALUMINIUMN GLAZED VENTILATOR TOP HUNG WITH 4MM THK. GROUND GLASS.
	V2	750	600	1500	2100	ANODISED ALUMINIUMN GLAZED VENTILATOR TOP HUNG WITH 4MM THK. GROUND GLASS.
	LV1	1200	600	1500	2100	ANODISED ALUMINIUMN LOUVERS

NOTE: (*) – ALUMINIUM GRILL SHALL BE PROVIDED FOR ALL GROUND FLOOR WINDOWS.
(**) – SILL FOR W3 WINDOW SHALL BE 900 FROM LANDING LVL AT STAIRCASE.

SCHEDULE OF FINISHES :-

FLOOR	AREA	FLOORING / SKIRTING	INTERNAL WALL/DADO	CEILING
ALL FLOORS	SIMULATOR ROOM, SWITCH YARD CONTROL ROOM,SERVER ROOM LIBRARY, WELFARE, SAFETY,SECURITY, FIRST AID ROOM MODEL DISPLAY ROOM, VIP LOUNGE TELEPHONE EXCHANGE ROOM, LAB CE'S ROOM, SR. OFFICER ROOM, CONFERENCE ROOM,COMPUTER ROOM, OFFICE SPACE	VITRIFIED CERAMIC TILES	ACRYLIC EMULSION PAINT	GYPSUM BOARD FALSE CEILING
	ENTRANCE, LOBBY, RECEPTION, ATRIUM, STAIRCASE & LIFT FACADE	20MM THICK POLISHED GRANITE STONE	ACRYLIC EMULSION PAINT	GYPSUM BOARD FALSE CEILING AND ACRYLIC WASHABLE DISTEMPER FOR STAIRCASE
	STORE, RECORD ROOM, MACHINE ROOM	KOTA STONE	ACRYLIC WASHABLE DISTEMPER	ACRYLIC WASHABLE DISTEMPER
	PANTRY, TOILETS	ANTI SKID CERAMIC TILES OF MATT FINISH	GLAZED CERAMIC TILES UPTO 2.1M & ACRYLIC WASHABLE DISTEMPER FOR BALANCE HEIGHT.	ACRYLIC WASHABLE DISTEMPER
	AC PACKAGE ROOM, MCC ROOM, ELECTRICAL ROOM	GRANOLITHIC FLOORING WITH NON METALLIC FLOOR HARDNER	ACRYLIC WASHABLE DISTEMPER	ACRYLIC WASHABLE DISTEMPER
	BATTERY ROOM	VITRIFIED CERAMIC TILES	ACRYLIC WASHABLE DISTEMPER	ACRYLIC WASHABLE DISTEMPER
	EXTERNAL WALL/ SUNSHADE	GRANULAR FINISH		

NOTES

1. ALL DIMENSIONS ARE IN MILIMETERS AND ELEVATIONS IN METERS UNLESS NOTED.
2. ALL ELEVATIONS ARE REFERRED TO THE FINISHED GROUND FLOOR LEVEL OF POWER HOUSE BUILDING AS EL. 0.00 M WHICH CORRESPONDS TO RL. +10.00 M.
3. UNLESS NOTED OTHERWISE WINDOW / DOOR/ ROLLING SHUTTER LOCATION SHALL BE AT CENTER BETWEEN GRIDS.
4. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH CONTRACT TERMS AND CONDITIONS, SPECIFICATION AND SCHEDULE OF ITEMS.

ARCH. REF. DWG.

1. PLOT PLAN ---------- PE-DG-412-100-M001
2. ARCH. PLAN AT EL+0.000M ---------- PE-DG-412-640-C001
3. ARCH. PLAN AT EL+4.250M ---------- PE-DG-412-640-C002
4. ARCH. PLAN AT EL+8.500M ---------- PE-DG-412-640-C003
5. ARCH. PLAN AT EL+12.750M ---------- PE-DG-412-640-C004
6. ARCH. PLAN AT EL+17.000M ---------- PE-DG-412-640-C005
7. WINDOWS DETAILS ---------- PE-DG-412-640-C013
8. DOOR AND PARTITION DETAILS ---------- PE-DG-412-640-C014
9. FOR GENERAL NOTES REFER DRAWING NO. -- PE-DG-412-611-C031

LEGENDS

1. T.O.C ------TOP OF CONCRETE
2. F.G.L ------FINISHED GROUND LEVEL
3. B.O.L ------BOTTOM OF LINTEL
4. F.F.L ------FINISHED FLOOR LEVEL
5. TYP -------TYPICAL
6. THK.-------THICK
7. LVL -------LEVEL

BHEL-PROJECT ENGINEERING MANAGEMENT(CIVIL)
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☐ COMMENTS/APPROVAL
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ISSUED BY	
NAME	S.PANDIT
SIGNATURE	
DATE	02.02.2015

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REV.	DATE	ALTD	CHD	APPD
A		Anshul	S A Khan	Praveen Kishore

JOB NO.	412
STATUS	CONTRACT
DISTRIBUTION	
TO	
No. OF	

PROJECT: 2x660 MW 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

BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR, PROJECT ENGINEERING MANAGEMENT, NEW DELHI

DEPT CODE		NAME	SIGN	DATE
C	DRN	OM		02.02.2015
	DESN	SB		02.02.2015
	CHD	S. PANDIT		02.02.2015
	APPD	A. NARAYAN		02.02.2015

TITLE: SERVICE BUILDING
ROOF PLAN, DOOR, WINDOW & FINISHING SCHEDULE

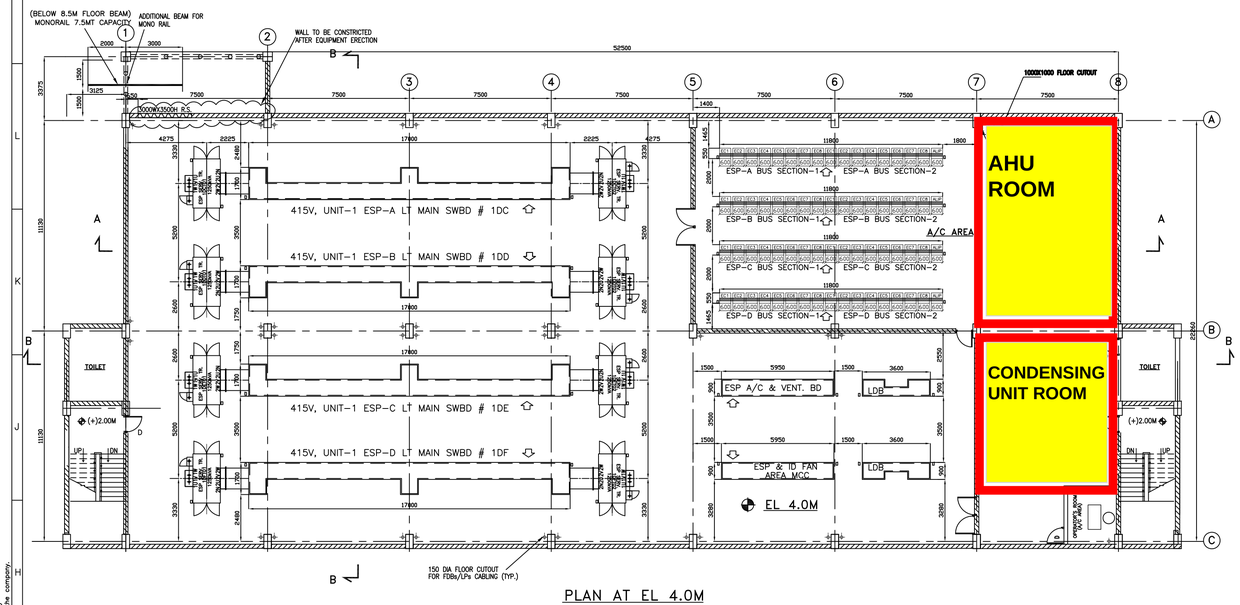
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SIGN		PE-DG-412-640-C006
DATE		SHEET 1 OF 1 REV. 0

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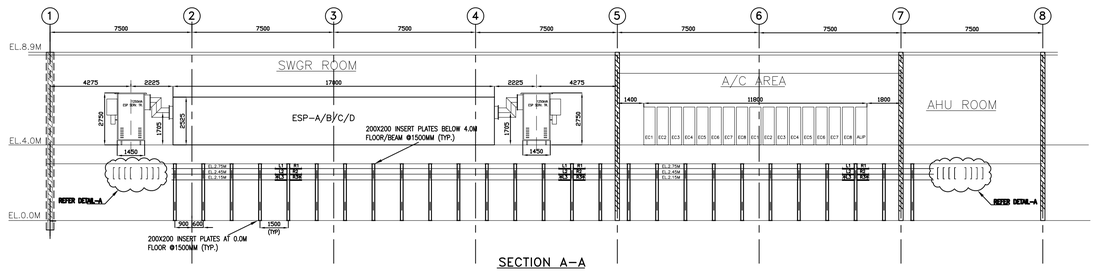
DRAWING NO. PE-DG-412-100-E008

FIRST ANGLE PROJECTION — ALL DIMENSIONS ARE IN MM

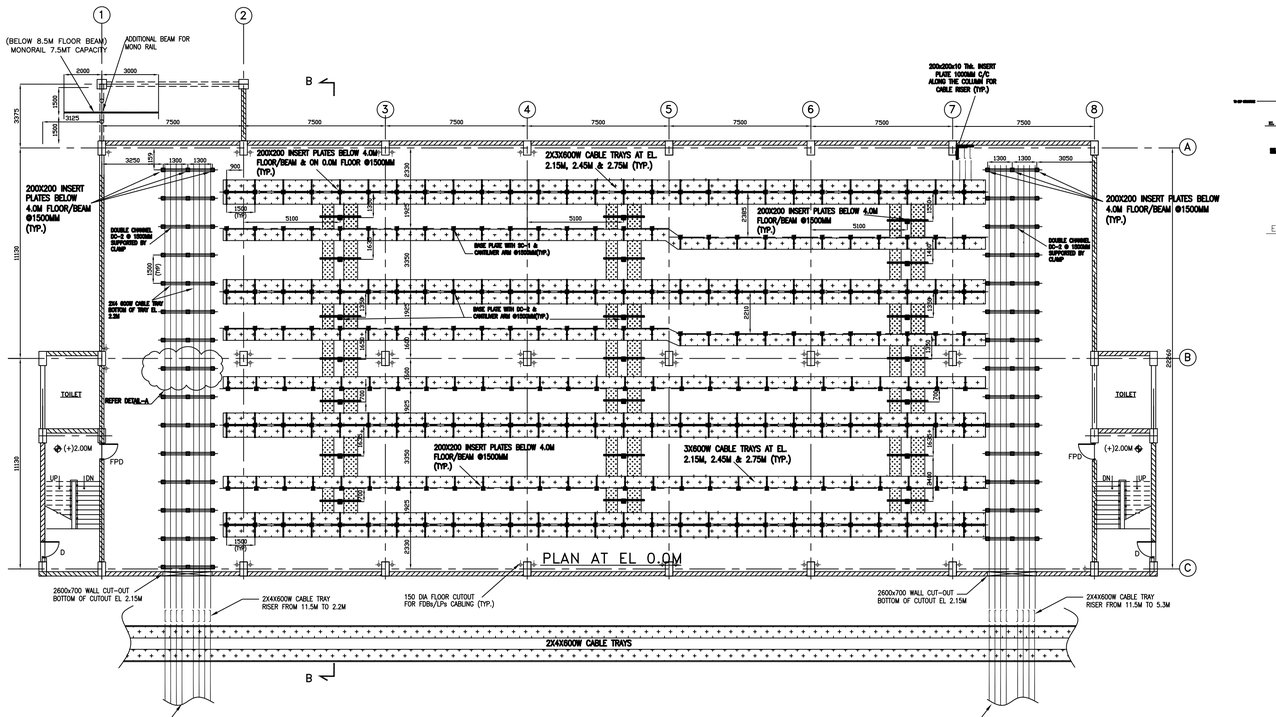
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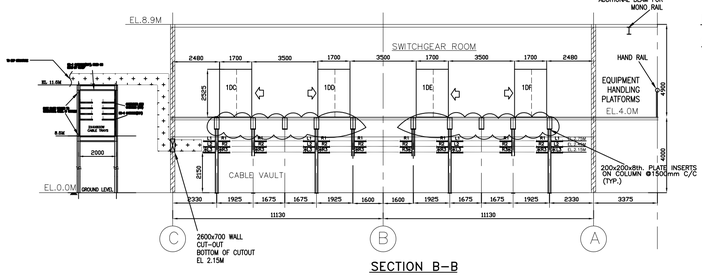
PLAN AT EL 4.0M



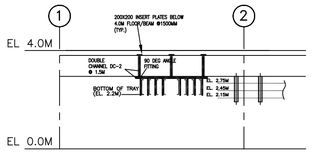
SECTION A–A



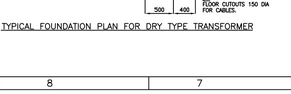
PLAN AT EL 0.0M



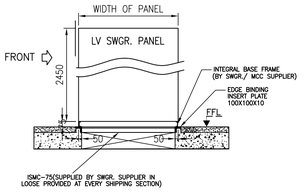
SECTION B–B



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
E				

DEPT CODE		NAME	SIGN	DATE
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DRN	AA			05.03.2015
CHD	SM/ SL			05.03.2015
APPD	RS			05.03.2015

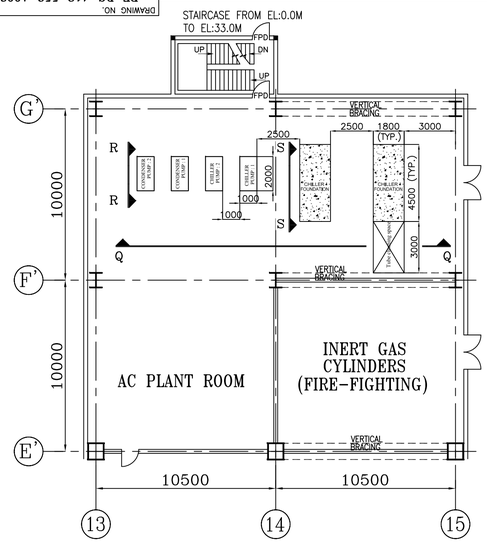
TITLE: ELECTRICAL EQUIPMENT & CABLING LAYOUT IN ESP CONTROL BUILDING (UNIT–1)

DEPT. | SCALE 1:100 | DRAWING No. PE-DG-412-100-E008 | SHEET 1 OF 1 | REV 0

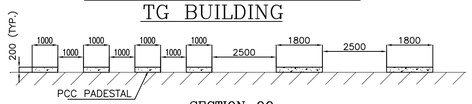
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PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT
FIRST ANGLE PROJECTION
ALL DIMENSIONS ARE IN MM

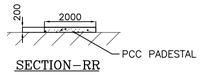
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AC PLANT-1 AT EL 0.0M
TG BUILDING



SECTION-QQ

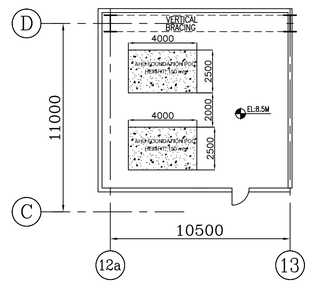


SECTION-RR

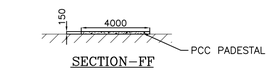


SECTION-SS

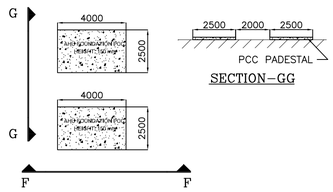
DETAILS OF CHILLER & PUMP FOUNDATION



AHU ROOM AT EL:8.5M
TG BUILDING

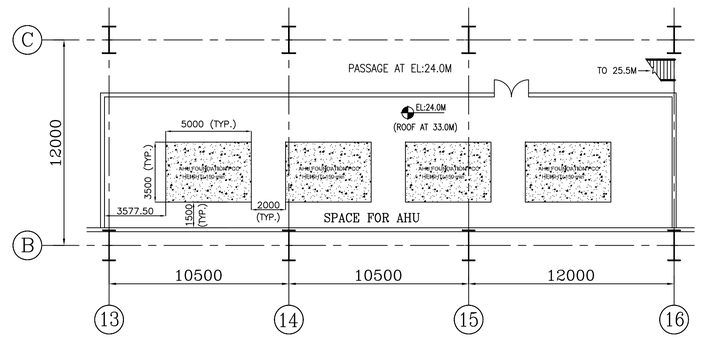


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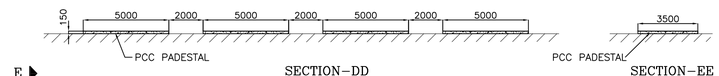


SECTION-GG

DETAILS OF AHU FOUNDATION (PCC BLOCK)

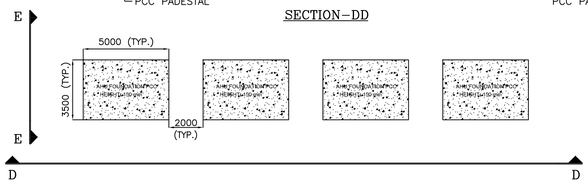


AHU AT EL:24.0M/25.5M

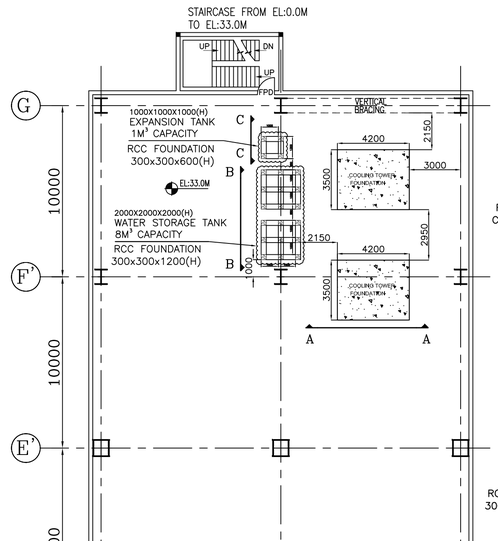


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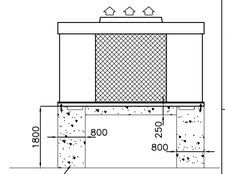
SECTION-EE



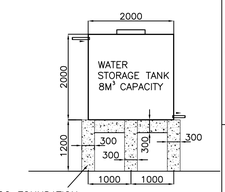
DETAILS OF AHU FOUNDATION (PCC BLOCK)



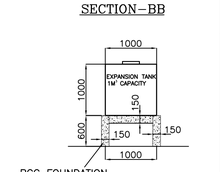
PLAN AT EL+33.0M
TG BUILDING



SECTION-AA

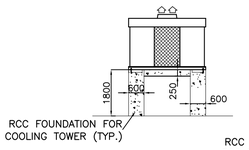


SECTION-BB

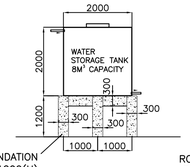


SECTION-CC

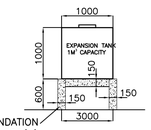
COOLING TOWER & TANK FOUNDATION



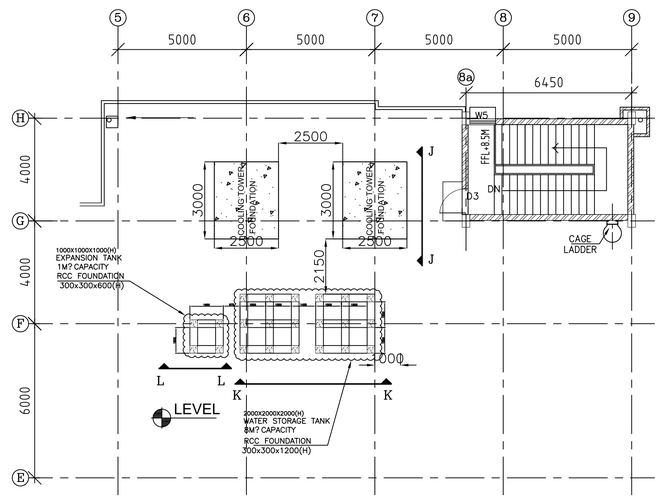
SECTION-JJ



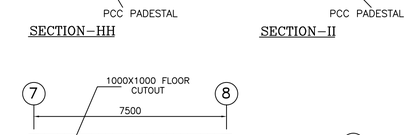
SECTION-KK



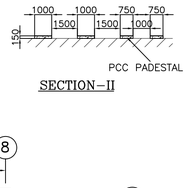
SECTION-LL



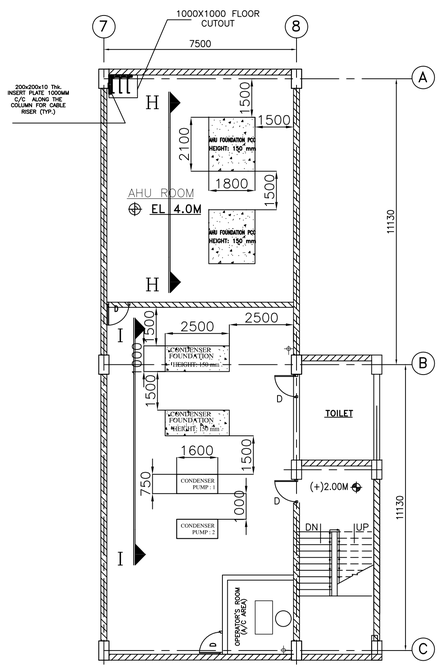
ADMINISTRATIVE BUILDING
DETAILS OF COOLING TOWER & TANK FOUNDATION



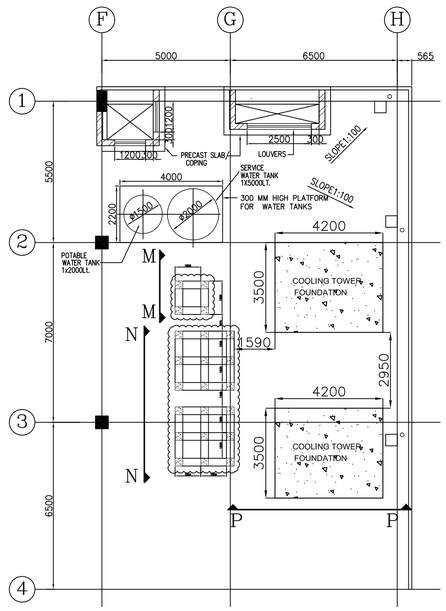
SECTION-HH



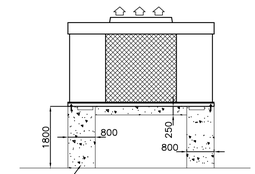
SECTION-II



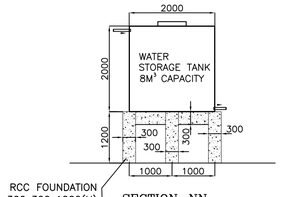
ESP BUILDING
AC PLANT-2 & AHU AT EL 4.0M



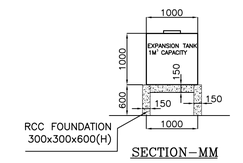
SERVICE BUILDING
DETAILS OF COOLING TOWER & TANK FOUNDATION



SECTION-PP



SECTION-NN



SECTION-MM

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 CHILLER/AHU/PUMPS ETC.
2. BIDDER SHALL FIX THE EQUIPMENT USING PROPER ANCHOR FASTENER TO SECURE THE EQUIPMENT AND OBTAIN PARAMETER RELATED TO VIBRATION AND NOISE.

FOR TENDER ONLY

Anshul — S A Khan — Praveen Kishore

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

BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR, PROJECT ENGINEERING MANAGEMENT, NEW DELHI

JOB NO.	412
STATUS	CONTRACT
DISTRIBUTION	
TO	
No. OF	

DEPT CODE		NAME	SIGN	DATE
M	DRN	AG	sd/-	29.04.2015
	DESN	SD	sd/-	29.04.2015
	CHD	SAK	sd/-	29.04.2015
	APPD	PK	sd/-	29.04.2015

TITLE: FOUNDATION DETAIL FOR AC EQUIPMENT

DEPT.	SCALE: 1:125	DRAWING NO.
SIGN		PE-DG-412-553-A003
DATE		SHEET 1 OF 1 — REV. R0

FORMAT SIZE A0

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