TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED

2X800 MW TANGEDCO UPPUR TPP BTG

TECHNICAL SPECIFICATION

FOR

VENTILATION SYSTEM

SPECIFICATION NO.: - PE-TS-425-554-A001 (REV 00)



BHARAT HEAVY ELECTRICALS LIMITED POWER SECTOR PROJECT ENGINEERING MANAGEMENT PROJECT ENGIEERING INSTITUTE BUILDING SECTOR-16A, PLOT NO.-25, NOIDA, INDIA



TITLE: 2X800 MW TANGEDCO UPPUR TPP BTG TECHNICAL SPECIFICATINS FOR VENTILATION SYSTEM

SPECIFICATION No: PE-TS-425-554-A001

REV. 00 DATE: 17-04-2018

SHEET : 1 OF 2

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SECTION - I

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SECTION-I

SUB-SECTION-A

INTENT OF SPECIFICATION



VENTILATION SYSTEM INTENT OF SPECIFICATION

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1.0 INTENT OF SPECIFICATION

- 1.1 The specification covers design, engineering, manufacture, supply / procurement, inspection and testing at vendor's / sub vendor's / manufacturer's works, painting, forwarding, proper packing and shipment and delivery at site, unloading, handling & transportation, storage, preservation, security / safety at site, Erection & Commissioning, minor civil & structural (as applicable) works as required on FOR site basis, Performance and guarantee testing / demonstration testing and handing over to BHEL's customer of **VENTILATION SYSTEM along with mandatory spares** as per details in different sections / volumes of this specification and various pre award agreements for **2X800 MW TANGEDCO UPPUR TPP BTG**, **Tamil Nadu**.
- 1.2 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve the contractor of the responsibility of providing such facilities to complete the supply, erection and commissioning, performance and guarantee/demonstration testing of **VENTILATION SYSTEM**.
- 1.3 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to highest standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgement is not in full accordance herewith.
- 1.4 The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing. Similarly, the extent of supply also includes all 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



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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

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2X800 MW TANGEDCO UPPUR TPP BTG VENTILATION SYSTEM PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA

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SUB-SECTION: B

PROJECT INFORMATION

SPECIFICATION FOR BTG EPC CONTRACT

VOLUME II – GENERAL & SCHEDULES

CHAPTER 1

PROJECT SYNOPSIS

1.0 GENERAL BACKGROUND AND SALIENT FEATURES

1.1 Introduction

Tamilnadu Generation and Distribution Corporation owns the proposed greenfield 1600 MW (2 units of 800 MW each) Coal Based Thermal Power Station. The Project Site is located in Uppur, Valamavoor and Thiruppalaikudi villages of Thiruvadanai Taluk, Ramanathapuram District.

1.2 Location

The proposed site for main power plant is located at Uppur in Ramnathpuram District of Tamil Nadu.

The nearest Railway station is Thiruppalaikudi Railway Station, 3Kms from site

ECR Connecting Ramanathapuram and Pattukottai is the nearest road access.

The nearest airport is at Madurai at a distance of 140 km.

The nearest port is Tuticorin located at a distance of 130 km.

1.3 Type of Plant

The proposed 2 x 800 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**





1.1	Owner	:	Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO)	
1.2	Project Title	:	2 x 800 MW Uppur Thermal Power Project	
1.3	Owner's Engineer	:	Desein Private Limited; New Delhi	
1.4	Project Site Location	:	Place Uppur	
			State Tamil Nadu	
4.5			Country India	
1.5	Nearest Railway Station	:	Ramanathapuram at 28 KM away	
1.6	Nearest City	:	Ramanathapuram	
1.7	Nearest Highway	:	ECR Connecting Ramanathapuram and Pattukottai	
1.8	Nearest Airport	:	Domestic air port at Madurai (140 KM)	
1.9	Nearest Sea Port	:	Tuticorin Port (130 KM)	
1.10	Site Elevation	:	+ 4.5 m	
1.11	CLIMATOLOGICAL DATA	•		
i.)	HIGHEST	:	37.8°C	
	TEMPERATURE			
			22.2%	
II.)		•	22.3 0	
	RECORDED			
iii.)	DRY BULB	:	30 ± 10°C	
	TEMPERATURE (DBT)		50°C (for electrical equipment)	
	FOR DESIGN			
is ()			75 + 159/	
IV.)		•	75±15%	
	PURPOSE			
v.)	ANNUAL RAINFALL	:	827 mm (avg.)	
1.12	Source of Water	:	Sea	
	(Distance from site)			
1.13	Primary Fuel & Source	:	Imported Coal (Indonesia and S. Africa)	
1.14	Startup Fuel & Source	:	HFO/ L.D.O. (Domestic)	
1.15	Earthquake Data	:	Zone III as defined in IS: 1893-2002	

1.5 Access to Site

Site is well connected and located along ECR Connecting Ramanathapuram and Pattukottai. Site is 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 800 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 765 KV voltage level through 765 KV transmission lines . The power evacuation lines would be double circuit 765 KV lines which will act as Line in & Line out circuit.

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 approx. 900 acres which is under the possession of TANGEDCO.

1.9 Fuel

1.9.1 Source of Fuel





Coal shall sourced from Indonesia or any other source Domestic coal requirement for the power plant will be sourced from coal mines in Orissa.

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

* for SG design the belnded coal is the weighted average of the parent coal. For mill design HGI 45 shall be considered, <u>DOMESTIC COAL</u>

Sr. No.	Particulars	Units	Parameters
Α.	Proximate Analysis		
1.	Moisture	%	16.00
2.	Volatile Matter	%	19.00
3.	Ash	%	45.00
4.	Fixed carbon	%	20.00
	Total	%	100
В.	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





Sr. No.	Particulars	Units	Parameters
8.	Carbonates	%	0.38
9.	Phosphorous	%	0.04
10.	Others	%	-
	Total	%	100.00
C.	Ash fusion	deg C	
	temperature		
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.	AI 2 O3	%	29.00
3.	Fe2O3	%	6.42
4.	CaO	%	1.50
5.	Na2O	%	0.08
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.	Particulars	Units	Parameters
No.			
Α.	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
В.	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 fusion temperature	deg C	
1.	Initial deformation, IT	deg C	1230
2.	Spherical, ST	deg C	1270





Sr.	Particulars	Units	Parameters
No.			
3.	Hemispherical, HT	deg C	1320
4.	Fluid, FT	deg C	-
D.	Ash Analysis, %		
1.	Sio2	%	36.00
2.	AI 2 O3	%	13.90
3.	Fe2O3	%	14.80
4.	CaO	%	12.70
5.	Na2O	%	0.70
6.	K2O	%	1.70
7.	TiO2	%	0.80
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.	Particulars	Unit	Parameter
No.			
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	Deg C	1100-1250
	Atmosphere)		
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

Coal is proposed to be imported from Indonesia or any other country and blended with domestic coal.

1.9.6 Fuel Transportation

The coal shall be received at Tuticorin port and transported by rail from there.

1.10 Source Of Water

1.10.1 Source

The raw water intake shall be from Bay of Bengal.

1.10.2 Chemical analysis of Sea Water:

S.No.	Parameters	Value (ppm)
1.	Total Solids	35,000
2.	Dissolved solids	21,620
3.	Suspended Solids	580
4.	Ignited residue	17,500
5.	Volatiles Solids	4,700
6.	Acid Insolubles	112
7.	Chlorides (as Cl)	20,232
8.	Sulphates (as SO ₄)	1,457
9.	Iron (as Fe)	70
10.	Total alkalinity (as CaCO ₃)	525
11.	Alkalinity due to Normal	Nil
	Carbonates (as	
	CaCO ₃)	
12.	Alkalinity due to bi-Carbonates	525
	(as CaCO ₃)	





13.	Total hardness (as CaCO ₃)	8,155
14.	Permanent hardness (as CaCO ₃)	6,200
15.	Temporary hardness (as CaCO ₃)	1,955
16.	Calcium hardness (as CaCO ₃)	1,255
17.	Magnesium hardness (as	6,900
	CaCO ₃)	
18.	Рн	8.2

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. 18000 m³/hr.

1.11 Source of Equipment

The proposed plant will be supplied, erected and commissioned on EPC basis with BTG & BOP as separate packages.

1.12 Power Evacuation Plan

Power will be evacuated from the proposed thermal power station at 765 KV voltage level and fed to Tamil Nadu Transmission Corporation Limited (TANTRANSCO). The Karaikudi substation is about 40 KM north west of the plant.

1.13 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 <u>11914 Million units</u>.

1.14 INFORMATION FOR ENVIRONMENTAL APPRAISAL

1.0 GENERAL INFORMATION ABOUT THE PROJECT

- 1.1 Name / Title of the Project : 2 x 800 MW Supercritical Coal Based Uppur Thermal Power
- 1.2 Name of Owner : Tamilnadu Generation and Distribution Corporation (TANGEDCO)

Project





1.3	Location of the Project	:	Uppur, Valamavoor and Thiruppalaikudi Villages, Ramanathapuram District, Tamil Nadu
1.4	Capacity of the project under consideration	:	2x 800MW
1.4.1	Govt. land / Private land / others	:	Land being acquiured
1.45.2	Topographical feature, demographic profile & physiography	:	Refer Volume VI
1.5.3	Nature of soil	:	Clayey soil
1.5.4	Distance from the nearest town / city / major human settlements	:	Madural – 140 KM
1.5.5	Population to be displaced	:	Nil
1.5.6	Distance from water source	:	Approx. 1 km
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	:	2 x 800 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	:	900 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 2x800 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 /	: Site is adjacent to Bay of Bengal
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 b. Forest	: Refer details in the specification
	c. Grass landd. Endangered speciese. 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 v. Estuary / sea vi. Hills / mountains vii. Historic / cultural / tourist / archaeological scenic	: : : : Bay of Bengal is 1 km from site





	sites / defence installations	
2.7	Human settlement	:
2.7.1	Total number of persons proposed to be employed	:
	i. During construction	: 2500
		1200(0.75person/MW) TANGEDCO
	ii. During operation	: direct employees





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SECTION: I

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TECHNICAL SPECIFICATIONS

BļļH	2X800 MW TANGEDCO UPPUR TPP BTG VENTILATION SYSTEM SPECIFIC TECHNICAL REQUIREMENT	SPECIFICATION No: PE-TS-425-554-A001 SECTION : I		
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SPECIFIC TECHNICAL REQUIREMENT



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1. FUNCTION

The purpose of the system is to provide Ventilation System for different areas of **2X800 MW TANGEDCO UPPUR TPP BTG** under the scope of BHEL.

2.0 SPECIFIC REQUIREMENTS

2.1 Design Criteria for Ventilation system:

- 2.1.1 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. A minimum 10% margin shall be considered while sizing the equipment/plant capacity.
- 2.1.2 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 (TG hall & ESP control room building)	8
ii.	General areas	15
iii.	Various pump houses	20
iv.	Switch gear / MCC rooms(for offsite areas with dry ventilation).	25
V.	Battery rooms & other areas where gaseous fumes are generated	30
vi.	CPU plant building (Regeneration room)	20
vii.	D G set room	45

- 2.1.3 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. At designed Ambient Temperature and Wet Bulb Temperature, inside dry bulb temperature not to exceed 42 Deg. C in TG hall and ESP Control room Building (Evaporative cooled and ventilated area). Accordingly, Air Washer and UAF is sized.
 - Inside dry bulb Temperature shall be maximum 3 deg.C above the design ambient dry Bulb temperature during summer for mechanically ventilated areas.

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- 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 ambient +3 Dec 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.
- 2.1.5 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 pressurized condition shall be maintained with gravity operated backdraft dampers. However, as exception, hazardous areas and fumes/odor generating areas such as toilets shall be negatively ventilated by means of exhaust air fans/ roof exhausters and inlet louvers.
- 2.1.6 Supply air fan catering for electrical switchgear/MCC 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.
- 2.1.7 All the equipment of Ventilation system shall be designed for continuous duty for continuous operation of 24 hours a day.
- 2.1.8 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. In the event of detection of fire, auxiliary systems like ventilation, may require shutdown. For this purpose potential free contacts from the output of the fire protection system shall be made available by customer in the BOP's local/main fire panel.
- 2.1.9 For maintenance of Air washer unit material handling equipment Manually operated Chain pulley block of 1 T capacity shall be provided in the Air Washer rooms of Evaporative Ventilation System.
- 2.1.10 Circulating water capacity for Air washer units shall be minimum 1 M3/hr per 1000 M3/hr of air flow while for Unitary Filtration Unit, it shall be minimum 0.6 M3/hr per 1000 M3 /hr of air flow.
- 2.1.11 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.
- 2.1.12 The air distribution system shall be sized to have a constant frictional drop along its length.
- 2.1.13 The air washer unit and unitary air filtration unit shall be designed for a maximum face velocity of 2.0 m/sec.



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- 2.1.14 The air washer unit shall be designed for at least 90% saturation efficiency while UAF for 90% saturation efficiency.
- 2.1.15 For pumps, fans and blowers, continuous motor rating (at 50^o 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.
- 2.1.16 For Belt drives, the belts shall be sized for 150% of the rated power and there shall be minimum of two belts per drive.
- 2.1.17 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.
- 2.1.18 For calculating friction loss in piping system, WILLIAM & HAZEN formula shall be used with C value as 100.
- 2.1.19 Supply air fans, exhaust air fans/ roof ventilators of each area shall be provided with their local starter panel.
- 2.1.20 Design Criteria for Back Draft Damper Velocity across damper shall not exceed 6 m/s.
- 2.1.21 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.

3.0 System description Ventilation System

3.1 Evaporative Cooling System for Turbine Building

For each unit Four (4) nos. air washers of adequate capacity shall be provided for evaporative cooling of various floors of turbine building including maintenance bay electrical bay. Each air washer system shall consist 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. The air washer capacity is to be decided based on:

- a. Total internal heat load within the turbine building, inclusive of electricity bay, maintenance bay 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



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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.

- i. 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 & fine filters and a pump with piping valves, strainers and specialties 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.
- ii. The supplied air will be exhausted through roof exhausters to maintain an overpressure of to reduce dust ingress.

3.2 Unitary Air Filtration Unit for ESP Control Buildings

For ventilation of this building (except the control room), ambient air will be drawn through unitary air filtration unit 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 to reduce dust ingress.

3.3 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.

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.

3.4 Specific Requirements

- a. For hazardous areas, fans with anti-spark characteristics to be provided.
- b. Online non- chemical type scale preventer shall be used to avoid formation of scale in the Airwasher nozzles/ water circuit.

3.5 Centrifugal pumps

a)	Туре	:	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



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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
x) efficiency	:	75 % minimum

3.6 Air Filters

a) Pre-Filters

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 Aluminum alloy of (minimum 16 gauge) supported by galvanized steel wire mesh of 10 mm Square with handles.					
3)	Other requirem	Other requirements :					
	a)	Suitable aluminum 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.					

b) Fine filters (Microvee type)

	(
1)	Construction	:	By pleating a continuous sheet of filter medium into closely spaced plates separated by heavy corrugated aluminum spacers.
2)	Frame	:	Aluminum 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.



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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.

3.7 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: -

S.No.	Larger dimensions of Duct	Thickness of GS sheet (mm)	Type of Transverse Joint Connection	Bracing
а.	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.
с.	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.
е.	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.

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f.	2251 larger	and	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. 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 galvanized bolts and nuts at about 125 mm centers. All flanges shall be connected to the ducts by rivets at about 125 mm centers. 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 shell ace varnish or approved equal adhesive. The holes in the felt packing shall be burnt through.
- III. 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 red oxide 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/M2 (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.

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- 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 masonry 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 riveted at approximately 125 mm centers to the casing. 'Pecora' or equivalent caulking compound shall be inserted between the base of angle and all masonry construction to which angles are fastened.
 - 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 aluminum 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 aluminum 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 finalization 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.



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

3.8 Pipe work Valves and Specialties

- i. Unless otherwise specified herein the specification. Piping for sizes smaller than 150 mm NB shall be continuous welded Galvanized steel pipes to IS: 1239 heavy class. Piping for sizes 150 mm and larger shall conform to IS: 3589 with minimum 6.35 mm thickness.
- ii. Fabricated elbows from pipe (5 piece miter) 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 slip-on 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.
- vi. 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 aluminum 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.
- vii. 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.



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viii. 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.

3.9 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 throughout 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 arrangement.
- 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.

3.10 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 fabricated from MS sheet. 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



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avoid leakage of water. The inside of casing shall be protected by spray galvanization.

- 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 atomized 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/cm2 (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 stabilized 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 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.

3.11 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



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nozzle. Water shall be sprayed at filter bank. Screen type suction strainer, Pumps, Necessary controls & Instrumentation, and all other required accessories.

All equipment, 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.

3.12 Centrifugal Fans for Evaporative cooling plants

- i. The casing shall be of welded construction fabricated with heavy gauge galvanized sheet steel or MS sheet with spray galvanization. In case of spray galvanization 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 than 96%.
- viii. The static pressure of fan shall not be less than 75 mmwc.

3.13 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



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galvanized and impeller shall be made of cast aluminum 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.

3.14 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.

3.15 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.



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4.0 Plant control for Evaporative cooling and Ventilation system

- i. Brief scheme of controlling the operation is described below.
 - 1) The operation of the Ventilation plant and associated Air washers/UAF shall be done from the DDCMIS based control System.
- ii. Air Washer Units (AWU) & Unitary Air Filtration Units (UAF)
 - a) 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.
 - b) 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.
 - c) Auto/Manual selector Switches and working/Standby selector switches for the pump shall be provided in the panel.
 - d) A selection switch enabling the running of AWU fan or pump alone shall be provided.
- iii. Miscellaneous control requirements
 - a. Separate emergency local stop push button shall be provided for each pump, fans etc. of Ventilation system.
 - b. Lamps shall be provided for indicating the status of each pump, fans etc. of Ventilation system in the main and local panel.
 - c. All the annunciations related to failure of equipment, tripping of equipment, 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.
 - d. The fans (both supply and exhaust fans) associated with mechanical ventilation system shall be operated locally.
 - e. Fully wired, twenty percent (20%) spare annunciation windows shall be provided in all the panels.

5.0 SYSTEM ENVISAGED

5.1 Ventilation System for various buildings

a) TG Building (Unit-1 & 2)



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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.

- 1. 2 nos (all working) Airwashers of 2,75,000 CMH with 90 mmwc shall be provided at BC bay EL. 29.5 M of each unit
- 2. 2 nos (all working) Airwashers of 2,75,000 CMH with 90 mmwc shall be provided outside A row side of each unit

Total 11,00,000 CMH shall be handled by all running Air washers per Unit.

b) ESP Control Room (Non air conditioned areas) (Unit-1 & 2)

Unitary Air filtration units of double 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.

1 no UAF unit of 95,000 CMH at 75 mmwc shall be provided for each unit at elevation 8.7 M

Sizing calculations are attached as per Annexure-1

c) Ambient air ventilation system for the other areas shall be provided by installing exhaust fans on each area

- i. Turbine hall- Roof exhausters
- ii. AC plant rooms (common for unit 1 &2)
- iii. DG set rooms
- iv. CPU (Regeneration room)
- v. Battery rooms
- vi. All MCC rooms & cable vaults
- vii. Toilets
- viii. Pantries

6.0 DESIGN INPUT / CRITERIA

6.1 System design criteria* As per tender requirement cl 19.3.1 vol :III Spec no. SE/E/T&H(P)/OT no. 01/2015-16# As per Table 1-T-2: Outside Design Data for station: Madurai (nearest city to Uppur thermal power station)


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The outside design conditions considered are as follows: -Season / Temperature Type	Summer
DBT (°C)	47*
WBT (°C)	25.6#

Season Temperature Type	/	Summer
DBT (⁰ F)		116.60*
WBT (⁰ F)		78#

6.2 The inside design conditions to be maintained are as follows for Evaporative cooling systems: -

Season Temperature Type	/	Summer
DBT (°C)		42*

6.3 REDUNDANCY OF EQUIPMENTS

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

7.0 PERFORMANCE GUARANTEE

7.1 Auxiliary Power Consumption: Aux. power in following area as per clause no. 3.8.1, S. No. XXXV, Volume –III chapter 3 of tender Specification shall be guaranteed:

Ventilated areas in TG hall and ESP control room buildings

7.2 Demonstration Tests (As per clause no. 6.18, Volume –III chapter 3 of tender Specification):

Demonstrated at Shop:

- a. Capacity and discharge pressure of pumps of air washer and unitary air filtration units at its rated duty point of Ventilation system.
- **b.** Capacity and static pressure of air washer unit fans, Unitary air filtration unit fans, roof exhausters of TG building Ventilation system.

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Demonstrated at Site

a) Parallel operation (if applicable), Vibration & Noise level of all rotating equipment's

8.0 WATER SUPPLY ARRANGEMENT

Makeup water for Air washer and UAF plants shall be supplied from HVAC make-up pumps by CUSTOMER/TENGEDCO mounted on plant service storage tank. This Water shall be generated from sea water based RO plant stage-1 (TDS <400 ppm) followed by remineralisation system.

Items	Unit s	Copper	Carbon Steel
рН (25°С)		6.8 -8.5	6.8 -8.5
TDS	ppm	< 600	< 500
Turbidity	NTU	< 10	< 10
M Alkalinity	ppm	< 100	< 100
Chloride Ion CI	ppm	< 300	< 200
Sulphates Ion SO4	ppm	< 300	< 300
Silica	ppm	< 50	< 50
Total Hardness	ppm	< 300	< 300
Calcium Hardness	ppm	< 200	< 200
Total Iron Fe	ppm	< 0.5	< 0.5
Sulphide Ion S	ppm	ND	ND
Ammonium Ion NH4 +	ppm	< 1	NA
BOD	ppm	< 50	< 50
COD	ppm	< 100	< 100
Free Chorine	ppm	< 0.2	< 0.2
Oil & Grease	ppm	< 1	< 1
Free Carbon dioxide	ppm	< 3	< 3
Other contaminants	ppm	ND	ND

Allowable Range for Circulating Water (< 40 °C) is as below

*ND – Not Detected

*NA – Not Applicable

*COD - Chemical Oxygen Demand

*BOD - Biological Oxygen Demand

*Other Contaminants - Phenol, cyanide, lead, manganese etc

Water quality in make-up and circulating systems shall be maintained by customer/operator with suitable COC so that the water quality remains within allowable range.

Water shall be provided at terminal points by TANGEDCO for further distribution/connection by BHEL. Total Make-up water requirement shall be approx 80 m3/hr for all ventilation plants.



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9.0 POWER SUPPLY ARRANGEMENT

Electrical Requirements shall be as per contract specification with customer agreed deviation.

10.0 PAINTING SCHEDULE

Painting shall be in compliance to chapter 6 of VOL II of customer specification.

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

1.	Roof extractor units with 15 mmwc static pressure.		
	Capacity	Motor rating	Roof / Slab opening
a.	50,000 CMH	5.5 KW	1320mm
b.	40,000 CMH	5.5 KW	1320mm
C.	20,000 CMH	2.2 KW	1140mm
2	Axial flow su	pply fans with 30 mm	nwc static pressure.
	Capacity	Motor rating	Wall opening
a.	10,000 CMH	2.2 KW	800mmx800mm
b.	7,500 CMH	1.5 KW	700mmx700mm
C.	6,000 CMH	1.1 KW	600mmx600mm
d.	4,000 CMH	0.75 KW	500mmx500mm
3	Axial flow su	pply fans with 20 mm	nwc static pressure.
	Capacity	Motor rating	Wall opening
a.	10,000 CMH	1.5 KW	800mmx800mm
b.	7,500 CMH	1.1 KW	700mmx700mm
C.	6,000 CMH	1.1 KW	600mmx600mm



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d.	4,000 CMH	0.75 KW	600mmx600mm	
4	Axial flow ext	naust fans (Bifurcated ty	pe) with 15 mmwc static pressure.	
	Capacity	Motor rating	Wall opening	
a.	15,000 CMH	2.2 KW	900mmx900mm	
b.	10,000 CMH	1.5 KW	800mmx800mm	
C.	7,500 CMH	1.1 KW	700mmx700mm	
d.	4,000 CMH	0.75 KW	600mmx600mm	
e.	2,000 CMH	0.55 KW	500mmx500mm	
5	Axial flow exhaust fans with 10 mmwc static pressure.			
	Capacity	Motor rating	Wall opening	
a.	15,000 CMH	1.1 KW	900mmx900mm	
b.	10,000 CMH	0.75 KW	800mmx800mm	
C.	7,500 CMH	0.55 KW	700mmx700mm	
d.	6,000 CMH	0.55 KW	600mmx600mm	
e.	4,000 CMH	0.55 KW	600mmx600mm	
f.	2,000 CMH	0.37 KW	500mmx500mm	
6	Exhaust fan (propeller type) with 5 mmwc static pressure.		
	Capacity	Motor rating	Wall opening	
а.	1200 CMH	100 W	300 cir ula r	

12. 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



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like data sheet/ technical particulars etc. Are subject to Customer approval during detail engineering stage.

- 2) Vendor to furnish characteristic curves for all major equipment offered indicating duty point during detailed engineering.
- 3) Vendor to include the Back wash arrangement of pot strainer with gate valve, piping etc for the Air Washer.
- 4) Vendor to include level gauge & level switch for each Air-washer tank for alarm & trip of the pumps. Also include one no. Pressure switch for each air washer pump
- 5) All drawings and documents shall be computer based.
- 6) All commissioning spares & consumables for trouble free operation shall be provided.
- 7) Quality Requirements in the Technical Specification are indicating minimum requirements for inspection and testing. Vendor shall note that quality plan is subject to Customer & BHEL-approval during detail engineering stage. Standard QP format is enclosed in the technical specification.
- 8) Indicative list of makes is enclosed as per Annexure-I however these equipments / items shall be subject to Customer & BHEL approval during detail engineering Stage.
- 9) Inserts or any support arrangement for fixing ducting, fans, piping etc. shall not be provided by BHEL. Necessary supports may be taken from nearest structure / walls / roofs / floors etc. by Vendor.
- 10) Fixing frame works for diffusers and grilles in the scope of Vendor.
- 11) Anchor fastener shall be used by vendor for fixing duct pipes etc. wherever applicable.
- 12) Necessary supports and structures / frames etc. as required for supporting the duct / piping / equipments etc. as lump-sum basis is in the scope of Vendor and no unit rates shall be applicable for these items.
- 13) Drain piping within room up to the drain point to be provided by the Vendor.
- 14) Vendor to furnish schedule of power and control cables. Vendor to furnish cable termination details interconnection drawings etc. during detail engineering stage.
- 15) The tools and machine required for erection of equipment shall be arranged by Vendor.
- 16) Tools & tackles as required for regular maintenance shall be supplied by Vendor.



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- 17) Instruments required for performance testing of various equipment / system of the package shall be arranged by Vendor at site.
- 18) Instrument for testing shall be calibrated by Ventilation plant supplier before taking up testing.
- 19) Temperature gauges shall be provided with thermo wells and fixing arrangement.
- 20) Pressure gauges shall have provision for air venting. Three way valves shall be used which shall have air venting provision.
- 21) Matching sockets / stubs (weld type) for flow switches and other instruments shall be supplied.
- 22) Bidders shall guarantee to maintain specified inside design conditions during summer, monsoon and winter and also even if the internal equipment load varies from 100% to 25%.
- 23) Besides the system performance as above, bidder shall guarantee major technical parameters of various equipments as per design basis / details furnished.
- 24) The guarantee tests shall cover but not limited to the following rated parameters for smooth operation of ventilation system.
 - Design dry bulb temperature and relative humidity of conditioned air, Auxiliary power consumption, Vibration and noise level etc.
 - Performance test of the Ventilation system shall be carried out at site after proper installation. The site test shall include performance testing of equipment for 72 continuous hours in summer or monsoon and 24 continuous hours in winter. Bidder, as may be required to carry out site tests shall arrange all instruments, tools etc.
 - All calibrated instruments to be used for the tests at manufacturer's works/site shall be arranged by the bidder. Any Electrical/C&I items and accessories like junction box, glands etc. shall be included by vendor in his scope. Only those items shall be provide free of cost which are categorically listed in the Electrical scope sheet of technical specification.
- 25) Motorized fire damper will be installed at supply air duct in electrical areas like MCC / Switchgear room / cable spreader room etc. in power house building and ESP building. Fire damper will close on receiving fire signal from fire protection system and shall also be possible manually from remote control panel. Also respective Air washers / UAFs shall trip on receiving fire signal from fire protection system.

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- 26) Vendor to furnish drawings / documents as per the drgs. /documents submission schedule given in the contract.
- 27) Each motor terminal box shall be provided with cable gland and lugs for the size and type of power and control cable of respective motor.
- 28) All electrical equipment shall be suitable for the power supply fault levels and other climatic conditions indicated in project information / synopsis enclosed.
- 29) The bidder's proposal shall be for equipment in accordance with the Tech. Specification.
- 30) Tender drawings enclosed form the part of specification and the bidder shall check the space requirements.
- 31) Bidder should suitably group the signals coming from various instrument etc. and the same shall terminate in local JB, from Local JB common cable to PLC / panel / MCC shall be selected. Any Electrical / C&I items and accessories like junction box, glands etc. shall be included by vendor in his scope. Only those items shall be provided free of cost which are categorically listed in the Electrical scope sheet of technical specification.
- 32) Feeder for a combination of fire dampers / valves etc. shall be derived from respective control panel by bidder. Distribution through junction box / distribution board shall be in bidders' scope and shall have provision for isolation of individual fire damper / valves. Suitable transformer shall be provided by bidder (if required) to derive the power input.
- 33) In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, the more stringent requirement as per the interpretation of the owner shall apply.
- 34) Bidder to note that BHEL reserve the right for drg/doc submission through web based Document Management System. Bidder would be provided access to the DMS for drg/doc approval and adequate training for the same. Bidder to ensure proper net connectivity at their end.
- 35) Quality requirements in the Technical specification are minimum requirements for inspection and testing. Vendor to note that quality plans are subject to Customer approval during detail engineering stage. Standard QP format is enclosed in the technical specification.
- 36) The drawings/ documents submitted by vendor shall be complete in all respects with revised drawing submitted incorporating all comments. Any incomplete drawing submitted shall be treated as non- submission with delays attributable to vendor's account. For any clarification/discussion required to



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complete the drawings, the bidder shall himself depute his personal to BHEL / Customer's place any number of time as per the requirement for across the table discussions/ finalizations/ submissions of drawings.

- 37) All openings required in brick wall for installing the axial supply and exhaust fans, propeller fans, duct opening, louvers and damper openings etc shall be done by vendor. Grouting of fans along with anchor fasteners shall also be done by vendor. The openings shall be finished properly. In case openings are done once the wall have been painted, repainting, to match with the existing wall paint shall also be done by the vendor. Sealing of duct opening, grouting of foundation / foundation bolts etc. including special type of grouting like GPX2 etc. are in the scope of Ventilation system vendor.
- 38) Flat, platform type RCC / PCC foundation shall be provided for installing Air washer / UAF and UAF fan / pumps etc. Vendor shall fix the equipment using proper anchor fasteners to secure the equipment and obtain parameter related to vibration and noise.
- 39) Bidder to note that the P&ID shows only the bare minimum requirement of valves and instruments. Any instrumentation & valves as required for the completion of the system in line with technical specification shall be provided by bidder during detailed engineering without any commercial implication.
- 40) All codes and standards shall be as per contract specifications

13.0 EXCLUSIONS

- Items of works listed below are excluded from scope of the Ventilation plant supplier.
- Construction of Air washer plant room, foundations for Ventilation equipment (air washer, centrifugal fan, RE Unit only).
- Slab cut out for running ducts, pipes, cables, grilles/dampers. Underground masonry trenches and masonry risers.
- Provision of drain traps / points,
- For Electrical scope, refer Electrical scope matrix sheet.
- Structure for running the ventilation ducting header outside 'A'- Row, however required inputs shall be provided by the vendor.

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CUSTOMER SPECIFICATIONS



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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 equipment 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:

	Area	Air Changes
S No.		
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.	CPU 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°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.

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- 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 pressurized condition shall be maintained with gravity operated backdraft dampers. However, as exception, hazardous areas and fumes/odor 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 equipment 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 M3/hr per 1000 M3/hr of air flow while for Unitary Filtration Unit, it shall be minimum 0.6 M3/hr per 1000 M3 /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^o 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.



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- 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.

19.5.2 Ventilation System for various buildings

a) TG Building (Unit-1 & 2)

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) (Unit-1 & 2)

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. AC plant rooms (common for unit 1 &2)
- iii. DG set rooms
- iv. CPU (Regeneration room)
- v. Battery and battery charger rooms
- vi. All MCC rooms & cable vaults



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- vii. Elevator machine rooms
- viii. All other areas not air-conditioned.
- ix. Toilets
- x. Pantries

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 consist 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°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 specialties 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 Buildings

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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.

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
 - a. All battery rooms to be painted with acid & fume resistant paint.
 - b. For hazardous areas, fans with anti-spark characteristics to be provided.
 - c. For elevator machine room, filtered air shall be supplied by supply air fan. Exhaust shall be through gravity dampers.
 - d. Online non- chemical type scale preventer shall be used to avoid formation of scale in the Airwasher nozzles/ water circuit.
- 19.8.4 Centrifugal pumps

a)	Туре	:	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



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vii) Packing	:	As per manufacturer's standard.
viii) Base Plate	:	Carbon steel as per IS:2062
ix) Speed	:	Maximum 1500 rpm

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: -

S.No.	Larger dimensions of Duct	Thickness of GS sheet (mm)	Type of Transverse Joint Connection	Bracing
а.	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.
с.	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.
е.	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	50 x 50 x 5 angle braced at 600 mm from joints.



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40 mm pocket
or 40 mm bar
slips 1 m
centers with
35 x 3 bar
reinforcing

- 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 galvanized bolts and nuts at about 125 mm centers. All flanges shall be connected to the ducts by rivets at about 125 mm centers. 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 shell ace 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 red oxide 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/M2 (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)

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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 masonry 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 riveted at approximately 125 mm centers to the casing. 'Pecora' or equivalent caulking compound shall be inserted between the base of angle and all masonry construction to which angles are fastened.
 - 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 aluminum 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 aluminum 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 finalization 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 Specialties

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i.	Unless otherwise specified herein the specified 150 mm NB shall be continuous welded Galv class. Piping for sizes 150 mm and larger sha 6.35 mm thickness.	cation. Pipin anized steel all conform to	g for sizes smaller than pipes to IS: 1239 heavy IS: 3589 with minimum		
ii.	Fabricated elbows from pipe (5 piece miter) 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.	iii. Unless otherwise specified, all flanges shall be ASA # 150 standard (as applicable) forged carbon steel slip-on flanges to A-105 Gr.II or approved equal, faced and drilled to ASA-B-16.5. The 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.	n 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 nstruments shall be as per manufacturer's drawings.				
v.	valves for sizes 65 mm and larger shall be 150 # ASA standard, double flanged, t iron body to IS:210 Gr.260, stainless steel trim, bolted bonnet, bolted gland, ng stem outside scraw and yoke, back seated, ends flanged (PF) faced and ed to ASA-B-16.5. All valves for sizes 50 mm and smaller shall be 800 class indard forged carbon steel body construction to ASTM A 105 stainless steel trim, on bonnets, rising stem inside screw, renewable seats ends female screwed to 554.				
vi.	The butterfly valves shall be designed as per between flanges. The butterfly valves shall black nitrile rubber integrally moulded seating, Gr. AB2/AB1, shafts of stainless steel AISI 4 for 16 bar; body/disc tested at 24 bar and seat	r AWWA C be provided disc of alumi 10. The butte at 14 bar.	504 and designed to fit with flow control lever, inum bronze to BS 1400 erfly valve shall be rated		
vii.	All the pipe supports, guides, anchors, turn be structural steel framing shall be furnished and support shall utilize the Purchaser's steel as secondary steel is required for the hange secondary auxiliary steel required for the hange the Purchaser's steel structure as directed by permitted across the bottom flange of main structure	uckles, rods, installed by far as practic ers, these sl gers and sup the Enginee uctural memb	hangers with secondary the Seller. The Seller's cable. Where additional hall be furnished. The ports shall be welded to or. Welding shall not be pers.		
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- viii. The bidder shall ensure that the location of hangers and supports shall not increase the force and moments on equipment beyond the permissible limits. The anchors shall be designed for rigid fastening to the structure directly or through brackets. As far as possible, attachments of supports brackets to brick walls shall be avoided. All concrete inserts shall be galvanized and shall be installed on the concrete structure where required for fastening supporting devices.
- ix. 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.
- x. 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.
- xi. All the drain piping between the drain connections of each equipment up to 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.
- xii. 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 throughout 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 arrangement.

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- 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 atomized 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/cm2 (g).

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- 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 stabilized 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 trav 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 alvanized 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 equipment, 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.

19.8.12 Centrifugal Fans for Evaporative cooling plants

- i. The casing shall be of welded construction fabricated with heavy gauge galvanized sheet steel or MS sheet with spray galvanization. In case of spray galvanization 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

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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 than 96%.
- viii. The static pressure of fan shall not be less than 75 mmwc.

Power Roof Extractors 19.8.13

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 aluminum 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.



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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.



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19.8.18 PLANT CONTROL FOR EVAPORATIVE COOLING AND VENTILATION SYSTEM

- 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 filtration 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 equipment, tripping of equipment, 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.

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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 air-conditioning system equipment (A/c units, ahus, cooling towers, pumps etc.)

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		REV. 00	DATE: 17-04-2018

SECTION: I

SUB-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).
 - (I.) 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)
- (I.) 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.
- 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.





- Thermal cvcle information (heat balance diagrams. boiler х. 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.
- Civil Task drawings(for the Engineering by Owner), Design and XXV. Drawings for the Civil & Structural works in the scope of the Bidder.
- Model study reports wherever applicable. xxvi.
- Functional & guarantee test procedures and test reports. XXVII.





- 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.
- I) 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.
- General layout plan and layout of main plant building and auxiliary5. 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 subvendors) 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.

- (I.) 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 resubmission. 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/ Coordination 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.





- (I.) 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 subcontractors 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, guality 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)	remperature	-	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 clearance of the project is at an advanced stage

Hence, it is stated that the implementation of Environmental measures including self monitoring system (for air, Water and land), 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	NO. OF CD-
		(sets)	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, DESIGNCALCULATI ONS, 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	



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S. NO.	DESCRIPTION OF MANUALS	NO OF PRINTS	NO. OF CD-	
		(sets)	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	





(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				

ANNEXURE-II





PRODUCT	AREAS OF TRAINING REQUIREMENT					
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant		
	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.					
	Layout of over all plant, steam generator area, pressure part arrangements, platforms, equipment, piping and duct, coal pipe, flue gas ducts, bunker arrangement, valves and damper, ESP area, cable & piping tressels etc.					
	Erection stretegies, erection procedures					
	Performance and demonstration tests.					
MANDAYS	120	20	20	20		
CFD model development and validation for Steam Generator	Familarisation of fundamentals and basis for the development of the CFD models.					
	Solving of set of simple problems by Employer's engineers with the help of trainer.					





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	-	-	-	





PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
TURBINE GENERATOR AND IT'S INTEGRAL	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	
AUXILIARIES	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.)			





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	Familiarization of power plants of various makes of feed pumps	Manufacturing process of various components of BFP	
	Criteria for selection of boiler	Data collection of BFP	Assembly of BFP	





PRODUCT	AREAS OF TRAINING REQUIREMENT				
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & & Maintenance Of Plant	
	Feed Pump parameters	parameters and configur ation			
	Rotor design, strength calculation and rotor dynamic behavior studies wrt critical speed, vibration etc	Collection of data for analysis of availability of BFP	Testing, capabilities of BFP at works wrt performance, NPSH, thermal shock, dry run, visual cavitation, string test, axial thrust measurement		
	Impeller design and its hydraulic behavior	O&M history/problems related to BFP	Product development in process		
	Role of critical para- meters such as NPSH(R), Suction specific speed, running clearances, speed etc. in design of feed pumps	Comparative studies for various types of BFP& its features	Future plan for technology induction		
	Material selection of BFP components		R&D work in progress		
	Guiding factors for selection of BFP seals				
	Computation of axial thrust under various flows				
	Performance calculation				
	Transient analysis in pump				





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	Collection of data for analysis of availability of Condenser	Testing capability at works		
	Condenser support selection & design	O&M history/problems related to condenser	Product development in process		
	Sizing of condenser w.r.t. super critical units		Future plan for technology induction		
	Latest technological trends in condenser arrangement and design		R&D work in progress		
	Condenser vacuum system design				





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	Comparative studies of salient features	Manufacturing process of various components of heaters		
	Basis of selecting horizontal/vertical heaters	Analysis of data	Assembly		
	Selection of TTD and DCAs for various heaters, and their effect on turbine heat rate	O&M history/problems related to heaters	Testing capability at works		
	Configuration of HP heaters (2x50% v/s100% capacity		Product development in process		
	Sizing criteria for De- aerator/Heaters		Future plan for technology induction		
	Selection of tube & tube sheet material of heaters		R&D work in progress		
	Latest technological trends in heaters design				
MANDAYS	15	10	10		
3-dimensional CFD modeling	CFD model develop ment and validation of design data for steam turbine, BFP, CEP, condenser, heaters etc.				




PRODUCT	AREAS OF TRAINING REQUIREMENT							
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant				
MANDAYS	20							
Compressors	Equipment Theory & Maintenance Practice							
MANDAYS	16		4					
Ash Handling System	Equipment Theory & Maintenance Practice							
MANDAYS	16	4	4					
Coal Handling System	Equipment Theory & Maintenance Practice							
MANDAYS	20	5	5					
H₂ Plant	Equipment Theory & Maintenance Practice							
MANDAYS	10	3	3					
Condensate Polishing Unit	Equipment Theory & Maintenance Practice							
MANDAYS	15	5	5					





PRODUCT	AREAS OF TRAINING REQUIREMENT						
	Product Design	Plant Visit	Visit Work	То	Manufacturer's	Operation & Maintenance Of Plant	
CONTROL & INSTRUMENTATION							
DDCMIS-Man Machine Interface - Hardware &	Hardware & Software organization of the system	Operational feedback					
Operating System	Basis of selection of H/W memory sizing						
	Operating system features, interface with other system, openness & inter- operability						
	Upgradability						
	System testing features						
MANDAYS	24	6				16	
DDCMIS-Man Machine	Specific system customisation	Operation feedback					
Interface System	Various system						
Application Software	modules & interface with OS						
	Database organization & development						
	Development of mimics						
	Other application like calculations, logs historical storage functionalities & use						
MANDAYS	40	6				8	





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	Operation feedback	Manufacturing processes special attention to handling of the modules				
	System capabilities & system design techniques		Maintenance facilities				
	Communication with MMI & other system						
MANDAYS	24	5	10				
DDCMIS-Control system Application Software	Database structure Organisation & inter- face between application program & database	Operational feedback	System integration & System capabilities testing				
	Application for implementation of Control functions						
	Study of standard algorithms & development of new algorithms						
MANDAYS	18	4	4				
DDCMIS - Control Loop Study Loop Study	General description of closed loop controls of thermal power plant	Specific operational feedback					
	Critical analysis of few control loops e.g., TSCS Stress Control boiler startup control etc.						





PRODUCT	AREAS OF TRAINING REQUIREMENT							
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant				
MANDAYS	12	4						
DDCMIS-Burner Management System	Hardware logic, NFPA/ VDE requirements other safety standard	Operational feedback	Manufacturing procedure& precautions for handling the system					
	Flame scanner location		System testing facilities					
MANDAYS	16	6	6	12				
DDCMIS - EHTC, Turbine stress control system, Turbine protection system& ATRS	Basic design concept& features Logics of turbine stress control system Implementation of failsafe philosophy in turbine protection system	Operational feedback	Manufacturing procedure & precautions for handling for handling the system System testing facilities					
MANDAYS	16	6	6	12				
Furnace and Flame	Theory & principle of operation	Operational feedback						
Viewing System.	Details of software & methods of modification/ customisation							
Misc. systems for SG/TG C&I								





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 &							





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:	Equipment Theory &								
System Engineering	Maintenance Practice								
MANDAYS	6	3	3						
PADO:	Equipment Theory &								
Operation & Analysis	Maintenance Practice								
MANDAYS	18	6	-						
Actuators	Equipment Theory & Maintenance Practice								
MANDAYS	18	-	6						
Simulator	Equipment Theory &								





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					





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	(a) Manufacturing process for					
	 Insulation system 	- Familarisation with	- Core					
	- Cooling medium & arrangement	different sub-systems	- 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					
	Excitor	- Familiarisation with various equipment functioning at reference	facilities for various					
	PMG		equipment of excitation system					
	Transformer	plants						
	Controllers & different limiters etc.							
	PSS & associated system studies							
MANDAYS	30	15	15					





PRODUCT	AREAS OF TRAINING REQUIREMENT						
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant			
Boiler Feed pump H.T. Motor	Design Criteria for the	Operational feed back	Manufacturing process & test facilities				
	Stator core & wdg						
	Rotor core & wdg						
	Insulation system						
	Cooling arrangement						
MANDAYS	20		5				
POWER TRANSFORMER	Equipment Theory & Maintenance Practice						
MANDAYS	12	-	4	4			
UPS/BATTERY CHARGER	Equipment Theory & Maintenance Practice						
MANDAYS	8	-	4	4			
GIS	Equipment Theory & Maintenance Practice						
MANDAYS	24	4	12	24			
SAS	Equipment Theory & Maintenance Practice						
MANDAYS	12	-	6	6			





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.							





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					





ANNEXURE-III

Project : LIST OF ITEMS REQUIRING QUALITY PLAN D					AN DOC.	NO.:							
		Sta	ge	:		AND SUB-SUPPL	AND SUB-SUPPLIER APPROVAL				REV. NO.:		
		Pa	ckage	:						DATE	:		
		Sup	oplier	:		SUB-SYSTEM:				PAGE	: OF		
		Bid	der No.	:									
S. N.	ltem		QP/ Cat.	Insp.	QP No.	QP Sub. Schedule	QP approval schedule	Proposed sub- supplier	Place	Sub- suppliers approval status/ category	Sub- supplier Details submission schedule	Remarks	
LEG 1. S A – DR – NOT be ic 2. C CAT CAT CAT conf	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. 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.												
UNI	5/WUKKS	: Pia	ce or ma	anutactu	ring Place	or main Supplier of mu	uiti units/work	S.					





ANNEXURE-IV

	Project : STATUS OF ITEM REQUIRING QP& DOC. NO.:										
		Packag	je :		SU	B-SUPPL	IER APPROVA	L	REV.	NO.:	
		Bidder	:						DATE	:	
		Bidder	No. :						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 manufacturi ng works	Appro val Status	Sub-supplier detail submission schedule	Remarks
		·	·	·	•						





ANNEXURE-V

		Project : Stage				Stage :	FIELD V	VELDING \$	SCHED	ULE			DOC. NO.:				
		Bidder	:	1			(To be r	aised by t	he Bidd	ler)				REV	/. NO.:		
		Bidder N	lo. :	1			Welding Code:						DATE :				
		System	:	1										PAG	SE :	(OF
SI. No.	DRG No. f	for Weld and	Descrip tion of	Matl. Spec.	Dime ons	ensi Process of	Type of	Electrod e filler	WPS. No.	Min. pre-	Heat tro	eatment	NDT meth	od/	REF		Re mar
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ANNEXURE-VII

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CHAPTER - 3

GUARANTEES

1.0 General

- 1.01 The term "Performance Guarantees" wherever appears in the Technical Specifications shall have the same meaning and shall be synonymous to "Functional Guarantees". Similarly the term "Performance Tests" wherever appears in the Technical Specifications shall have the same meaning and shall be synonymous to "Guarantee Test(s)".
- 1.02 The term "BMCR" (Boiler Maximum Continuous Rating) appearing in the Technical Specification shall mean the maximum continuous steam output of Steam Generator ("As guaranteed") at superheater outlet at rated parameters.
- 1.03 The term "TMCR" (Turbine Maximum Continuous Rating) appearing in the Technical Specification shall mean 800 MW electrical power output at generator terminals (power at generator terminals as per clause indicated in this section) under 0% cycle make-up and design condenser pressure.

2.0 PERFORMANCE GUARANTEES / PERFORMANCE TESTS

2.1 General Requirements

- 1. The Contractor shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in these specifications.
- 2. The guaranteed performance parameters furnished by the Bidder in his offer, shall be without any tolerance values whatsoever and all margins required for instrument inaccuracies and other uncertainties shall be deemed to have been included in the guaranteed figures.
- 3. 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 chapter. The guarantee tests shall be conducted by the Contractor at site in presence of Owner.
- 4. 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 bid price.
- 5. It is the responsibility of the contractor to perform the Performance Guarantee / Acceptance test as specified in this chapter. 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.
- 6. It shall be responsibility of the Contractor to make the plant ready for the performance guarantee tests. At all times during the Performance Tests the emissions and effluents from the Plant shall not exceed the Guaranteed Emission and Effluent Limits.
- 7. The Contractor shall make the plant ready for the performance guarantee tests.



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- 8. 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.
- 9. Tools and tackles, thermo wells (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.
- 10. The Performance test shall be carried out as per the agreed procedure. The PG test procedure including demonstration tests shall be submitted within 90 days of the date of Notification of Award and finalization of the PG test procedure shall be done within 180 days from the date of Notification of Award. 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. However, preliminary test reports shall be submitted to the Owner after completing each test run.
- 11. 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.
- 12. 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.

13. 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. Four (4) 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.





14. In case during performance guarantee test(s) it is found that the equipment/system has failed to meet the guarantees, the Contractor shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to the Owner and re-conduct the performance guarantee test(s) with Owner's consent. In case the specified performance guarantee(s) are still not met by the contractor even after modification and/or replacement but are achieved within the Acceptable Shortfall Limit as specified at clause 3.02 of this section, Owner will accept the equipment/system/plant after levying liquidated damages as per clause 3.02 of this section. However, if, the demonstrated guarantee(s) continue to be beyond the stipulated Acceptable Shortfall Limit, even after the above modifications / replacements within ninety (90) days or a reasonable period allowed by the Owner, after the tests have been completed, the Owner will have the right to either of the following:

A.) For Category-I Guarantees

Reject the equipment / system and recover from the Contractor the payments already made.

OR

Accept the equipment /system after levying Liquidated Damages as indicated in clause 3.02 of this chapter. The liquidated damages shall be prorated for the fractional parts of the deficiencies. The performance guarantees coming under this category shall be called `Category - I' Guarantees.

B.) For Category-II Guarantees

Reject the equipment / system 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.

C.) For Category-III Guarantees

Reject the equipment /system 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.

D.) For Category-IV Guarantees.

The parameters/ capability is to be demonstrated of various equipments/system as listed elsewhere in this chapter.

3.0 GUARANTEES UNDER CATEGORY-I

3.1 The Performance Guarantees which attract Liquidated Damages (LD) are as follows:





i.)Turbine Heat Rate

- a) Turbine heat rate in kcal/kWhr under rated steam conditions at design condenser pressure with zero make up at 840 MW unit load (i.e. 105% of rated load).
- b) Turbine heat rate in kcal/kWhr under rated steam conditions at design condenser pressure with zero make up at 800 MW unit load (i.e. 100% of rated load).

Turbine heat rate shall be computed as per formula specified elsewhere in the specification.

ii.)Turbine Generator Output

Continuous TG output of 840 MW unit load (i.e. 105% of rated load) under rated steam conditions design condenser pressure with 0% make-up.

The performance & acceptance of turbine generator shall be conducted in line with the requirement stipulated under clause 6.0 of this chapter.

iii.)Condenser pressure in mm Hg (abs)

Condenser Pressure in mm Hg (abs) for duel pressure condenser measured at 300mm above the top row of condenser tubes at 840 MW unit Load, 1% make 32.5 DegC cooling water temperature.

Design condenser pressure for duel pressure condenser shall mean average value of all the condenser pressures.

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

iv.) Steam Generator Efficiency.

- a) Efficiency of steam generator at 105 % TMCR(840 MW unit load) with 30 DegC ambient temperature & 75% RH at rated steam parameters, while firing design coal, rated coal fineness, rated excess air. The Guaranteed efficiency shall be based on GCV of Coal.
- b) Efficiency of steam generator at 100 % TMCR(800 MW unit load) with 30 DegC ambient temperature & 75% RH at rated steam parameters, while firing design coal, rated coal fineness, rated excess air. The Guaranteed efficiency shall be based on GCV of Coal.

v.) Steam Generator 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 elsewhere in the specification.

Steam Generator capacity shall be decided as per criteria specified elsewhere in the specification.

vi.)Coal Mill Wear Parts Warranty



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Life of coal pulveriser wear parts, in hours of operation, for the entire range of coal characteristics specified. (To be demonstrated as per clause 3.7 of this chapter).

vii.) Auxiliary Power Consumption

Auxiliary Power Consumption for all specified BTG & Its auxiliaries required for continuous unit operation at 800MW (i.e. 100 of rated load) under rated steam conditions and at design condenser pressure with 0% make up shall be guaranteed in line with the requirement stipulated in clause # 3.8 of this chapter.

Note: Power consumption of each of the pump / fan / coal Pulverizer / heater etc. wherever mentioned shall be measured with its own drive.

3.2 AMOUNT OF LIQUIDATED DAMAGES (LD) APPLICABLE UNDER CATEGORY-I GUARANTEES

If the performance guarantee(s) specified at clause 3.1 are not met by the Contractor even after the modifications and/or replacements mentioned at clause 2.1 of this Chapter but are achieved within the stipulated Acceptable Shortfall Limit as indicated in this clause, Owner will accept the equipment/system after levying liquidated damages as indicated hereunder. However, if the demonstrated guarantee(s) continue to be more than the stipulated Acceptable Shortfall Limit, the Owner may at his discretion reject the equipment/system and recover the payment already made or accept the equipment/system only after levying liquidated damages against the Contractor, at the rates listed herein, and such liquidated damages shall be deducted from the Contract Price:

SI. No.	Variation Factor	Loading for evaluation of shortfall in performance.	Penalty for shortfall in performance
1.	 Minimum Gross Turbine cycle heat rate at 105% TMCR after subtracting excitation power and power of TG integral auxiliaries with following conditions: a) Cycle make-up : 0% makeup b) Cooling water inlet temperature of 32.5 deg.C. c) TDBFP's in operation. d) Generator powerfactor of 0.85 (Gross Turbine cycle heat rate at 105% TMCR condition is guaranteed after accounting for pressure drop in main steam piping, Reheater system and all extraction steam piping from steam 	performance.	
	turbine to feed water heaters & deaerator)		



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SI. No.	Variation Factor	Loading for evaluation of shortfall in performance.	Penalty for shortfall in performance
2.	Minimum Gross Turbine cycle heat rate at 100% TMCR after subtracting excitation power and power of TG integral auxiliaries with following conditions:		
	a) Cycle make-up : 0% makeup		
	b) Cooling water inlet temperature of 32.5 deg.C.		
	c) TDBFP's in operation.		
	 d) 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) 		
3.	Total Auxiliary power consumption for the Plant (1600 MW) including balance of plant at 100% TMCR condition after subtracting excitation power and power of TG integral auxiliaries with following conditions: a) Cycle make-up : 0% makeup		
	b) Cooling water inlet temperature of 32.5 deg.C.		
	c) TDBFP's in operation.		
	d) Generator power factor of 0.85		
4.	Capitalization of losses of Transformers (applicable for each transformer separately for the transformers listed below) a) Generator Transformers		
	b) Unit Transformersc) Station Transformers		
	d) Standby/Maintenance Transformer		
	 Iron losses Copper losses Cooler pump/fan losses 		





SI. No.	Variation Factor	Loading for evaluation of shortfall in performance.	Penalty for shortfall in performance
5.	 Gross continuous TG power output at 105% TMCR after subtracting excitation power and power of TG integral auxiliaries with following conditions: a) Cycle make-up : 0% makeup b) Cooling water inlet temperature of 32.5 deg.C. c) TDBFP's in operation. d) Generator power factor of 0.85 		
6.	 Condenser Pressure in mm Hg (abs) for duel pressure condenser measured at 300mm above the top row of condenser tubes at 105% TMCR with following conditions. a) Cycle make-up : 1% makeup b) Cooling water inlet temperature of 32.5 deg.C. 		
7.	 Steam generator efficiency with following conditions: a) 100% TMCR b) Firing design coal. c) On Gross Calorific value (GCV) basis d) At 30 deg C DBT and 75% 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.) or actual whichever is higher h) With Out any heat credit 		





SI. No.	Variation Factor	Loading for evaluation of shortfall in performance.	Penalty for shortfall in performance
8.	Steam generator efficiency with following conditions:		
	 a) 105% TMCR b) Firing design coal. c) On Gross Calorific value (GCV) basis d) At 30 deg C DBT and 75% RH ambient air conditions. e) Excess air at economizer outlet at 		
	 105% TMCR load 20% (min.) f) Corrected flue gas temperature at air preheater outlet (at 105% 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.) or actual whichever is higher. h) With Out any heat credit. 		
9.	 Boiler Maximum Continuous Rating (BMCR) in TPH of steam at rated steam parameters at superheater outlet & rated steam parameters at reheater outlet with following conditions. a) Any combination of mill working as per Owner choice. b) With range of coal specified. 		
10.	Life of coal Pulverizer wear parts, in hours of operation, for the entire range of coal characteristics specified. (To be demonstrated as per clause 3.7 of this chapter).		

NOTE:

- a) Each of the liquidated damages specified above shall be independent and these liquidated damages shall be levied concurrently as applicable.
- b) If the contract currency is other than INR, then the liquidated damages shall be in equivalent amount in contract currency based on Bill selling exchange rate of State Bank of India prevailing on the date of award of contract.
- c) All these liquidated damages for short fall in performance shall be deducted from the contract price as detailed in accompanying General Condition of Contract (GCC) / Special Conditions of Contract (SCC).





- d) Contractor's aggregate liability to pay Liquidated Damages (LD) for failure to attain the functional guarantee shall not exceed twenty five percent (25%) of the Contract Price.
- e) The LD values and acceptable shortfall limits are applicable for one single 800 MW unit.

3.2.1 Guarantee under Category-I (Performance Guarantee under Penalty)

SI. No.	Particulars	Value inclusive of design manufacture and all other Tolerance.
1.	 Minimum Gross Turbine cycle heat rate at 105% TMCR after subtracting excitation power and power of TG integral auxiliaries with following conditions: e) Cycle make-up : 0% makeup f) Cooling water inlet temperature of 32.5 deg.C. g) TDBFP's in operation. h) Generator power factor of 0.85 (Gross Turbine cycle heat rate at 105% 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





SI. No.	Particulars	Value inclusive of design manufacture and all other Tolerance.
2.	Minimum Gross Turbine cycle heat rate at 100% TMCR after subtracting excitation power and power of TG integral auxiliaries with following conditions:	
	 f) Cooling water inlet temperature of 32.5 deg.C. c) TDDEDIS is exercised 	Kcal/Kwh
	 g) TDBFP's in operation. h) 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) 	
3.	Total Auxiliary power consumption for the Plant (1600 MW) including balance of plant at 100% TMCR condition after subtracting excitation power and power of TG integral auxiliaries with following conditions: e) Cycle make-up : 0% makeup	kW
	 f) Cooling water inlet temperature of 32.5 deg.C. 	
	g) TDBFP's in operation.h) Generator power factor of 0.85	





SI. No.	Particulars	Value inclusive of design manufacture and all other Tolerance.
4.	Capitalization of losses of Transformers (applicable for each transformer separately for the transformers listed below)	
	Generator Transformers a) Iron losses b) Copper losses c) Cooler pump/fan losses Unit Auxiliary Transformers a) Iron losses b) Copper losses c) Cooler pump/fan losses. Station Transformers a) Iron losses b) Copper losses c) Cooler pump/fan losses. Standby Maintenance Transformer. a) Iron losses b) Copper losses c) Cooler pump/fan losses. Standby Maintenance Transformer. a) Iron losses b) Copper losses c) Cooler pump/fan losses.	
5.	 Gross continuous TG power output at 105% TMCR after subtracting excitation power and power of TG integral auxiliaries with following conditions: a) Cycle make-up : 0% makeup b) Cooling water inlet temperature of 32.5 deg.C. c) TDBFP's in operation. d) Generator power factor of 0.85 	MW





SI. No.	Particulars	Value inclusive of design manufacture and all other Tolerance.
6.	 Condenser Pressure in mm Hg (abs) for duel pressure condenser measured at 300mm above the top row of condenser tubes at 105% TMCR with following conditions. a) Cycle make-up : 1% makeup b) Cooling water inlet temperature of 32.5 deg.C. 	mmHg(abs)
7.	 Steam generator efficiency with following conditions: a) 100% TMCR b) Firing design coal. c) On Gross Calorific value (GCV) basis d) At 30 deg C DBT and 75% 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.) or actual whichever is higher h) With Out any heat credit 	%





SI. No.	Particulars	Value inclusive of design manufacture and all other Tolerance.
8.	 Steam generator efficiency with following conditions: a) 105% TMCR b) Firing design coal. c) On Gross Calorific value (GCV) basis d) At 30 deg C DBT and 75% RH ambient air conditions. e) Excess air at economizer outlet at 105% TMCR load 20% (min.) f) Corrected flue gas temperature at air preheater outlet (at 105% 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.) or actual whichever is higher. h) With Out any heat credit. 	%
9.	 Boiler Maximum Continuous Rating (BMCR) in TPH of steam at rated steam parameters at superheater outlet & rated steam parameters at reheater outlet with following conditions. c) Any combination of mill working as per Owner choice. d) With range of coal specified. 	ТРН
10.	Life of coal Pulverizer wear parts, in hours of operation, for the entire range of coal characteristics specified. (To be demonstrated as per clause 3.7 of this chapter).	Hrs.

3.3 Turbine Cycle Heat Rate

Turbine Cycle Heat Rate shall be calculated as follows & indicated in all computed heat balance diagrams:

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

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.
- 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.
- Pg Unit output after deducting the power consumption by auxiliaries as listed below and the same shall be 800MW and 840 MW respectively for 105%, and 100% TMCR unit load:
 - (a) Power taken by Excitation system (KW) including excitation 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 Gland Steam Exhauster (GSC) if GSC Exhausters are separately driven
 - (h) Power required for any other continuously operating integral auxiliary. These need to be specified during bidding stage.

3.4 Applicable corrections for Turbine Heat Rate, Output and Condenser Pressure

(i) Corrections Applicable for Turbine Cycle Heat rate & Turbine Generator Output tests

Based on cycle condition & covering entire range of operation for Turbine following correction curves for variation in Turbine Cycle Heat rate & Turbine Generator output to be furnished:

- (a) Variation in main steam pressure.
- (b) Variation in main steam temperature.
- (c) Variation in reheater steam temperature.





- (d) Correction Curves, if applicable, due to change in reheater spray quantities with respect to coal properties.
- (e) Variation in condenser pressure for main condenser.
- (f) Variation in power factor, frequency, generator hydrogen pressure and voltage.
- (g) Change in system water storage.

(ii) Corrections Applicable for Condenser pressure Guarantee

- (a) Change in CW inlet temperature.
- (b) Change in CW quanitity.

3.5 SPECIFIC AND LIMITING REQUIREMENTS FOR STEAM GENERATOR EFFICIENCY

- (i) Guaranteed Steam generator efficiency shall be calculated as per the requirements of PTC 4 and as per stipulations of Clause 3.6 of this section.
- (ii) The guaranteed efficiency quoted by the Bidder shall comply with following limiting parameters with design coal firing:

a.	Excess air at economizer outlet at 105% & 100% TMCR load	20% (min.)
b.	Corrected flue gas temperature at air preheater outlet (at 105% & 100% TMCR)	125 degree C or as predicted by the Bidder whichever is higher
C.	Unburnt fuel at all efficiency load at 105% & 100% TMCR load	1.0 % (min)

- (iii) 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 (a), (b) & (c) above are lower than those specified above.
- (iv)For the purposes of guarantees the ambient air temperature and relative humidity shall be taken as 30 degree Celsius and 75% respectively.
- (v)Unless otherwise specified, the guarantees shall be based on design coal firing with coal/ash analysis as specified elsewhere in the specification.
- (vi)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

3.6 MAJOR REQUIREMNTS/ METHOD OF STEAM GENERATOR EFFICIENCY TESTS

a)	Test Code	As per ASME PTC 4
b)	Test Loads	105% TMCR (840 MW unit Load)
		100% TMCR (800 MW unit Load)
C)	Test Conditions	Boiler operating with rated excess air at economiser outlet, coal
		fineness and firing design coal.
d)	Ambient air	30 degree Celsius temperature (Dry bulb) and 75% relative
	condition	humidity. The reference air temperature for the Steam





		Generator efficiency guarantee/ testing shall be taken as the temperature of air (i.e. 30 degree Celsius) entering APH.		
e)	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.		
f)	Measurement and co	Measurement and computation of heat losses: As Per ASME PTC 4		
g)	The guaranteed stean	n generator efficiency shall be without any heat credit.		
h)	The Steam Generator of 30 degree Celsius a	efficiency shall be guaranteed based on ambient air temperature and relative humidity of 75%.		
i)	Correction to tested ef only:	ficiency shall be applicable for variation in following parameter		
	(a) Ambient air temperature.			
	(b) Relative humidity of ambient air.			
	(c) Hydrogen in coal.			
	(d) Moisture in coal.			
	(e) GCV of coal.			
	(f) Percentage of ash in coal.			
j)	The duration of the test shall be at least four hours. No soot blowing shall be allowed during the test period or during stabilization period of four hours prior to commencement of the test.			
k)	The Bidder shall furnish the correction curves, for Owner's approval covering the expected ranges of variations for all these parameters for the range of coal specified. These curves shall be submitted along with Techo-commercial bid			
I)	For all other aspects, not spelt out above, or in the specifications, where code stipulates the agreement between the parties concerned before commencement of the test, the Bidder shall get these approved by the Owner. However no correction to SG efficiency on account of variation in turbine cycle parameters, or vice versa shall be allowed.			
m)	The number, location, type and accuracy of the test grade thermocouples and pressure gauges shall be to Owner's approval			
n)	The Steam Generator mills in operation to O	efficiency testing shall be carried out with any combination of wner's choice, with fineness of pulverized coal as specified.		
0)	Steam generator effici whichever is higher.	ency shall be with guaranteed or actual air heater leakages,		

3.7 MAJOR REQUIREMENTS FOR COAL PULVERISER WEAR PART WARRANTY

- a) The Contractor shall warrant the wear life of all wear parts of the coal pulveriser when grinding the specified range of coal(s). Pulveriser wear parts are defined as those parts of the pulveriser which are in contact with coal or coal dust and are likely to wear out during the operation of the pulveriser. The guarantee/warrantee shall be demonstrated on each pulveriser during the Guarantee Trial Period (GTP) commencing after establishing successful operation of the pulveriser continuously for a period of not less than twenty four (24) hours, at or near its guaranteed rated capacity. The GTP for the respective wear part(s) shall be at least two years or the wear life of that wear part(s), whichever occurs later. The establishment of the specified coal. The average wear life (AWL) of the mill wear parts during GTP shall, however be corrected for the variation in YGP index for the coal fired during GTP.
- b) **Minimum Guaranteed Life** for various coal pulveriser wear parts shall be as indicated elsewhere in the specification.





c) 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 pulveriser (as per requirements of Technical Specification) during the guaranteed life of the wear part. No weld build-up or reversing of grinding elements will be permitted for achieving the guaranteed wear life. In case any of the wear part has worn out to such an extent that either the normal or safe operation of the pulveriser is jeopardized if this part is not replaced/repaired, or continuous use with this part may lead to exposure or wear of other parts which are not meant for the purpose of checking the shortfall in wear life, even if there is no reduction in pulveriser rated capacity of pulveriser is defined in subsequent section of Technical Specification. If any of the wear parts fail to meet the warranted life, additional quantities of these wear parts shall be supplied on pro-rata basis as defined in Clause 3.7 g) below.

d) Computation of Credit for GTP

For the duration of this warranty period, the replacement wear parts shall be available to the Owner at the spare part price indicated in the Contract, adjusted as per terms and conditions of the Contract. For wear parts that do not fulfill warranty requirements, credit shall be provided at the end of GTP to the Owner at the rate of one and a half times the shortfall worked out on item wise pro-rata basis. For example should an individual wear part or set of wear parts taken together have a price of Rs.10,000 (Rupees ten thousand) and any of the wear part or any part of wear parts set that failed to meet the warranty test lasts only 6000 hrs, a credit of 1.5 times of 2000 hrs out of guaranteed 8000 hrs or Rs.(10000x1.5x2000)/6000 would apply towards Owner and shall be provided by the Contractor. This credit shall be worked out for each replaced wear part/wear part set, throughout the GTP. This credit shall apply to all the affected mandatory spare parts purchased under original Contract.

e) Computation of Liquidated Damages for remaining plant life

On the expiry of GTP (minimum 2 years), deficiency in the life of each wear part that has not fulfilled the warranty will be worked out on an item wise basis and shortfall so established due to reduced wear life and its implications for the remaining plant life shall be worked out. The contractor at no extra cost to the Owner shall provide one and half times the wear parts needed to make good the shortfall in the wear life during the plant operation period of 23 years from the successful completion of GTP or the remaining of 25 years of plant life period after completion of GTP for the respective wear part.

f) The shortfall part settlement (SPS) will be calculated based on the actual wear life at the parts that have worn-out in the GTP on a pulveriser-by-pulveriser basis. In this connection the procedure given below in clause 3.7 g) shall be followed.

g) Pulveriser Warranty Shortfall Part Settlement (SPS) Procedure (With Example):

For all wear parts of each vertical coal pulveriser:

S. No.	Description	Procedure	Example
(i)	Guaranteed wear life of wear part	(say X hours)	X=15000 Hrs.
(ii)	Total life achieved by failed wear part for two similar parts 1 & 2 (say X1 & X2 hours)	X1=12000 Hrs X2=13000 Hrs	Life of wear parts replaced during guarantee trial period (GTP)
(iii)	Average wear life (AWL) of		



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	failed wear parts	$AWL = \frac{X1 + X2}{2}$	$AWL = \frac{12000 + 13000}{2}$
(iv)	Short fall in Hrs Total shortfall for wear part during 2 year GTP	S = (X - X1) + (X - X2)	(15000-12000) + (15000-13000) = 5000
(v)	Shortfall part settlement (SPS)	$=\frac{S \times (25 - GTP)}{AWL \times GTP}$	$=\frac{5000 \text{ x } (25-2)}{12500 \text{ x } 2}$
			= 4.6 = 5.0 (say) (To be rounded off to next higher whole
			next higher whole number)

- h) The Contractor shall provide to OWNER either the wear parts of original or better quality material in number equivalent to one and a half times the quantity worked out based on the method explained in the above example so as to compensate for the shortfall in wear life for a plant life of 25 years as has been established above, or the cost of such number (i.e. one and half times the quantity worked out as per the above example) of wear parts based on the prices agreed for mandatory spares. The final mode of compensation for such shortfall viz by means of additional quantities of spares worked out or by cost thereof shall be as per Owner's discretion. The total cost of such replacements shall be without any limit to the maximum amount recoverable subject to the provisions of Clause 3.2 note (d) of this chapter.
- i) Average Wear Life (AWL) during GTP, to be considered for pulveriser wear part warranty shall be as arrived at from the station record for each pulveriser, and as corrected for variation in YGP index of the coal being fired during GTP. For this purpose the coal YGP shall be the average tested value during GTP. The Contractor shall collect the coal samples and get them tested for YGP index at recognized, Owner's approved test lab, periodically. (The frequency of sampling and testing shall be mutually agreed between Contractor & Owner). The YGP index testing shall be done as per the Standard specified. A jointly signed record shall be maintained during GTP.

3.8 AUXILIARY POWER CONSUMPTION

3.8.1 Unit Auxiliary Power Consumption

The unit auxiliary power consumption shall be calculated using the following relationship.

- Pau = Pu + TL (Unit)
- Pau = Guaranteed Unit 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 for unit.

The power consumption (Pu) of entire unit auxiliaries fed from unit transformers shall be measured at the incomers of respective unit boards. Suitable correction for auxiliaries not in service at the time of this measured power consumption like MDBFP etc, shall be done on as per the technical specification.

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:




- (i) Turbine Unit Oil purifier.
- (ii) Turbine Unit control oil purifier.
- (iii) Electric oil heaters for turbine lube oil (if applicable).
- (iv) Feed and discharge pumps of turbine oil purification system.
- (v) Main turbine Condenser air evacuation pumps.
- (vi) BFP drive turbine Condenser air evacuation pumps (if envisaged).
- (vii) BFP drive turbine Condensate extraction pumps (if envisaged).
- (viii) Main turbine Condenser tube cleaning system pumps.
- (ix) BFP drive turbine Condenser tube cleaning system pumps (if envisaged).
- (x) Condensate extraction pumps.
- (xi) Drip pump (if envisaged).
- (xii) COLTCS
- (xiii) Hydrazine dosing pumps (if required).
- (xiv) Ammonia dosing pumps (if required).
- (xv) Oil purifiers of 2x50% TDBFPs and their feed and discharge pumps.
- (xvi) Lube oil pumps of 2x50% TDBFPs and the electrical oil heater for lube oil.
- (xvii) Auxiliary oil pump for MDBFP.
- (xviii) Oil pumps for HP-LP bypass system.
- (xix) Motor Driven Boiler Feed Pump (For this purpose only 15% of the deemed power consumed by the MDBFP at 100% TMCR unit load shall be considered).
- (xx) BFP Booster pumps (if applicable)
- (xxi) Mills.
- (xxii) Rotary Classifier
- (xxiii) PA Fans.
- (xxiv) FD Fans.
- (xxv) ID Fans.
- (xxvi) Air Heaters.
- (xxvii) Coal Feeders.





- (xxviii) Steam Generator Start up drain recirculation Pumps (If required).
- (xxix) Seal Air Fans.
- (xxx) Lube oil pumps for fans/ Air heaters & mill system etc
- (xxxi) Scanner air fans.
- (xxxii) Electrostatic Precipitator with all ESP fields of all ESP passes working and rapping system in normal operation (as measured at the input terminals of the TR set. Refer Note 4 below).
- (xxxiii) Gas Recirculation Fan (if applicable)
- (xxxiv) Air Conditioning Plant for Main Plant Area, ESP Control Room,
- (xxxv) Power consumption of any other continuously operating auxiliary for unit operation at 100% TMCR.

Note:

- 1. The bidder shall furnish a list of equipment's to be covered under Unit auxiliary power consumption, which shall be subject to Owner's approval.
- 2. The bidder shall ensure that power supply to all such equipment's to be covered under unit auxiliary power consumption is fed from unit board of the respective unit.
- 3. Number of coal mill and coal feeders shall be corresponding to the design coal.
- 4. Method of Computation of Auxiliary Power consumption for ESP:-

For guarantee purpose, total maximum continuous Auxiliary power consumption will be the power consumption of corona power (Excluding power consumption by hopper heaters, insulator heaters, rapping system, ventilation fans etc.) of all fields of all passes of ESPs for one unit. Corona power of TR sets will be computed at the input terminals of the TR sets when all ESP fields of all ESP passes are working and rapping system is in normal operation at the guarantee point condition as specified. The measurement for guaranteed auxiliary power consumption shall be carried out during ESP collection efficiency test. The method for computing the corona power shall be as described below:-

- a) Power consumption of TR sets will be measured pass wise and for one pass (Say ESP-A) at a time with the help of energy meter in ESP MCC.
- b) Energy meter reading will be taken before starting the collection efficiency test and after completion of collection efficiency test.
- c) Before starting collection efficiency test, switch off all the TR sets serving to one pass (ESP-A) temporally and note down energy meter readings for period t1 i.e. E1. Power consumed by hopper heaters, shaft and support insulator heaters and rapping systems shall be W1 = E1/t1.The time period t1 shall be minimum 4 hours.
- d) During the collection efficiency test the total energy fed in to ESP MCC of one pass (say ESP-A) will be measured during entire period of collection efficiency test i.e. E2. Total time period (t2) of test shall be noted. The power consumption shall be W2=E2/t2. During this period, no change in the status of hopper





heaters, insulator heaters, rapping system, ventilation fans etc. will be allowed w.r.t. the condition at clause c) above. In case there is any change in the status of hopper heaters, insulator heaters, rapping system, ventilation fans etc., then auxiliary power consumption test will be repeated again.

- e) Measured corona power consumption for one pass (say ESP-A) = (W2-W1)
- f) Measured corona power of one unit= Corona power of (ESP-A + ESP-B + ESP-C + ESP-D + ESP-E + ESP-F).
- g) Number of fields shall be as per the PG test of ESP as detailed elsewhere.

4.0 GUARANTEES UNDER CATEGORY-II

4.1 The Performance Guarantees, conformances to which are mandatory are as follows:

4.1.1 Particulate Emission / ESP Efficiency

Contractor's design shall ensure that the particulate emission from ESP(s) shall not be more than 17 mg/ Nm3 under guarantee point as specified elsewhere in the specification at 100 %TMCR i.e. at 800 MW unit load with design coal firing and all field in service.

The corresponding ESP efficiency shall be worked out as per the procedure outlined in clause 4.2 of this Chapter.

4.1.1 NOx emission

Contractor shall guarantee that maximum total NOx emission from the unit shall not be more than 510 grams of Nox per Nm³ at 6% O2 level on dry gas basis(from thermal as well as fuel) 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 in control range of steam generator.

4.2 Method of Computing Test Efficiency of ESP & Suspended Particulate Matter Emission of Esp.

- 4.2.1 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.
- 4.2.2 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 six 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.:

$$Di = \frac{(Vm1 \times Di1) + (Vm2 \times Di2) + (Vm3 \times Di3) +}{(Vm4 \times Di4) + (Vm5 \times Di5) + (Vm6 \times Di6)}$$

Where suffix 1, 2, 3, 4, 5 & 6 are representing the six gas streams.

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.

$$Ti = \frac{(Ti1 \times Vm1) + (Ti2 \times Vm2) + (Ti3 \times Vm3) +}{(Ti4 \times Vm4) + (Ti5 \times Vm5) + (Ti6 \times Vm6)}$$
$$Ti = \frac{(Ti4 \times Vm4) + (Ti5 \times Vm5) + (Ti6 \times Vm6)}{(Vm1 + Vm2 + Vm3 + Vm4 + Vm5 + Vm6)}$$

d) The measured test efficiency shall be:

$$Em = \frac{Di - Do}{Di} \times 100(\%)$$

- e) The corrections for the flue gas flow and ESP inlet flue gas temperature in excess of the values for these parameters under guarantee point conditions, shall be allowed only in case and to the extent such variations are caused solely due to changes in specified coal properties and ambient conditions. Further, the corrections for the flue gas flow and temperature lower than the guarantee point values shall be applied based on actually measured test values. Subject to the above, the corrections for the variation in flue gas flow, inlet dust burden and ESP inlet flue gas temperature shall be based on the above computed test values and the procedure indicated in the next para.
- 4.2.3 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:

$$Ec = 1 - e^{Z}$$

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).
- 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 three corrected test efficiencies.

However, method & detail procedure shall be subjected to Owner's approval.

4.2.4 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

4.3 Guarantee under Category-II (Performance Guarantee under Compulsory Rejection)

SI. No.	Particulars	Value inclusive of design manufacture and all other Tolerance.	Applicable Test Code
1.	Nox Emission (within the range of coal specified)	mg/Nm ³	
2.	Particulate Emission at 100% TMCR with design coal firing and all field in service.	mg/Nm ³ .	

5.0 GUARANTEES UNDER CATEGORY-III

The parameters/capabilities to be demonstrated for various systems/ equipments shall include but not be limited to the following:





5.1 Noise

- 5.1.1 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.
- 5.1.2 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.
- 5.1.3 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.
- 5.1.4 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

5.2 Equipment Cooling Water System

- a) Parallel operation of pumps without undue noise & vibration to be demonstrated at site.
- b) Pressure drop across the heat exchanger on the primary & secondary water circuit to be demonstrated at site.
- c) 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.

5.3 Steam Generator and Auxiliaries

Category-III Guarantees of this sub-section for various systems/ equipment for steam generator and auxiliaries shall be based on and demonstrated corresponding to ambient air condition of 30 deg. C temperature & 75% RH.

(i) Coal Pulveriser capacity at rated fineness

Performance testing shall be conducted on coal pulverisers toward establishing their guaranteed capacity meeting the specification requirement. Corrections may be applied for the variation in coal characteristics i.e. HGI & Total Moisture of test coal with respect to specified design coal.

Capacity demonstration test shall be carried out for the following conditions:

- (a) The Contractor shall demonstrate capacity output on one coal pulveriser (of Owner's choice) of Steam Generator for establishing its capacity at 100% mill loading, at rated pulverized coal fineness with specified design coal with new set of grinding elements.
- (b) Further, Contractor shall also demonstrate capacity output on four coal pulverisers (of Owner's choice) of Steam Generator, not less than the 85% 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	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 Contractor successfully demonstrates the guaranteed capacity of coal pulverisers as stated above, 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 by the contractor to demonstrate guaranteed capacity.

During the demonstration of the pulveriser capacity output, manufacturer's operating instructions will be followed and pulveriser will be operated with the specified range of coals without any such readjustment that requires a shutdown of the pulveriser or reduction of the load and/or any replacement of any pulveriser 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 pulveriser measured capacity shall be corrected using the capacity correction curves furnished by the Contractor and approved by the Owner. HGI versus coal pulveriser capacity curve shall be furnished for HGI variation upto a value above which the capacity remain constant.

(ii) Furnace Exit Gas Temperature (FEGT)

The Contractor shall conduct a comprehensive thermal performance test (TPT). Through such TPT the Contractor, by indirect measurement, shall demonstrate that the Furnace Exit Gas Temperature (FEGT) does not exceed the specified maximum temperature limit, with coal pulverizer combinations to Owner's choice and all other requirement in line with Section 2, Chapter 1 of Volume III (Mechanical) of Technical Specifications. The demonstration shall be done by backward calculations method, after having measured/tested/calculated the economizer outlet gas temperature (average), excess air (average), unit heat load (based on turbine flow and reheater flow), characteristics of coal being actually fired during testing, heat absorption in different stages of heat transfer equipment's (based on steam/water temperature and pressure measurements) etc. FEGT for the specified design and worst coals shall be calculated using the measured FEGT (with test coal) as above and using computer modeling technique for necessary conversion of the results to the specified design and worst coals. The FEGT demonstration using computer modeling technique shall involve following steps:

- (a) Development of a computer field model (FM) (backward) using above measured/computed field data. This will be used to calculate the surface effectiveness factor (SEF) for each of heat transfer banks including furnace water walls with test coal.
- (b) The above field model shall have to be validated by various tests (loads, coal pulverizer combination etc. with test coal) to ensure SEFs for each bank are consistent (within ±5%) for all tests.





- (c) Using above SEFs, for each heat transfer bank contractor's original boiler design model will be changed to make it project specific to this EPC Package.
- (d) The validity of the above model shall be checked for each test by feeding the test coal both from backward direction FM and the calibrated "(Project Name) TPS Specific" model as per step-(c) above. The model validity is established if the results for flue gas temperature profile in the boiler, zonal assumptions etc. are identical in both the 'BACKWARD' and 'FORWARD DIRECTION'.
- (e) The validated "(Project Name) TPS Specific" model shall have "Fuel Switching" capability i.e. it shall be able to appropriately vary the furnace absorption with changes in the coal properties. Validation of the above fuel switching capability will also have to be established to the satisfaction of Owner.
- (f) Having established and demonstrated FUEL SWITCHING capability, the contractual FEGT can be demonstrated by using the SITE SPECIFC calibrated model as per step-(d) and plugging in the specified coal(s).

The detailed procedure and the correction curves for the above test shall be to Owner's approval.

The contractor through thermal performance test (TPT) as per above shall also demonstrate that the flue gas temperature (Actual/MHVT values) at the entry and exit of various boiler heating surfaces and also the variations across the cross section perpendicular to gas flow do not exceed the values indicated in the data sheets for 100% TMCR (800 MW).

(iii) Run back capability

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/ BFP etc.) shall be demonstrated ensuring smooth and stable runback operation.

(iv) Air Preheater Air in Leakage

Contractor shall demonstrate that the air-heater air-in-leakage and maximum drift in air leakage do not exceed the guaranteed or specified value (whichever is lower) as per indicated in subsequent section of Technical specifications. Above requirement needs to be complied with recirculation of flue gas (if applicable) from downstream of ESP

5.4 The parameters/capabilities to be demonstrated for following systems/ equipments shall be:

5.4.1 **Turbine hall EOT Crane:**

Over load test, travel & hoist speed checks etc., shall be demonstrated as per IS: 3177 (latest edition).

- 5.4.2 **EOT Cranes:** Over load tests, travel and hoist speed checks etc. as per relevant Indian standards IS (latest edition).
- 5.4.3 **HOT Cranes, Monorails etc.: Over** load test, Travel and speed checks, functional and performance tests as per relevant Indian standards IS (latest edition).

5.5 Mill Reject System

5.5.1 Continuous effective discharge and conveying at the rated capacity of the mill rejects without spillage or blockage in the system.



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- 5.5.2 A) Following shall be demonstrated at shop for compressor
 - > **Power consumption**, Capacity and discharge pressure of each air compressor
 - B) Following shall be demonstrated at site for compressor,
 - > Parallel Operation of air compressor, if applicable
 - Vibration and noise level of air compressors

5.6 Condensate Polishing Plant

Effluent quality at the outlet of each vessel at its rated design flow and design service length between two regenerations (as defined elsewhere).

Pressure drop across polisher vessel in clean & dirty condition.

5.7 Solar PV cell capacity test.

The performance Guarantee (PG) Test shall be carried out after successful commissioning of all solar rooftop locations. PG Test shall be carried out on any rooftop location by measuring Performance Ratio (PR) and comparing to the Guaranteed PR. The test shall be repeated for each location having different type of inverter. The mathematical formula for calculating PR is given below:

For the purpose of measuring Global Inclined Insolation (GII), another pyrometer shall be installed by the Contractor.

5.8 Guarantee under Category-III (Performance Guarantee under Compulsory Correction)

SI. No.	Particulars	Unit	Value inclusive of design manufacture and all other Tolerance.	Applicable Test Code
1.	Noise Level	dBA		





SI. No.	Particulars	Unit	Value inclusive of design manufacture and all other	Applicable Test Code
			Tolerance.	
2.	Equipment Cooling Water System. a) Pressure drop across PHE. • Primary Side • Secondar y Side.	mmWC		
	b) Design heat Load of PHE.	Kcal/Kwhr		
	 c) Inlet & outlet temp. of PHE Primary Side Secondary 	DegC		
3.	 Steam Generator & Auxiliaries. a) Coal Pulveriser capacity at rated fineness. b) Furnace Exit Gas Temperature (FEGT). c) Run back capability. d) Air Preheater Air in Leakage 	TPH DegC %		
4.	 A. Turbine hall EOT Crane a) Over Load Test. b) Travel & Hoist Speed Check. B. Other hall EOT Crane a) Over Load 			





SI. No.	Particulars	Unit	Value design and Toleran	inclusive manufact all o ce.	of ture ther	Applicable Test Code
5.	 Mill Reject System. a) Capacity of compressor. b) Power consumption of compressor. 					
6.	Condensate Polishing Unit. a) Pressure drop across CPU. • Clean condition • Dirty condition.	mmWc				
7.	Solar PV cell capacity test.					

Flor Other Category II Guarantees Refer Volume - I

6.0 GUARANTEES UNDER CATEGORY-IV

The parameters/ capability is to be demonstrated of various equipments/system as listed below:-.

6.1 Start-up time

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

6.2 Performance characteristics of fans

Satisfactory operation of FD, ID and PA fans without undue noise and vibration while operating in isolation or in parallel with other fans shall be demonstrated at site.

6.3 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 100 C under all load conditions.

6.4 SH and RH tube metal temperature

It shall be demonstrated that superheater and reheater tube metal temperature at critical locations remain within maximum tube metal temperature limits as per design of the OEM under various load conditions (i.e. 100%, 80%, 60% & 50%).

6.5 Superheater and reheater attemperation system





It shall be demonstrate that the spray water flow of SH attemperation system does not exceed 8% of main steam flow, at superheater outlet, while firing any coal from within the range specified with HP heaters in service while maintaining the rated SH outlet steam temperature at all loads upto and including BMCR. It shall also be demonstrate that the RH temperature is maintained at the rated value without any spray water requirement under normal operating conditions.

6.6 Generator excitation system

The performance of generator excitation system as specified shall be demonstrated.

6.7 Steam condensing plant

- i. Temperature of condensate, at outlet of condenser, shall be demonstrated to be near to saturation temperature corresponding to the average condenser pressures of duel pressure condenser at all loads.
- ii. Oxygen content in condensate at hotwell outlet shall not exceed 0.015 cc/litre over 50-100% load range and shall be determined according to calorimetric Indigo-Carmine method.
- iii. 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.
- iv. When one condenser is isolated, condenser shall be capable of taking at least 60% T.G. load under TMCR conditions.
- v. The design 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 degC below the temperature corresponding to absolute suction pressure shall be demonstrated. Correction curves for establishing the capacity at site conditions shall also be furnished.
- vi. The air and vapour mixture from air cooling zone of condenser shall be 4.17 degC 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.
- vii. Pressure drop across of condenser cooling system with COLTCS in operation

6.8 Rate of change of load and sudden load change withstand capability

The contractor shall demonstrate capability of boiler-turbine-generator in regards to ramp rate and step load change as specified and sudden load change withstand capability.

6.9 No fuel oil support shall be required above 35% BMCR

Contractor shall guarantee that oil support for flame stabilization shall not be required beyond 35% of BMCR load when firing the coals from the range identified. The Contractor shall demonstrate that with any combination of mills/ adjacent mills in service (to Owner's choice) the Steam Generator does not require any oil firing for stable and efficient boiler operation at and above 35% BMCR loads.

6.10 ESP Air in Leakage

Bidder shall guarantee that ESP air in leakage shall be limited to 1% of the total gas flow under guarantee point conditions.



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6.11 Pressure Drop across ESP

Bidder shall guarantee that the maximum flue gas pressure drop across the ESP under specified guarantee point conditions shall not exceed 20 mmWC for base offer ESP.

6.12 Feed Water Heaters and 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)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.
- d)Free carbon dioxide in deaerator effluent shall be non-traceable at all loads from zero to VWO with 1% cycle make up.
- e)Continuous and efficient operation and performance of feed heating plant without undue noise and vibrations at all loads and duty conditions.

6.13 HP/LP Bypass capabilities

The HP/LP Bypass system shall satisfy the following functional requirements under automatic interlock action. It shall 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 these conditions while passing the required steam flows as per the relevant heat balances, the condenser shall be able to swallow the entire steam without increasing the exhaust hood temperature and condenser pressure beyond the maximum permissible value indicated by the BIDDER in his offer and accepted by the OWNER.

6.14 Power cycle pumps

Satisfactory operation of BFPs and CEPs, drip pumps (if required) without undue noise and vibration while operating in isolation or in parallel with other pumps shall be demonstrated at site.

6.15 Condenser on load tube cleaning system

Life of sponge rubber balls and number of balls lost during 1000 hours of plant operation as agreed in contract shall be demonstrated.

6.16 Automatic on-line turbine testing (ATT) system

On-load testing of turbine protective equipments without disturbing normal operation and keeping all protective functions operative during the test shall be demonstrated.

6.17 Power Cycle Piping



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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.

6.18 Air Conditioning & Ventilation System

- **A.** Following shall be demonstrated at Shop.
 - 1) Capacity and discharge pressure of chilled water pumps, condenser water pumps and pumps of air washer and unitary air filtration units at its rated duty point of Air conditioning and Ventilation system.
 - Capacity and static pressure of air washer unit fans, Unitary air filtration unit fans, roof exhausters of TG building and AHU fans at its rated duty point of Air conditioning and Ventilation system.

B. Following shall be demonstrated at Site

- 1) AC plant capacity of each area and guaranteed room conditions during summer for all the Air conditioned areas.
- 2) Parallel operation, Vibration & Noise level of all rotating equipment's.

6.19 Fuel Oil System

- a) Pressurizing pumps shall be guaranteed for capacity, total dynamic head either in isolation or during parallel operation.
- b) Entire piping and supports for smooth operation within terminal points of the bidder.

6.20 Passengers & Goods Elevator

The elevators shall be subjected to the following tests:

- i) Overload test.
- ii) Travel speed and hoist speed checks.
- iii) Drop test.
- iv) Checks for interlocks & safety systems.
- v) Checks for operation from inside the cage.

6.21 ESP Particulate Emission.

Particulate emission from ESP_s shall be less than 30 mg/Nm³ at 105% TMCR load (840 MW) with worst coal firing and any one field (of each pass) are out of service.

6.22 Balancing of Coal/Primary air Flow.

Contractor shall balance the primary air as well as coal flow in pulverized fuel pipes such that minimum PF & PA flow imbalance in the PF pipes from each coal Pulverizer does not exceed 5 % of average flow.

6.23 Cold Air velocity test (CAVT)

A CAVT shall be conducted on each steam generator during commissioning before its final operation to establish the average cold air velocity and velocity distribution at minimum three predetermined section (Owner choice) of steam generator. The data





obtained from the CAVT will be used to compute the actual flue gas velocities as well as their distribution at test section during actual operation by co-relating the CAVT data with the test computed data. Through this test contractor shall also demonstrate the compliance with the specification requirement regarding the maximum allowable flue gas velocities as specified elsewhere in the specification.

Contractor shall submit a detail CAVT test procedure for Owner approval.

6.24 Auxiliary Boiler Rating

Contractor shall demonstrate the rated parameters of Auxiliary Boiler its steam generating capacity as specified elsewhere in the specification.

7.0 TURBINE GENERATOR PERFORMANCE/ ACCEPTANCE TEST

- 7.1 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 840 MW (105% TMCR) MW and 800 MW (100% TMCR) unit outputs corresponding to the conditions stipulated in Chapter-2: Turbine Generator and Auxiliaries, Volume-III. Power consumed by the auxiliaries mentioned in this 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.
- 7.2 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 national (within India) institute / laboratories, 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 in original submitted to Owner at least 15 days before conductance of the test for Owner's approval. 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 downstream 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.

7.3 Corrections to the test results for steam turbine shall be applied as per the correction curves listed in detailed 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).



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7.4 The performance guarantee test will be carried out after successful completion of initial operation. Ageing allowance (beyond three months from the date of completion of initial operation) 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.

- 7.5 The tests shall be arranged in a manner that the OWNER's operation is not disrupted. Duplicate test runs shall be performed at 840 MW and 800 MW unit loads. The results of corrected heat rate shall agree within 0.25%. If they differ by more than 0.25%, additional test run(s) shall be made at the same point until corrected heat rates of at least two test runs agree within 0.25% and the achieved heat rate shall be calculated as average of test run points satisfying the above criterion.
- 7.6 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 840MW (105% rated load) corresponding to the heat balance diagram specified in the tender specification.
 - (ii) Guarantee Turbine Cycle Heat rate test at 800 MW (100% rated load) corresponding to the heat balance diagram specified in the tender specification.
 - (iii) Guarantee Output test of 840 MW (105% rated load) corresponding to the heat balance diagram specified in the tender specification.
 - (iv) Maximum continuous output corresponding to both strings of HP heaters out of operation, corresponding to the heat balance diagram specified in the tender specification.

8.0 TEST REPORTS

- 8.1 The Contractor shall prepare test reports in which the methods followed, instrument readings, graphs, observations, final results obtained etc. and shall be recorded.
- 8.2 Four (4) hard copies and 2 soft copies on CD –ROM of each test report shall be submitted to OWNER for Approval.
- 8.3 Performance Guarantee/ Acceptance Tests on the equipment / systems not covered in this Sub-section shall be carried out as per the procedure/ test codes/ specified in respective detailed specifications/ Sub-sections in Volume III to VI.





CHAPTER 24

QUALITY ASSURANCE PLAN TURBINE GENERATOR

1.1 GENERAL REQUIREMENTS

i. Shop Tests

Shop tests shall include all tests to be carried out at Contractor's works, at works of his sub-contractor and at works where raw material supplied from manufacture of equipment is manufactured. Testing requirement of major equipment over and above the respective code / standard requirements are given for STG & Aux. including Condenser, HP Bypass System & Vibration Isolating System.

ii. Site Tests

The Contractor shall prepare and submit detailed field quality plans by setting out the quality practice and procedures to be adopted by him for assuring quality for each equipment of material at this specification from the receipt of material at site, during storage erection, pre commissioning to final commissioning of the plant. These procedures shall necessarily include all checks/tests conducted at site for preservation, assembly, alignment, positioning of the equipment, foundation preparation, welding/bolting heat treatment, non-destructive examination, hydraulic test, running test, performance test etc. The Contractor shall also furnish detailed quality procedure proposed by him for storage, preservation, painting, acid cleaning, alkali boil out, steam blowing, hydraulic test air/gas tightness test etc. to the Owner. The same shall be discussed and finalized with the Owner and six numbers of such finalized copies shall be submitted.

1.2 STEAM TURBINE AND ASSOCIATED EQUIPMENT

1.2.1 High Pressure & Intermediate Enclosure

- 1.2.1.1 High pressure Cast Steel Enclosures (for example High pressure and Intermediate Pressure Inner and Outer Cylinders, Steam Chests and liner, Steam Inlet Pipes, nozzle boxes).
 - 1) Test pieces fully representative of the material and condition of the casting shall be provided to enable the properties of material to be determined.

Creep requirements:

- a) Steels chosen for design metal temperatures less than 400°C are exempt from creep /stress rupture testing.
- b) Steels chosen for design metal temperatures between 400°C to 540°C and having less than 3% chromium, shall require 5 years performance feedback experience in the absence of which, creep rupture test will be required to be carried out for maximum test duration of 1000 hrs/mutually agreed parameters for Owner approval.
- c) Steels chosen for design metal temperatures above 540°C and/or having more than 3% chromium, shall require 10 years performance feedback experience OR adequate stress rupture data, in the absence of which, creep rupture test will be required to be carried out for maximum test duration of 1000 hrs/mutually agreed parameters for Owner approval.



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- d) Unspecified alloying elements shall be controlled as per the applicable standard.
- Each casting shall be subjected to magnetic particle examination on 2) the entire inner and outer surfaces after heat treatment.
- 3) Each casting shall be subjected to a 100% examination for internal flaws by ultrasonic/ radiographic method after heat treatment and suitable preparation.
- Cast enclosure shall be subjected to a hydraulic pressure test based 4) on established practice of manufacturer. Bidder to furnish their practice in this regard for Owner approval.
- 5) Excavated area of all the defects shall be subjected to MPI to ensure excavation up to sound area. All the areas repaired/upgraded by welding shall be examined by UT, RT (to confirm findings of UT wherever required) and MPI. Sketches/reports of location of repair and reports of NDT carried out on repaired with certificates. Hardness survey shall be areas shall be submitted along carried out on the repaired area.
- Where stub pipes and transition pieces are welded to the main body of 6) an enclosure the following shall be carried out:
 - Radiographic examination and Magnetic particle or dye penetrant i. examination of weld preparation.
 - ii. Magnetic particle examination of finished welds after stress relief.
 - iii. Radiographic or ultrasonic examination of finished welds.
 - iv. Before dispatch to site, the site weld preparations on the stub pipes and transition pieces shall be subjected to 100% RT/UT and magnetic particle examination.
 - Hardness survey on the weld joint, HAZ and parent material. ٧.
- Wall thickness measurement by ultrasonic for critical and highly stressed zones 7) of the casting shall be carried out.
- 8) Colour matching of castings by putting two halves together and feeler gauge tightness check from both sides, i.e. inside and outside to ensure required contact area and joint tightness shall be carried out.

1.2.2 Low Pressure Enclosure (Fabricated)

- Where welds are made by chipping and grinding back to the first side weld a) before completing the weld from second side, a magnetic particle or dye penetrant examination of the chipped area shall be carried out.
- Bidder to furnish their practice regarding stress relieving of the fabricated b) enclosures for Owner approval.
- C) Bidder to furnish their standard practice regarding NDT on welds for Owner approval, however following are minimum NDT requirements:

Butt welds	10% RT or UT and 10% MPE/DP test
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Fillet welds	10% MPE/DPT
Nozzle welds	10% MPE/DPT
Lifting lug & other load bearing fillet welds	100% MPE/DPT
Site weld edge preparations	10% MPE/DPT

- d) Bidder to furnish his proven practice for hydraulic pressure tests. If it is not their practice, the justification for not carrying out hydraulic test shall be furnished for Owner approval.
- e) Feeler gauge tightness check from inside and outside to ensure required joint tightness shall be carried out.

1.2.3 **Rotors**

a) Forgings

Rotor forgings (mono block and/or discs), Impulse Wheel & Nozzle Box and coupling forgings:

- Fully representative tangential, radial and axial test pieces shall be provided at each end of the body, at each shaft end and from the trepanned core (when a core is trepanned) to determine mechanical properties including impact, brinell hardness etc. and tests for notch toughness i.e. FATT / NDTT (both transition temperature and room temperature impact values).
- 2) Creep requirements:
 - a) Steels chosen for design metal temperatures less than 400°C are exempt from creep /stress rupture testing.
 - b) Steels chosen for design metal temperatures between 400°C to 540°C and having less than 3% chromium shall require 5 years performance feedback experience in the absence of which, creep rupture test will be required to be carried out for maximum test duration of 1000 hrs/mutually agreed parameters for Owner approval.
 - c) Steels chosen for design metal temperatures above 540°C and/or having more than 3% chromium, shall require 10 years performance feedback experience or adequate stress rupture data, in the absence of which, creep rupture test will be required to be carried out for maximum test duration of 1000 hrs/mutually agreed parameters for Owner approval.
 - d) Unspecified alloying elements shall be controlled as per the applicable standard.
- 3) Heat treatment should be carried out in such a way so as to ensure minimum residual stress in the rotor. Residual stress measurement will be carried out.
- 4) Each forging shall be subjected to a 100% ultrasonic examination. Normal probes and angular probes with different probe angles shall be used for thorough examination to ensure complete soundness of the



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forging. Supplier should furnish the proposal, along with scanning plan and probe angles to be used, for Owner approval.

- 5) Each rotor shall be subjected to a 100% magnetic particle examination after final machining on journal areas and before gashing on other areas.
- 6) When a rotor forging is bored, a visual and magnetic particle examination of the bore shall be carried out.
- 7) Thermal stability tests shall be carried out on HP and IP rotor forgings to ensure the thermal stability of the rotors in service and at over speed.
- 8) Following tests shall be carried out on the rotor welds:
 - i. Ultrasonic examination with normal and angular probes of the weld to ensure complete coverage and freedom from harmful defects.
 - ii. Run out of rotor before and after welding
 - iii. MPE on finish welds.
 - iv. Hardness survey on the welds
 - v. Stress relieve annealing.
 - vi. Test reports of filler material used.
 - vii. Dimensional record of weld preparation.
- 9) Dimensional Examination of the rotor blade grooves and other important dimensions to be carried out to ensure the conformance to drawing dimensions, Log sheets/records shall be prepared for all important dimensions.

b) Complete Rotors

- Axial & radial run-outs and surface finish checks shall be carried out before and after blading and after over speed tests. Run out examination will be carried out at blade shrouds also.
- 2) Check for clearance between rotor groove and blade at the root.
- 3) Rotors shall be dynamically balanced at rated speed.
- 4) An over speed test shall be carried out during which the rotor shall withstand an over speed of 120% for two continuous minutes. If bidder's practice is different from as stated above, then same shall be furnished to Owner approval. During this test vibration measurement and analysis shall be carried out.
- 5) After blading and again after over speed testing, rotor stages with blades over 225 mm of active length are to be given standing vibration tests to determine natural frequencies in various vibration modes to ensure that the ranges are outside operating frequencies. The modes to be tested are: Bucket group tangential, wheel axial and group axial.



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- 6) In case, impulse stage and or blade discs are fitted on the rotor, fit up between such disc and rotor to be checked up before and after over speed.
- 7) Lock blade lift after the over speed shall be checked and record for same shall be maintained.

1.2.4 Stator & Rotor Blades and Shroud Bands

- a) Fully representative test pieces shall be provided to enable mechanical properties of the material to be determined. In case of blades machined from bar stock, mechanical tests shall be carried out on the hardest and softest specimens of each heat treatment batch. Hardness test will be carried out on 100% basis.
- b) Each bar stock for machining blades and forging shall be subjected to 100% ultrasonic examination.
- c) When erosion shielded, the erosion shield and blade joint shall be radiographed.
- d) Dye penetrant checks shall be made on the erosion shield and blade joint in manufacture prior to fitting to the wheel and after over speed tests.
- e) Magnetic particle inspection or dye-penetrant examination (when MPI is not applicable) shall be carried out on finish machined blade profile, roots and shrouds.
- f) All moving blades of over 225 mm active length are to be moment weighed and assembled on shaft in a prescribed sequence to ensure optimum balancing of rotor.
- g) Natural frequencies of the L.P. Turbine blades shall be determined before mounting on rotors to ensure that the same are outside operating frequency range.
- h) Shroud bands after punching and after rivet-ting shall be subjected to 100% DPT to ensure freedom from harmful surface defects.
- i) In case of cast blades, following testing shall be done:-
 - 1. Chemical analysis/Mechanical testing per heat/heat treatment batch.
 - 2. Rough machined and finish machined blade shall be subjected to MPI.
 - 3. RT on blades.
 - 4. Before starting mass productions, following technological tests shall be carried out on the first lot of 10 to 15 blades :
 - i. 100% radiography and 100% MPI on blades
 - ii. 100% hardness testing.
 - iii. Mechanical testing and metallurgical testing.
 - iv. Weld repair shall not be permitted unless prior approval of Owner is obtained.



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1.2.4.1 In case of repair is allowed, manufacturer shall submit WPS/PQR and defectogram for Owner approval before welding. After weld repair, RT shall be carried out on repaired area.

1.2.5 Diaphragms

- a) Welded and fabricated Diaphragms
 - 1) Concentricity checks shall be carried out on finally machined diaphragms to ensure that there are no negative overlaps between guide and moving blades.
 - 2) 10% Ultrasonic examination and 100% magnetic particle examination shall be carried out on finished, stress relieved and machined welds.
- b) Cast/Forged/Machined Diaphragms
 - Details of the results of the tests conducted to determine mechanical properties together with chemical analysis, metallographic/ metallurgical examination, and heat treatment procedures recommended and actually followed shall be recorded on certificates.
 - 2) Concentricity, flatness, blade drop and area checks shall be carried out on finally machined diaphragms to ensure that there are no negative overlaps between guide and moving blades and port wall. Finish shall be to Owner approval.
 - 3) A 100% ultrasonic examination shall be carried out on diaphragm materials. Blade junction areas with the side walls shall be checked by magnetic particle or dye penetrant testing.
- c) Colour matching of all the diaphragms by putting two halves together, and feeler gauge tightness check shall be carried out.

1.2.6 Stop, Control and bypass valves, actuators/servo-motors and steam strainers

a) Test pieces shall be provided to enable the mechanical properties of valve bodies, bonnets, valve disc and seat, and valve spindle material to be determined.

Test Creep requirements:

- i. Steels chosen for design metal temperatures less than 400°C are exempt from creep /stress rupture testing.
- ii. Steels chosen for design metal temperatures between 400°C to 540°C and having less than 3% chromium, shall require 5 years performance feedback experience in the absence of which, creep rupture test will be required to be carried out for maximum test duration of 1000 hrs/mutually agreed parameters for Owner approval.
- iii. Steels chosen for design metal temperatures above 540°C and/or having more than 3% chromium, shall require 10 years performance feedback experience OR adequate stress rupture data, in the absence of which, creep rupture test will be required to be carried out for maximum test duration of 1000 hrs/mutually agreed parameters for Owner approval.



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- iv. Unspecified alloying elements shall be controlled as per the applicable standard.
- b) Dye penetrant checks shall be carried out on stellited / nitride areas of components and stellite components in the finish ground or honed condition. Hardness check shall be carried out to ensure required hardness.
- c) Valve body and bonnet castings/forgings shall be subjected to 100% radiography or 100% ultrasonic examination. Body and bonnet shall also be subjected to 100% magnetic particle examination on entire surface. All pressure containing welds in body and bonnet shall be subjected to 100% RT/UT and MPI examination.
- d) Wall thickness of the body and bonnet after finish machining shall be measured by ultrasonic method and valve seat bore shall be checked for size and concentricity.
- e) Bar stock for valve stem shall be subjected to ultrasonic examination and finish machined stem shall be subjected to magnetic particle/Dye penetrant examination.
- f) Each valve body and bonnet shall be hydraulically tested at minimum 1.5 times the maximum working pressure after applying temperature corrections.
- g) All the actuating cylinders/servomotors shall be performance tested.
- h) Performance testing shall be carried out on valve operators/ actuators to check functional requirements like trip closing and opening time, valve lift and hysteresis.
- i) Colour matching of the valve disc and seat to ensure the required contact area is to be carried out.
- 1.2.7 Cast and Forged Steel Components such as LP casing, in case of cast design, inlet & extraction / exhaust connections, shaft seal covers and rings, governor shaft, breach nut, threaded ring, angle ring, U-ring, servomotor parts such as body, piston, cover, yokes; turning gear casing and other items which are not specifically covered elsewhere
- 1.2.7.1 Results of tests conducted to determine mechanical properties, chemical analysis, metallurgical/ metallographic examination, and heat treatment procedures recommended and actually followed shall be recorded on certificates.
- 1.2.7.2 Each pressure containing enclosure shall be subjected to a hydraulic pressure test at 1.5 times the design pressure.
- 1.2.7.3 Each casting/forging shall be subjected to suitable non-destructive examination by Radiographic or ultrasonic and magnetic particle or dye penetrant examination methods to ensure freedom from harmful defects.

1.2.8 Bolts and nuts for pressure Retaining enclosures and Rotor Couplings

- a) Bar stock for bolts shall be subjected to ultra- sonic examination.
- b) Finish machined bolts shall be subjected to magnetic particle examination for surface defect examination.
- c) Coupling bolts and nuts shall be suitably identified after weight control checks.



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1.2.9 Governing and Protection System Equipment such as Electro-hydraulic Controller, Hydraulic Amplifier, Hydraulic Controller, Electro hydraulic Convertors, Hydraulic Convertors, Hydraulic Speed Governor, Trip Devices etc.

- a) All pressure retaining parts shall be subjected to hydraulic testing.
- b) All the major castings/forgings shall be subjected to suitable NDT methods depending upon their application and criticality to ensure the freedom from harmful defects.
- c) All the main assemblies and sub-assemblies shall be subjected to functional test.
- d) All butt welds shall be subjected to minimum 10% RT/UT and all fillet and corner welds shall be subjected to MPI/DPT.
- e) All control equipment shall be subjected to rig testing, if it is not possible to test it on the steam turbine light run. The purpose of rig testing shall be as far as practical to prove that the functioning of the control equipment is in accordance with the approved design.
- f) Nitride and stellited components will be subjected to DPT and hardness check shall be carried out on test sample.

1.2.10 Inspection of Completed Turbine

- 1.2.10.1 The steam turbine shall be assembled in the manufacturer's works to such an extent that a thorough inspection can be carried out. The purpose of this inspection will be to ensure that the fit between mating components is correct and that all clearances are in accordance with the design requirement. Contractor will prepare the checklist in this regard and submit the same for Owner approval. However, minimum clearances which are required to be checked and records to be maintained during assembly of Inner Casing Rotor, Inner Casing Outer Casing, Rotor Outer Casing, Gland Steam Housing Shaft Casing etc. are shroud diameters, axial distances for shroud bands for casings, clearance between shaft seal casings and shaft seal rings, radial and axial blade clearance in blading section, axial and radial alignment of rotor in respect of shaft seals, alignment of over speed governor etc. This is indicative check only. However, the details shall be finalized during QP finalization stage.
- 1.2.10.2 These check lists shall be designed so that a comparison can be made between the design clearances, the clearances measured during works assembly, and those measured during the site turbine build. The vendor shall state, in his proposal, whether or not it is his practice to carry out no load works running tests on the steam turbine.
- 1.2.10.3 These tests shall be:
 - a) Part of a no-load run under steam and / or
 - b) By approved rig tests.

1.3 AUXILIARIES OF STEAM TURBINE

1.3.1 Bearing Pedestals and Bearings

- a) Cast Pedestals & Housing Leakage tests shall be conducted on pedestals.
- b) Fabricated Pedestals & Housing



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- 1) Leakage test shall be conducted on pedestals.
- 2) 10% weld shall be checked after stress relieving by magnetic particle test and minimum 10% of the butt welds will be checked by RT or UT.
- c) Bearings shell
 - 1) The shell and castings\forgings shall be subjected to suitable non destructive examination like RT\UT & MPI as applicable.
 - 2) Colour matching of the shells by putting two halves together and feeler gauge tightness checks from inside and outside to ensure required contact area and joint tightness shall be carried out.
 - 3) The shell shall be subjected to hydraulic pressure test.
 - 4) Chemical analysis of white metal shall be carried out. The effectiveness of the white metal adhesion shall be checked by ultrasonic or other approved method and the exposed edges of the white metal shall be subjected to a dye penetrant examination.

1.3.2 Cross around pipes

- a) Weld edge preparation of shop and site welds shall be checked by magnetic particle examination
- b) All butt welds shall be subjected to 100% Radiographic examination.
- c) Magnetic particle examination shall be carried out on all welds.

1.3.3 LUBRICATING OIL, JACKING OIL AND CONTROL OIL SYSTEMS

- a) **Pumps**
 - 1) Main oil pump shaft shall be subjected to ultrasonic examination. Butt welds shall be subjected to RT/UT.
 - Pump impeller shall be subjected to suitable NDT method like MPI/DPT for surface defect examination. Impeller of main oil pumps shall also be subjected to an over speed test at 120% of rated speed for 5 minutes.
 - 3) Pump casing shall be subjected to hydraulic pressure test at 2 times the working pressure or 1.5 times the pump shut off head whichever is higher. Rotor assemblies shall be dynamically balanced.
 - 4) All pumps shall be performance tested at the manufacturer's works. Test shall include check for vibration and noise levels also. Procedure for performance testing shall be submitted to Owner for approval.

b) Oil purifiers.

- 1) All pressure parts will be subjected to hydraulic pressure test.
- Components/parts of the equipment shall be subjected to suitable NDT depending upon the criticality of the application to ensure freedom from surface and sub surface defects.



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- 3) All rotating parts like bowl assembly etc, shall be subjected to static and dynamic balancing test.
- 4) The complete purifier shall be tested at manufacturer's works for capacity, mechanical running sequential operation and interlocks, moisture content, vapour tightness, vibration, noise level, quality improvements etc. Sample shall be drawn from inlet and outlet of purifier after works test and shall be tested for moisture content, chemical tests and particle size of impurities.
- c) Refer relevant clauses of the specification for other items such as piping, heat exchangers, valves, filters, blowers / exhausters etc in this system.

1.4 STEAM SURFACE CONDENSERS FOR MAIN TURBINE CONDENSER AND DRIVE TURBINE CONDENSER (IF OFFERED)

1.4.1 Shell, Hotwell, Water Boxes, Doors and Tube sheets.

- a) All welds shall be visually examined. Radiographic examination of 10% of butt welds shall be carried out. However, for vacuum containing welds, R.T on at least 10% of each butt weld shall be carried out. Surface defect examination by magnetic particle inspection or equivalent test method shall be carried out for minimum 10% weldments. This shall apply to site welds also.
- b) All edge preparations shall be examined for surface defects. Edge preparation for welds to be carried out at site shall be checked by magnetic particle inspection method before dispatch.
- c) In case of fabricated flanges, welds shall be checked by 100% radiographic / ultrasonic and 100% magnetic particle inspection methods to ensure freedom from internal and surface defects.
- d) To ensure dimensional control of condenser, parts\sub assemblies shall be trial assembled at shop. BIDDER shall furnish his proposal in this regard, which will be subject to Owner approval. Trial insertion of a few tubes through main tube plates and support plates shall be carried out to ensure alignment of tube plates and proper fitting and matching of parts\sub-assemblies.
- e) Bidder to furnish his practice regarding stress relieving of the water boxes and water chambers.
- 1.4.2 Condenser Tubes shall be tested as per the requirements of relevant codes and standards.

1.4.3 Steam Throw Off Device

- a) Edge preparations shall be examined for surface defects by MPI/DPT. 10% radiographic or ultrasonic examination shall be carried out for all weldments.
- b) Welds shall be subjected to surface defect examination by 10% magnetic particle/dye penetrant examination.

1.4.4Spring Assembly

a) Static load testing of the springs shall be carried out and spring characteristics shall be drawn and verified.



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- b) Surface defect test shall be carried out on all the springs after coiling and heat treatment.
- c) Surface cleaning shall be checked prior to painting and check for thickness of painting shall be carried out.

1.5 CONDENSER AIR EVACUATION SYSTEM FOR MAIN TURBINE CONDENSER AND DRIVE TURBINE CONDENSER (IF OFFERED)

1.5.1 **Pumps**

- a) Vacuum pump shafts shall be subjected to ultrasonic test. After finish machining, shaft shall be subjected to magnetic particle examination/dye penetration test.
- b) Pump casings and impellers shall be subjected to magnetic particle/dye penetration test. Finished pump rotor shall be subjected to dynamic balancing.
- c) Pump casings shall be subjected to hydraulic test at 1.5 times the shut off pressure or twice the maximum operating pressure, whichever is higher.
- d) Each pump shall be tested at supplier's works at full speed and load conditions to demonstrate successful operation and performance in accordance with the design requirements.
- e) Supplier shall demonstrate by carrying out visual cavitation test that pump will be operating under all operating condition including blank off condition without cavitation.
- f) Refer relevant clauses of the specification for other items such as heat exchangers, filters, piping, valves, etc. in this system.
- 1.5.2 The complete package shall be subjected to hydraulic pressure and leakage test and shop tested to check interlocks and functional requirements. The one complete unit shall also be subjected to demonstrate successful operation and performance testing, with saturated air conditions at condenser design vacuum point as well as vacuum pump design point with total minimum three points The test should be conducted with the respective motors to be supplied. The test shall include check for vibration and noise level.

1.6 FEED WATER HEATER, DRAIN COOLERS, GLAND STEAM CONDNSER, HEAT EXCHANGERS & PRESSURE VESSELS / STORAGE TANKS

- 1.6.1 All raw materials used shall have co-related mill test certificate meeting mandatory and supplementary checks of material specification.
- 1.6.2 Material for Tube plates shall be ultrasonically tested. Finished plates shall be subjected to suitable NDT. For cladded plates, bonding shall be checked by UT. Vendor shall furnish their practice regarding manufacturing & NDT for supply of cladded plates for Owner review. Drilled Tube plates shall be checked for ovality of holes, ligaments, surface finish etc.
- 1.6.3 Dished ends shall be subjected to 100% MPI and RT/UT on welded joints. Knuckle portion shall be checked by MPI for surface defects and thinning shall be checked by UT.
- 1.6.4 Butt Welded / Full penetration joints shall be checked by suitable RT / UT. Fillet welds shall be checked by MPI / DPT.



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- 1.6.5 Tubes shall be tested as per the relevant codes / specification / standards.
- 1.6.6 Before tubes expansion in the tube sheets, the mockup test for expansions shall be carried out, in case not done earlier. Torque setting of expander shall be based on mock up tests. Joints shall be checked for tube thinning.
- 1.6.7 Completed assemblies shall be pressure tested with working-fluid/ hydraulically/ pneumatically. The heat exchangers shall be tested on both tube side and shell side. After hydro test, the heat exchangers shall be suitably dried and nitrogen capped. Atmospheric tanks shall be tested for leakage by water fill test for at least 12 hrs.

1.7 PIPING, BELLOWS AND THERMAL INSULATION FOR TURBINE & AUX SYSTEMS

1.7.1 **Piping and Fittings**

- a) All raw materials used shall have co-related mill test certificate meeting mandatory and supplementary checks of material specification.
- b) All pipe lengths shall be subjected to 100% ultrasonic examination or hydraulic tests and UT/RT on longitudinal welds at the tube mill.
- c) All mother pipes used for fittings shall be subjected to a hydraulic test or an ultrasonic test at the tube mill. Raw material of all forged fittings shall be ultrasonically tested. Forged fittings shall be ultrasonically tested.
- d) Welded and cast fittings, if any, shall be subjected to suitable NDT as per applicable standards. However, as a minimum 100% RT shall be carried out on all alloy steel fittings and on carbon steel fittings for use above 71 bar design conditions.
- e) The edge preparation for shop and site welds shall be checked by MPI/LPI however edge preparation in stainless steel alloy/ steel shall be subjected to a Dye penetrant check.
- f) Thickness of pipe bends shall be checked by ultrasonic or other acceptable methods on sample basis for high pressure applications. Outer surface of bends shall be subjected to magnetic particle examination / LPI.
- g) Non-destructive examination of welds shall be carried out after post weld heat treatment, if any.
- h) Non-Destructive Examination of welds shall be carried out in accordance with the relevant design/manufacturing codes. However, as a minimum, the following requirements shall be met (except for oil piping). Further statutory requirement, wherever applicable shall also be complied with
 - 1) Temperature > 400°C and / or pressure exceeding 71 bar.
 - i. 100% RT/UT on butt welds and full penetration branch welds.
 - ii. 100% MPE.
 - 2) Temperature > 175°C up to 400°C and / or pressure exceeding 17 bar and up to 71 bar.
 - i. 100% RT / UT on butt welds and full penetration branch welds for pipe dia more than 100 NB.



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- ii. 10% RT / UT on butt welds and full penetration branch welds for pipe dia up to 100 NB.
- iii. 100% MPE.
- 3) Wherever SR/PWHT is envisaged, above NDTs shall be after SR/PWHT.
- 4) For all other pipes not covered above (except oil piping), shall be subjected 100% MPE / DPT in case of underground pipes and 10% MPE/DPT in case of piping above the ground. Further, 10% of butt welds of underground piping shall be subjected to RT.
- 5) Hardness survey of welds shall be carried out on alloy steel/stainless steel piping. (100% Hardness survey of welds on P91, X20 & X22 material grade pipings).
- 6) For welds in P91, X20 & X22 materials, only induction type of heating shall be deployed for heat treatment.

i) Oil piping shall be subjected to following NDT.

- Butt welds of Oil piping shall be subjected to 10% RT and 10% DP Test. For Jacking oil lines 100% RT & 100% DPT shall be carried out on butt welds.
- 2) Fillet welds with load transfer shall be subjected to 100% MPE/DPT and fillet welds without load transfer shall be subjected to 10% MPE/DPT.
- Rubber lined pipes shall be hydraulically tested before rubber lining. All rubber lining is to be subjected to following tests as per IS-4682 part-I or acceptable equivalent:
 - 1) Adhesion test
 - 2) Check for resistance to bleeding
 - 3) Measurement of thickness
 - 4) Shore hardness test
 - 5) Visual examination and spark test at 5 kv/mm of thickness.

1.7.2 Metallic Expansion Bellows

- a) Hydraulic pressure test shall be carried out on each pipe and expansion bellow.
- b) Longitudinal butt weld on bellow shall be subjected to suitable NDT examination before forming, and after forming MPE / DP test shall be carried out.
- c) All welds shall be subjected to 100% magnetic particle/dye pentrant check and butt welds shall be subjected to 100% radiographic testing.
- d) All the bellows subjected to vacuum service shall be subjected to vacuum test.
- e) The bellows shall be subjected to movement test to establish suitability to perform satisfactorily in site conditions. During this test spring rate shall also be measured.



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f) Life cycle test, meridional yield rupture test and squirm test to be carried out on a prototype / expansion bellow as per Sec.D clause 3.2 of standards of Expansion joint Manufacturer Association (EJMA). In case these tests have already been accepted by Owner on a prototype expansion bellow, as defined in Sec.D Clause 3.2 of Expansion Joints Manufacturers Association (EJMA) test reports may be furnished by manufacturer for consideration and approval of Owner.

1.7.3 Rubber Expansion Joint

- a) Rubber compound test slab after valcanising shall be tested for tensile strength, elongation and shore hardness. Tests on rubber compound shall also include hydrostability test as per ASTM D-3137 and ozone resistance test as per ASTM D- 380.
- b) Fabric strength of synthetic fiber for reinforcement shall be checked, and test for rubber to fabric adhesion as per IS:3400/ASTM D- 413, rubber to metal adhesion as per IS 3100/ASTM D-429 shall be carried out.
- c) All expansion joints in assembled condition shall be subjected to vacuum test at 730 mm Hg under conditions to ensure its suitability to withstand deflection in each axial transverse and longitudinal direction. Duration of test shall be of minimum 10 minutes.
- d) All bare bellows shall be subjected to hydraulic pressure test in normal condition at twice the design pressure for a duration of 30 minutes.
- e) Additionally, all bare bellows shall be subjected to deflection tests under pressure, pressure being raised from zero to the design value in regular steps and deflection measured at each step.
- f) All expansion joints in assembled condition along with control rod assembly shall be subjected to deflection test under design pressure. The details of test procedure shall be subjected to approval by Owner.
- g) Either during the hydraulic test or during the vacuum test, change in circumference at the top position of the arch shall not exceed 1.5% of measured circumference at normal position.
- h) Twenty Four (24) hours after the above tests, the permanent set (variation in dimensions with respect to its original dimension) shall be measured and recorded. The permanent set shall not be more than 0.5%.
- Life cycle test and burst test shall be carried out on bellows of each type, design and size. In case these test have already been accepted by Owner in earlier projects for the same type / size /design, test certificate for the same may be furnished for approval of Owner.

1.7.4 Thermal Insulation

- a) For mineral wool insulation, testing shall be carried out as per IS:3144.
- b) For sprayed mineral wool, testing shall be carried out as per IS:9724.
- c) Thermal conductivity (k value) shall generally be measured in line with IS:3346.

1.7.5 Hangers and Supports



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- a) Forged components such as clevis, turnbuckle, eye- bolts, coupling etc. will be subjected to material testing, hardness, MPE, proof load test etc.
- b) Dampers with viscous fluids will be checked for viscosity of liquid used, damping resistance of the damper, stiffness of the damper etc.
- c) Springs used for variable constant load and spring hangers shall be checked for chemical, mechanical and spring rate tests.
- d) Complete variable and constant load spring cage will be subjected to performance test and load/deflection test. Calibration of spring cages shall be done at shop.
- e) Complete hanger will be subjected to performance test and load test.

1.8 VALVES

- 1.8.1 Inspection and testing requirements for valves other than extraction line valves and butterfly valves shall be as follows:
 - a) Pressure retaining parts of valves shall be subjected to NDT as per Table 1.
 - b) Bar stock/forging above 40mm diameter for valve trim shall be subjected to UT
 - c) Hardened / stellitted valve disc and seat are to be subjected to LPI and hardness check.
 - d) Colour matching of valve disc/plug and seat shall be carried out to ensure contact.
 - e) Hydraulic pressure test and seat leak test shall be carried out as per ANSI 16.34.
 - f) Air seat leak test shall be carried out as per applicable Standards/Codes.
 - g) Functional testing shall be carried out on each valve to check the following as per the approved valve data sheet:
 - 1) Smooth operation
 - 2) Valve travel, closing and opening time.
 - 3) Current drawn by actuators.
 - h) Springs for safety valves shall be tested with suitable NDT and for spring rate.
 - i) Safety and safety relief valves shall be tested for performance.





TABLE-1

NDT REQUIREMENTS FOR PRESSURE RETAINING COMPONENTS OF VALVES

Valve size NB	ANSI Class	ANSI Class	ANSI Class	ANSI Class 900
in mm	upto 300	above 300	above 600	& above &
		below 600	below 900	below 4500
Less than 50	Visual	Visual	Visual	MPI
50 & above but	Visual	Visual	MPI	MPI & RT (on
below 100				10% of valves on
				100% area)
100 & above but	Visual	MPI	MPI & RT (on 10% of	MPI & RT on
less than 300			valves on change of	100% area)
			section & weld ends)	
300 and above	MPI	MPI	MPI & RT (on change of	MPI, RT (on
			sections & weld	100% area)
			ends)	

Note:

- i. For body and bonnet forgings UT with MPI may be adopted in place of RT. For austenitic steel MPI may be replaced by LPI.
- ii. Weld Edge Preparation shall be subjected to MPI/LPI

1.9 EXTRACTION LINE VALVES

- a) Surface crack examination and hardness check shall be carried out on all hard faced/stellieted surfaces, if any.
- b) As a minimum requirement of castings for all valves on cold reheat and extraction lines shall be subjected to 100% MPI on all areas and RT on Butt Weld ends and change of Section. For forgings minimum requirement shall be 100% UT and 100% MPI.
- c) Bar stock for valves stem shall be subjected to UT. Finish machined valve stem shall be subjected to magnetic particle examination/dye penetration test.
- d) Wall thickness measurement by ultrasonic for critical and highly stressed zones of the casting/forging shall be carried out.
- e) Colour matching of the valve disc and seat to ensure required contact area shall be carried out.
- f) Hydraulic pressure tests shall be carried out on each valve to check body and bonnet strength. Seat leakage and back seat leakage test (wherever applicable) shall be carried out. Air seat leakage test shall also be carried out. Minimum test requirements of pressure shall be as per ANSI B 16.34.
- g) Functional testing shall be carried out on each valve to check for freedom of movement, adherence to clearance, opening/ closing etc. Type tests for discharge co-efficient and pressure drop co-efficient, shall be carried out. In case the type tests have been carried out in the past and documents generated, the same shall be furnished to the Owner for approval.



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1.10 BUTTERFLY VALVES

- a) Valve disc shall be checked for surface and sub-surface defects by magnetic particle examination.
- b) Stubs and driving shafts shall be tested for internal defects by ultrasonic method.
- c) Dye penetration test shall be carried out on shafts, seat rings etc.
- d) Test samples for rubber seal shall be subjected to tensile and hardness test for vulcanizing and after ageing. Hydraulic stability test and ozone crack resistance tests also be carried out.
- e) Valve shall be subjected to hydraulic pressure test for body and air seat leakage tests as per AWWA-C504
- f) Proof of design tests for valves and actuator shall be carried out as per AWWA-C504. In case the test has already been carried out on previous supplies, the contractor may submit the test certification of same for approval of Owner.
- g) After complete assembly each valve with actuator will be subjected to performance test by opening and closing the valve from fully closed to fully open position and the reverse, under no flow for at least 25 cycles to check.
 - 1) Smooth uninterrupted movement of valve.
 - 2) Closing and opening time.
 - 3) Current drawn by actuator.
 - 4) Operation of tripping switch and position indicator.
- h) After assembly, one valve of each size with respective actuator shall be shop operated over the full range of movement in both the directions, with the body subjected to the full hydrostatic pressure conditions, to demonstrate that the unit is in working order without any leakage through the joints and torque switches/clutches, limit switches are operating satisfactorily. During the test, hand wheel operation, opening/closing time and current drawn shall also be checked. The test shall be conducted for three consecutive cycles with valve shaft both in vertical and horizontal planes.

1.11 MISC. ITEMS / EQUIPMENTS

1.11.1Filters / Strainers

- a) Filters / strainers shall be tested as per the requirements of relevant codes/ standards.
- b) Filters / strainer shall be performance tested for pressure drop, flow, particle size. If performance test is earlier established, then records shall be reviewed.

1.11.2 Blowers/Exhausters

- a) Rotors shall be dynamically balanced. Leakage tests (if applicable) shall be carried out.
- b) Performance tests including noise and vibration tests shall be carried out as per relevant standards / codes.

1.12 ELECTRICAL AND CONTROL & INSTRUMENTATION



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For Electrical and Control & Instrumentation, refer the respective Tender Specification Volumes.

1.13 SITE TEST

Quality requirements for site activities shall be as a minimum, those specified for corresponding shop activities.

1.13.1 Hydraulic Test of Pressure Parts:

On completion of erection of pressure parts of each steam turbine generator, the unit with its fittings and mountings in position shall be subjected to hydraulic test pressure in accordance with requirement of Indian Boiler Regulations. Water used for hydraulic test shall be made alkaline by addition of suitable chemical. After the test, all parts shall be drained and suitably preserved.

1.13.2 Condenser Assembly :

- a) If the condenser sections calls for site assembly, care shall be taken in assembly of sections and correctness of alignment and fit up shall be checked. Site welding shall be carried out as per the procedure approved by the Owner.
- b) All weld seams shall be subjected to magnetic particle examination. At least 10% of butt welds shall be subjected to radiographic examination.
- c) All welds between condenser neck and LP turbine shall be subjected to 100% radiographic and magnetic particle examination.
- d) Condenser tubes shall be visually examined for dents, mechanical damages or any other defects prior to insertion. Both tube ends shall be thoroughly cleaned to a length of 100mm to remove oil, grease etc. and shall be checked for freedom from burrs prior to insertion.
- e) Tube expansion shall be carried out by electronic automatic torque control expanding unit, which shall be calibrated before use. Tube wall thinning and length of expansion shall be controlled and recorded.
- f) Hydrostatic testing of condenser steam space shall be carried out after connecting all the pipes with the condenser along with condenser vacuum systems by filling the steam space with water up to the tip of the last stages of blades of LP cylinder.
- g) Condenser water boxes shall be tested hydraulically at a minimum test pressure of 1.5 times the design pressure.

1.13.3 Turbine Assembly

Bidder shall clearly indicate the extent of assembly to be carried out at site. Accordingly, bidder shall submit elaborate erection and assembly inspection program of turbine for Owner approval.



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1.14 CONDENSATE EXTRACTION PUMPS AND DRIP PUMPS (IF Applicable)

FINAL TESTS INPROCESS TEST TEST RPressure Drop Test Chemical Analysis test Nechanical Prop. Inclusion Rating <mark>∞</mark>Heat Treatment Strip Down Test EPerformance 1 NPSH Test **e**|Balancing 6 Hyd. Test 5Vibration Run out Р.Н M.P.I. 91 Noise ITEM .T.U 2 Я.Т DESCRIPTION 11 6 8 17 4 Pump Casing Y Y⁽¹ Y -Y^① Suction Bell Y Y _ _ _ _ _ _ $\overline{\mathsf{Y}^{\textcircled{1}}}$ Y Y Shaft Y Y Y γ Y _ Impeller Y Y^① Y Y Y _ _ _ _ Y Y Rotor _ -_ $\overline{Y^3}$ Y V^① Fabricated Y² Items Y^S CEP Y[@] $\overline{\mathsf{Y}^{\oslash}}$ $\overline{Y^{\$}}$ Y[©] Strainer Y Y Y* a) Body Y _ _ _ _ Assembly Y** b)

1.14.1 Condensate Extraction Pump

① Chemical/ Mechanical shall be one per heat/HT batch.

- 2 10% Random on Butt Welds.
- ③ Pressure Containing Parts.
- Performance Test on each Condensate Extraction Pump to determine the characteristic curve (Head, Capacity, Efficiency & Power) at Design Speed and to ensure Compliance with design requirements specified in the specification. Measurements shall be carried out at 0%,25%, 50%,65%, 80%, 100% and 125% of design flow with cold water.
- S NPSH (R) test shall be carried out on one Condensate Extraction Pump using cold water at pump flows of 25%, 50%, 80%, 100% and 125% of Design Flow at Design Speed. This shall be preferably done at 1 % and 3% head break by Suction Throttling Procedure.
- Wibration on all Condensate Extraction Pumps shall be measured in transverse, Horizontal and Vertical Direction at all measuring points. Vibration test has to be conducted to establish that the same is within the limit prescribed by VDI - 2056 or ISO -2372
- Noise Level on each Condensate Extraction pump shall be measured at a distance of 1.5 meter above floor level in elevation and 1 mtr horizontally from the nearest surface of the equipment as per HIS. The measurement shall be taken at six points around the equipment for each flow condition.
- One Condensate Extraction Pump shall be dismantled for visual inspection after completion of performance test and NPSH Test. For other Pumps strip down test shall be



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conducted only in case abnormal performance such as Excessive Vibration, High noise, high bearing temperature etc. is observed during performance test.

Note:-

- a) The Manufacturer will conduct all tests required to ensure that the equipment will conform to the requirements of this specification and in compliance with requirements of applicable codes and standards. The particulars of the proposed tests and the procedures for the tests will be submitted to the purchaser for approval before conducting the tests. Materials will be tested as per relevant standards.
- b) All pressure parts will be subjected to hydraulic testing at a pressure of 150% of shut-off head or 200% of rated head (effective head), whichever is higher, for a period not less than half an hour
- c) Cavitations test and dynamic balancing test of all rotating components will also be conducted
- d) After installation, pumps offered will be subjected to testing at site. If the performance at site test does not meet the requirement, then the equipment will be rectified by the Bidder without any extra cost. Prior to performance testing the procedure for such tests will be mutually agreed between the Purchaser & Bidder. The Bidder will furnish all necessary instruments, accessories, and personnel for site testing. Prior to testing, the calibration curves of all instruments and the permissible tolerance limit of instruments will be mutually agreed upon.
- e) The purchaser or his authorised representative will be given full access to all tests. Prior to performance tests, the Bidder will intimate the purchaser allowing adequate time so that if the purchaser desires, his representatives can witness the test
- f) Quantum of In-Process Checks/ Tests is 100% until & unless specified otherwise.
- g) Shop tests shall be conducted with soften Quality Water.
- h) Bidder shall furnish details of proposed test procedures including test lay out, type and level of accuracy of instruments, sample calculation etc.
- i) Tests shall be done in accordance with latest edition of Hydraulic Institute standard.
- j) Tested Pump parameters shall be within following tolerances.

At design head	+ 10% of design capacity
At design capacity	+ 5% of design head (Under 152.4 meter)
	+3 % of design head (for 152.4 meter and above)

- * In case of fabricated construction
- ** One per type and size.

Results must show no minus tolerance with regard to flow and head.

No minus tolerance on efficiency or positive tolerance on power input at motor terminals shall be allowed.

1.14.2 **Tests at Site:**



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The pumps with its drives will operate satisfactorily at site for the whole range of rated operating condition as specified. The auxiliary power consumption and head developed will also be tested. The controls such as auto starting of pumps, speed, recirculation, etc. will also be tested for satisfactory performance. Parallel operation of pumps with different combinations will also be tested. During entire range of operation the vibration level will conform to VDI 2056



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1.15 HEATERS AND DEAERATOR

1.15.1 Deaerator

SI. No.	TESTS/CHECKS COMPONENTS/ ACTIVITY	Chemical Analysis	Mech. Properties	Impact	Hardness	Flattening	Flaring	UT	RT	MPI	DPT	Eddy Current	Helium Leak Test	SR	НТ	Hydraulic	Pneumatic	Dimensions	WPS/PQR/W QR/App.	Mock up Test
1.	Shell & Dished End	Y	Y	Y				Y ^(a)		Y ^(g)				Y ^(a)				Y ^(e)		
2.	Fabrication/ Welding													Y				Y		
a)	Edge Preparation/ Fillet Weld									Y ^(b)	Y ^(b)									
b)	Butt Joints/ Branch Welding							Y ^(c)	Y ^(c)	Y	Y			Y				Y ^(d)	Y	
3.	Complete Deaerator															Y		Y		
4.	Safety & Safety Relief Valve & other valves	Y	Y					Y ^(f)	Y ^(f)	Y ^(f)	Y ^(f)					Y		Y ^(h)		

1.15.2 Heaters



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Vol. III: Mechanical Works Quality Assurance Plan Turbine Generator

SI. No.	TESTS/CHECKS COMPONENTS/ ACTIVITY	Chemical Analysis	Mech. Properties	Impact	Hardness	Flattening	Flaring	UT	RT	MPI	DPT	Eddy Current	Helium Leak Test	SR	НТ	Hydraulic	Pneumatic	Dimensions	WPS/PQR/WQ R/App.	Mock up Test
1.	Tube Sheet																			Y
a)	Forging	Y	Y					Y		Y					Y			Y ^(I)		
b)	Plates	Y	Y	Y				Y			Y							Y ⁽¹⁾		
c)	Cladding							Y			Y			Y		Y		Y ^(j)		
2.	Shell Plates	Y	Y	Y				Y												
3.	Feed Nozzle Manhole forging	Y	Y			Y ^(k)		Y ⁽¹⁾				Y ^(k)		Y ⁽¹⁾				Y		
4.	Welding/Fabrication																			
a)	Weld Edge Preparation									Y ^(b)	Y ^(b)									
b)	Back Chipping									Y ^(b)	Y ^(b)									
c)	Weld Joints																			
i.	Butt							Y ^(c)	Y ^(c)	Y	Y				Y		Y	Y		
ii.	Fillet									Y	Y				Y		Y	Y		
iii.	Nozzle / Branch							Y ^(c)	Y ^(c)	Y	Y				Y		Y	Y		
iv.	Tube to tube sheet										Y		Y			Y				



Vol. III: Mechanical Works Quality Assurance Plan Turbine Generator

SI. No.	TESTS/CHECKS COMPONENTS/ ACTIVITY	Chemical Analysis	Mech. Properties	Impact	Hardness	Flattening	Flaring	UT	RT	MPI	DPT	Eddy Current	Helium Leak Test	SR	НТ	Hydraulic	Pneumatic	Dimensions	WPS/PQR/WQ R/App.	Mock up Test
5.	Dished End & Hemi Head	Y	Y	Y				Y ^(a)		Y ^(b)	Y ^(b)			Y			Y ^(e)			
6.	Tubes	Y	Y			Y ^(q)	Y ^(q)					Y			Y ⁽ⁿ⁾	Y		Y		
7.	Tube expansion in tube sheet																	Y ⁽⁰⁾		
8.	Complete Heater															Y ^(p)	Y			



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1.16	REMA	RKS FOR DEAERATORS AND HEATERS
	a)	After forming of plates. For dished end and Hemi head.
	b)	DPT may be used as an alternate to MPI.
	c)	UT/RT to be decided according to configuration/accessibility.
	d)	(a) For plates(b) For welding(c) For wall thickness
	e)	Including wall thickness
	f)	(a) 100% RT/UT shall be carried out on bodies, bonnets, nozzle and stem of valves of HP heater.
		 (b) 100% DPT/MPI on machined surfaces of valve body, bonnet, stem, disc & springs.
	g)	Outer surface (Dished end Knuckle Portion)
	h)	Including - Seat leakage - Relieving
		Capacity-popping test at set and blow down pressure
	i)	Include ovality of holes, surface finish and size of holes.
	j)	For cladding bond and cladding thickness during bond check and after drilling
	k)	For feed nozzle (pipes)
	I)	For forgings
	m)	After bending also
	n)	Dimension to include wall thinning
	o)	Both tube and shell side. After Hydro test drying and nitrogen filling to be done.
	p)	As per the code.
	q)	For HP Heater & Gland steam coolers the statutory requirements as per IBR to be ensured and to be certification original to be furnished as per IBR statutory requirements.
	Note:	
	1) 2)	Quantum of Checks shall be 100% unless otherwise specified. Chem./Mech. shall be One/ per heat or HT batch.



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1.17 LP & HP Heaters:

- a. At Manufacturer's Works:
 - All heaters will be subjected to manufacturer's standard shop inspection and all inspection and tests called for elsewhere in this specification. Mill certificates for the material for heater shell, tube support plates, tube sheets, water boxes, flash tanks etc. will be submitted to the purchaser for review.
 - ii) Heat exchanger tubes and water boxes will be tested by one of the following methods for cracks, imperfections etc.
 - A. Black light
 - B. Magnetic particles
 - C. Dye penetrant
 - iii) Each tube will be "Eddy Current" tested to detect any imperfection. The following tests will be performed on each lot of Heat Exchanger tubes.
 - A. Microscopic
 - B. Chemical Analysis
 - C. Yield strength
 - D. Flattening
 - E. Flanging
 - iv) Hydrostatic testing of the heat exchangers will be done in accordance with ASME TEST CODE for unfired Pressure Vessels Section VIII and I.B.R. as applicable. The LPH-1 will be hydraulically tested at 1.3 times the design pressure.
- b. At site:

The feed water heat exchangers will be field tested along with the TG set as per applicable code to determine the following. :-

- i) Temperature rise of the feed water/condensate at guaranteed capacity points.
- ii) Pressure drop in the water circuit.

The Bidder will furnish all instruments necessary to perform the above tests.

1.18 **DEAERATOR:**



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a. At Manufacturer's Works

Each deaerating heater and storage tank will be shop inspected during fabrication in accordance with applicable provisions of ASME "Code for unfired pressure vessel" Section VIII Div 1. Hydrostatic testing will be carried out as per the above code. Mill certificates for all the materials used will be submitted to the Purchaser for review. However hydro test for FST will be conducted at site.

b. At site

The Bidder will conduct field tests on the deaerating feed water heater. Tests will cover the determination of dissolved oxygen and free carbon dioxide in deaerator outlet water along with thermal and hydraulic performance of the deaerator.

All performance tests will be done and evaluated as per applicable code.



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1.19 BOILER FEED PUMPS & DRIVE TURBINE

	BFP + BOOSTER PUMP + DRIVE TURBINE																		
INPROCESS TESTS																			
SI.No.	TESTS ITEM/ DESCRIPTION	Chemical Analysis	Mechanical Prop.	Heat Treatment	Run out	U.T.	R.T	D.P.T.	M.P.I.	Balancing	F.A.T.T.	Hyd. Test	Inclusion Rating	Pr. Drop	Dimensions	Remark			
_		1	2	3	4	5	6	7	8	9	10	11	12	13	14				
Α.	BFP+BOOSTER PUMP															[©] Chemical/Mechanical Shall be one per heat /			
i.	Barrel Casing	Y	Y ^①	Y	-	Y	-	-	Y	-	-	Y	-	-	-	HT batch.			
ii.	Discharge Branch	Y	Y ^①	Y	-	Y	-	-	Y	-	-	Y	-	-	-	# On BFP Impeller as per			
iii.	Casing Cover	Y	Y ¹	Y	-	Y	-	-	Y	-	-	Y	-	-	-	*** In case of Fabricated			
iv.	Suction Branch	Y	Y ¹	Y	-	-	-	Y	-	-	-	Y	-	-	-	Construction.			
۷.	Diffuser	Y	Y ^①	Y	-	-	-	Y	-	-	-	-	-	-	-	² One per type and size.			
vi.	Ring Section	Y	Y ^①	Y	-	Y	-	Y	-	-	-	-	-	-	-	+ Type of NDE &			
vii.	Impeller	Y	Y ^①	Y	-	-	Y#	Y	-	Y	-	-	-	-	-	quantum of check shall be as per relevant code &			
viii.	Shaft	Y	Y ^①	Y	-	Y	-	Y	Y	-	-	-	Y	-	Y	pressure class.			
ix.	Rotor	-	-	-	Y	-	-	-	-	Y	-	-	-	-	-	++ Include body & seat			
В.	STRAINER															functional test			
i.	Body	Y	Y	-	-	-	-	Y***	-	-	-	Y	-	-	-	Note: Quantum of			





ii.	Assembly	-	-	-	-	-	-	-	-	-	-	-	-	Y ²	-	Checks/ Tests is 100%
C.	GEAR BOX AND HYDRAULIC COUPLING															otherwise.
i.	Gear	Y	Y ^①	Y	-	Y	-	Y	Y	-	-	-	-	-	-]
ii.	Pinions	Y	Y®	Y	-	Y	-	Y	Y	-	-	-	-	-	-	1
iii.	Shaft	Y	Y®	Y	-	Y	-	Y	Y	-	-	-	-	-	-	1
iv.	Casing	Y	Y®	-	-		-	-	-	-	-	Y	-	-	-	-
٧.	Wheels	Y	Y ^①	Y	-	Y	-	Y	Y	-	-	-	-	-	-	-
vi.	Assembled Rotating Component	-	-	-	-	-	-	-	-	Y	-	-	-	-	Y	
D.	RECIRCULATION VALVE	Y	Y ^①	Y	-	Y+	-	Y+	Y+	-	-	Y**	-	-	Y	
E.	DRIVE TURBINE			<u> </u>	_	Tests a	as per l	relevant	portion	of spe	cificati	on	-	•		





Final Test													
TESTS ITEM/ DESCRIPTION	Performance Test	NPSH Test	Vibration	Noise	Pressure Pulsation	Axial thrust	Dry Running	Thermal Shock	Visual Cavitation	Strip Down Test	Mech. Run test	Other Tests	Remarks
	1	2	3	4	5	6	7	8	9	10	11	12	
BFP	Y 1	Y2	Y ^{(3) (a)}	Y ^{(3) (b)}	Y ^{(3) (c)}	Y ^{(3) (c)}	Y ⁽⁴⁾	Y ^{(3) (d)}	Y ⁵	Y7	Y	Y 6	
Booster Pump	Y 1	Y2	Y ^{(3) (a)}	Y3 (p)	-	-	Y4	-	-	Y⑦	-	Y6	
Gear Box	Y®	-			-	-	-	-	-	-	Y®	-	
HYD Coupling	-	-	-	-	-	-	-	-	-	-	Y9	Y6	
Drive Turbine	Tests as per relevant portion of specification												
Elect Items	Tests as per relevant portion of specification												





Boiler feed pump

- (1) (a) Performance Tests on each Boiler Feed Pump to determine the characteristic curve (Head, Capacity, Efficiency & Power) at Design Speed and to ensure compliance with design requirements specified in the specification. Measurement shall be carried out at 10%, 25%, 50%, 65%, 80%, 100% & 125% of Design Flow with loop water at design temperature. Performance Test at other specified Conditions shall be carried out on all Boiler Feed Pumps at their respective Speeds at design temperature.
 - (b) Performance Test on each Booster Pump to determine the characteristic curve (Head, Capacity, Efficiency & Power) at Design Speed and to ensure Compliance with design requirements specified in the specification. Measurements shall be carried out at 0%, 25%, 50%, 65%, 80%, 100% and 125% of design flow with cold water.
- (2) NPSH (R) test shall be carried out on one Boiler Feed Pump and one booster pump using cold water at pump flows of 25%, 50%, 80%, 100% and 125% of Design Flow at Design Speed. This shall be preferably done at 1 % and 3% head break by Suction Throttling Procedure.
- (3) Boiler Feed Pumps and (a) Vibration on all Booster Pumps shall be Direction measured in transverse, Horizontal and Vertical all at measuring points.
 - (b) Noise Level on each Boiler Feed Pump and Booster Pump shall be measured at a distance of 1.5 meter above floor level in elevation and 1 mtr horizontally from the nearest surface of the equipment as per HIS. The measurement shall be taken at six points around the equipment for each flow condition.
 - (c) Pressure Pulsation and Axial Thrust Measurement shall be carried out on one Boiler Feed Pump at all measuring points. Pressure Pulsation shall be measured at suction as well as at discharge in the operating range.
- (4) Prefreably dry running withstand capability shall be demonstrated and established on one Boiler Feed Pump and its corresponding booster pump. Feed pump shall be capable of accepting complete loss of water and must be capable of being shut down in a controlled manner and brought down to rest after being tripped from design condition with simultaneous closure of suction valve. To demonstrate the capability during shop testing, suction valve actuation should be fast in order to ensure operation during vapour phase. Pump shall then be restarted and bring it back to design condition.
- (5) Visual Cavitation Test on one first stage production impeller of Boiler Feed Pump shall be carried out to demonstrate absence of Cavitation at test speed in Cold Water. The test will establish the cavitation characteristic of one production first stage impeller to confirm that the cavity length under dynamically scaled site conditions corresponding to test point will not exceed an agreed size. This test shall be carried out at 25%, 50%,65%,80%,100% and 125% of Design Flow
- (6) String Test:- Operational Test of One Motor Driven Boiler Feed Pump assembly using contract Booster Pump, Drive Motor, Hydraulic Coupling and Main Boiler Feed Pump to include test as specified at 1 & 3 (a) & (b). Dry Run Test shall preferably be carried out during String Test.
- (7) Complete Strip Down of Boiler Feed Pump which under goes Performance Test, NPSH Test, Dry Run Test, etc. shall be done in order to check problems like Internal Rubbing Damage, Excessive Wear etc. One Booster Pump shall be dismantled for visual inspection after completion of performance test and NPSH Test. For other Pumps strip down test



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shall be conducted only in case abnormal performance such as Excessive Vibration, High noise, high bearing temperature etc. is observed during performance test.

- (8) Full load full speed/back to back locked rotor torque test for one gearbox.
- (9) Smooth operation, vibration, noise and temperature rise check on all equipment.

Note:

- 1) Shop tests shall be conducted with soften Quality Water.
- 2) Bidder shall furnish details of proposed test procedures including test lay out, type and level of accuracy of instruments, sample calculation etc.
- 3) Tests shall be done in accordance with latest edition of Hydraulic Institute Standard, USA.
- 4) Tested Pump parameters shall be within following tolerances.

At design head	+ 10% of design capacity
At design capacity	5% of design head (Under 152.4 meter)
	+ 3% of design head (for 152.4 meter and above)

Results must show no minus tolerance with regard to flow and head.

No minus tolerance on efficiency or positive tolerance on power input at motor terminals shall be allowed.

5) It is preferred to carry out performance, NPSH(R) & Dry Running tests of the boiler feed pump at design speed. However, in case of any constraint of manufacturer to carry out the above tests at design speed, the testing of pump at reduced speed as per HIS guidelines may be proposed to Owner for review and approval.



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1.19.1 Tests at Site :

The pumps with its drives will operate satisfactorily at site for the whole range of rated operating condition as specified. The auxiliary power consumption and head developed will also be tested. The controls such as auto starting of pumps, speed, recirculation, etc. will also be tested for satisfactory performance. Parallel operation of pumps with different combinations will also be tested. During entire range of operation the vibration level will conform to VDI 2056.

1.20 POWER CYCLE PIPING

1.20.1 H.P.PIPING FOR TURBINE AND AUX.

- vii) **Piping:**
 - (k) All raw materials used shall have co-related mill test certificate meeting material specification. Raw material of all forged/formed fittings shall be ultrasonically tested. All mother pipes used for fittings shall either be ultrasonically tested or hydralucially tested. Forged fittings shall be ultrasonically tested and formed fittings shall be MPI tested.
 - (I) All pipe lengths shall be 100 % ultrasonic tested or hydralucially tested and UT/RT on longitudinal welds at the tube mill.
 - (m) The edge preparation for shop and site welds in stainless steel /alloy steel shall be subjected to a dye penetrate check.
 - (n) Non-destructive examination of welds shall be carried out after post weld heat treatment, if any.
 - (o) All butt welds in alloy steel piping of P-91, X -20, X-22 & material P-5B group & above shall be checked for RT/ UT & MPI after SR.
 - (p) For welds in P91, X20 & X22 induction type of heating shall be deployed for post weld heat treatment, or heat treatment can be carried out in furnace.
 - (q) Non-destructive examination of welds shall be carried out in accordance with the relevant design/manufacturing codes. However, as a minimum, the following requirements shall be met. Further statutory requirement, wherever applicable shall also be complied with
 - 4. Temperature > 400 Deg, C and/Or pressure exceeding 71 bar.
 - C. 100% RT/UT on butt welds and full penetration branch welds.
 - D. 100% MPE.
 - 5. Temperature >175 Deg, C upto 400 Deg. C and/or pressure exceeding 17 bar and upto 71 bar.
 - D. 100% RT/UT on butt welds and full penetration branch welds for pipe dia more than 100 NB.
 - E. 10% RT/UT on butt welds and full penetration branch for pipe dia upto 100NB.



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- F. 100% MPE.
- (r) For all other pipes not covered above, shall be subjected 100% MPE/ DPT in case of underground pipes and 10% MPE/DPT in case of piping above the ground. Further, 10% of butt welds of underground piping shall be subjected to RT. Wherever SR/PWHT is envisaged for alloy steel, above NDTs shall be after SR/PWHT.
- (s) Hardness survey of welds shall be carried out on alloy steel/stainless steel piping (100% Hardness survey of welds on P91, X20 & X22 & above material grade of P5B above piping) and 3% hardness survey on welds of other alloy steel).

viii) Hangers & Supports:

- vi) All raw materials used shall have co-related mill test certificate meeting mandatory checks of material specification.
- vii) Completed springs shall be tested for Scragging Test & Load vs Deflection Test and for dia. > 25mm MPI shall be carried out.
- viii) Butt Welds shall be tested for UT and fillet welds shall be tested for MPI.
- ix) Turn buckle/ pipe clamps/ Hangers of thickness > 25mm shall be checked by MPI/DPT on bent portion.
- x) Assembled Hangers shall be checked for Variation in deflection and Travel vs Load test.





1.20.2 Low Pressure Piping

SI.No.	Tests/Check										5			<u> </u>		
	Items / Components	Material Test	DPT/MPI	Ultrasonic Test	WPS/ WQS/PQR	Balancing	Hydraulic / Water Fill Test	Pneumatic Test	Assembly Fit up	Dimensions	Functional/ope ation al Test	Performance Test	Other tests	All Tests as pe Relevant Std	Adhesion / Spark	Remarks
1)	Pipes & Fittings and Metered Bends	Y ^a	Y ^b		Y		Y									
2)	Diaphragm Valves	Y ^a					Y۶			Y				Y ⁶		
3)	Butterfly Valves (Low Pressure)															
a)	Casted Butterfly Valves															
(i)	Body (Cast)	Y ^a	Y ^D				Y		Y	Y	Y		Y'			
(ii)	Disc (Cast)	Y ^a	Y ^D													
(iii)	Shaft	Y ^a	Y	Y ^c												
b)	Fabricated Butterfly Valves															Ref. Note14
4)	Gate / Globe / Swing Check Valves	Y ^a	Y ^b	Y ^c			Y⁵	Y	Y				Y ⁸			
5)	Dual Plate Check Valves	Y ^a	Y ^D	Y ^c			Y	Y	Y				Y ⁴			
6)	Rolled & Welded Pipes	Y ^a	Y ³		Y		Y ¹			Y						





SI.No.	Tests/Check Items / Components	Material Test	DPT/MPI	Ultrasonic Test	WPS/ WQS/PQR	Balancing	Hydraulic / Water Fill Test	Pneumatic Test	Assembly Fit up	Dimensions	Functional/oper ation al Test	Performance Test	Other tests	All Tests as per Relevant Std	Adhesion / Spark	Remarks
7)	Coating & Wrapping of Pipes	Y ²											Y ²			
8)	Tanks & Vessels	Y ^a	Y ^D		Y		Y									
9)	Strainers	Y ^a	Y۵				Y						Y ¹¹			
10)	Rubber Expansion Joints	Y ^a					Y ¹²		Y				Y ¹³			
11)	Rubber Lining of Pipes	Y ^a	Y ^D		Y		Y			Y				Y ⁹	Y	
12)	Hangers & Supports	Y ^a														
13)	Fastners	Y ^a		Y ^b												
14)	Site Welding		Y ¹		Y		Y									





Notes:

- 1. Weld Joints not subjected to ydraulic test shall be subjected to 100% RT.
- 2. Spark Test, Adhesion Test and Material Test for primer and enameled & Coal Tar Tapes as per AWWA-C-203-91
- 3. DPT on route run and after back gouging and on finish welds.
- 4. Dry Cycle Test (Spring Cycle Test) for one lakh Cycles shall be carried out as a type test.
- 5. Seat Leakage Test for Actuator Operated Valves, shall be done with by closing the valves with actuator.
- 6. Tests on rubber parts per batch of rubber mix such as hardness, adhesion, spark test, bleed test and flex test on diaphragm, type test for diaphragm for 50,000 cycles.
- 7. Hydraulic Test of Body, Seat and disc-strength shall be carried out in accordance with latest edition of AWWA-C-504 in presence of Owner representatives. Actuator operated valves shall be checked for Seat Leakage by closing the valves with actuator. Seat Leakage Test shall be carried out in both directions.
- 8. Blue matching, wear travel for gates, valves, pneumatic seat leakage, reduced pressure test for check valves shall be done as per relevant standard. Maximum allowable vacuum loss is 0.5 mm of Hg abs. for valves to be tested for vacuum operation for internal pressure 25 mm of Hg abs. for a period of 15 minutes 9.
- 9. Hardness, Bleeding Test and Ozone resistance test shall be done on rubber material
- 10. 2% of welds shall be subjected to DPT.
- 11. Pressure drop across the strainer for each type and size as a special test shall be carried out
- 12. During hydraulic and vacuum tests at 25mm Hg abs in 3 positions, the change in the circumference of arch should not be more than 1.5%. 24 hrs after the test permanent set in dimension should not exceed 0.5%.
- 13. Tests on rubber for tensile, elongation, hardness, hydraulic stability check as per ASTM D 471, ozone resistance test as per ASTM D 1149 aging test and adhesion strength of rubber to fabric, rubber to metal adhesion shall be carried out.
- 14. For fabricated butterfly valves: UT as per ASTM A-435 on plates material for body and disc. 100% RT as per ASTM, Section-VIII, Division-I, on butt joins of body and disc and post weld heat treatment as per ASME, Section-VIII, Division- I on butt joints of body and disc of thickness above 30mm shall be carried out in addition to other tests indicated for cast butter fly valves.
 - a) One per heat/heat treatment batch/lot.
 - b) On machined surfaces only for castings and on finished butt welds. For shaft/spindles > or = 50

1.21 ECW SYSTEM

1.21.1 Plate heat exchangers



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- i) Heat Transfer Plates, Cover Plates & Gaskets shall be tested for Chemical & Physical properties to the Standards to which they confirm.
- ii) Each Heat Transfer Plat at the pressing shall be subject to either of the following tests, as per Manufacturer's Practice;
 - (a) Light Box Test
 - (b) Vacuum Test
 - (c) Air Chamber Test

No defects are allowed in the test.

- iii) 10% of the Heat Transfer Plates shall be subjected to Dye Penetrant Test. However, in case of any defect, entire lot shall be subjected to Dye Penetrant Test and only defect free plates shall be supplied.
- iv) Cover Plates (Front & Rear) >25 mm thickness shall be ultrasonically Tested to SA-578 requirements.
- v) All welding shall be done by qualified welders only and all welds shall be subjected to Dye Penetrant Test.
- vi) Complete Heat Exchanger shall be Hydraulically tested at a pressure of 1.5 times the Design Pressure for 30 minutes for each side. No leakage/pressure drop is allowed.

1.21.2 Self Cleaning Filter

- v) Filter mesh shall be checked for Chemical composition and Mesh size.
- vi) Filter body shall be subjected to Hydraulic Pressure Test at 1.5 times the Design Pressure or 2 times the Working Pressure, whichever is higher, for 30 minutes
- vii) Filter assembly shall be checked for its function & Pressure Drop across the Filter.
- viii) All welding shall be performed by qualified welders only and all welds shall be subjected to Dye Penetrant Test as minimum.
- 1.21.2.1 The complete filtration system and the individual equipment shall be subjected to performance testing at site to demonstrate successful operation and performance to meet the design conditions. The tests shall also include hydraulic test, function test, check for interlocks and sequential operation. Site test shall also include tests to establish Pressure drop across the strainer section & proper functioning of DELTA-P system.

1.22 HORIZONTAL CENTRIFUGAL PUMPS

- 1.22.1 NDT on the pump components shall be done as per plant standards and design philosophy of the manufacturer, in accordance with relevant codes. NDT procedures alongwith acceptance standard shall be subject to owner's approval. However, atleast DPT on shaft & impeller and UT on shaft for dia > 50 mm, shall be carried out.
- 1.22.2 No weld repair on Cast Iron is allowed.



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- 1.22.3 All rotating components shall be subject to static and dynamic balancing and residual imbalance acceptance norms shall be subject to owner's approval.
- 1.22.4 All pressure retaining parts shall be hydrostatically tested at 200% of pump rated head or at 150% of shutoff head, whichever is higher, for atleast 30 minutes. No leakage is allowed.
- 1.22.5 All pumps shall be tested, at rated speed, for head, capacity, efficiency and power consumption for the entire operating range, i.e. from shut off head to maximum flow. A minimum of 7 (seven) readings shall be taken to Plot the curve, with one point at design flow. Testing standard shall be HIS (Hydraulic Institute Standard) of USA.
- 1.22.6 Performance test shall be done with Type tested contract motor, wherever Liquidated Damages are ascertained based upon shop Performance Test.
- 1.22.7 Only those pumps shall be subject to strip down test, to visually check for mechanical damages at the shop, where abnormal noise or excessive vibrations are observed during the performance test, otherwise it shall be limited to bearing inspection only.
- 1.22.8 Noise and vibration readings shall be taken at shop for reference and shall meet the parameters at site Technical Specification.

1.22.9 Piping, valves and fittings:

- 1.22.9.1 Pipes shall be hydraulically tested as per respective code to which they are supplied. In case of pipes, where standards are not available, hydrostatic test shall be carried out at 200% maximum operating pressure or at 150% design pressure, whichever is higher, for atleast 30 minutes. No leakage is allowed.
 - (i) Pipes, which are to be rubber lined subsequently, shall be either internal bed removed ERW pipes or seamless pipes.
- 1.22.9.2 All the valves shall be hydrostatically and pneumatically tested for body seat and back seat (if any) as per relevant codes/standards, before rubber lining (if any).
 - (iii) Actuated valves shall be tested alongwith corresponding actuator. However actuators also shall be separately tested at manufacturer's works, as per relevant standards.
 - a) For butterfly valves, disc strength test shall also be carried out as per AWWA-C504. Proof of Design Test is also required to be done in line with requirements of AWWA-C-504, in case not done earlier.
- 1.22.9.3 Piping system under IBR purview:
 - After Erection all piping systems shall be hydro tested at 1.5 times the design pressure subject to regulation of 343 (3) IBR. However, for such systems where it is practically not possible to do hydro tests, the tests as called for in ANSI B31.1& IBR in lieu of hydro test shall also be acceptable.
 - ii) Non-IBR Piping Systems:-
 - (a) After Erection All piping systems shall be hydro tested at 1.5 times the design pressure. However, for such systems where it is



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practically not possible to do hydro tests, the tests as called for in ANSI B31.1 in lieu of hydro test shall also be acceptable

1.23.1 Hooks

- i) All Tests including roof load test as per relevant IS shall be carried out.
- ii) MPI / DPT shall be done after proof load test.

1.23.2 Steel Castings:

i) DPT on machined surface shall be carried out.

1.23.3 Girders, End Carriage, Crab, Gear-Box And Rope Drum

- i) The plates of thickness 25mm and above shall be ultrasonically tested.
- ii) NDT requirements on weldments shall be as follows:
 - (a) Butt welds in tension:- 100% RT & 100% DPT
 - (b) Butt welds in compression:- 10% RT & 100% DPT
 - (c) Butt weld in rope drum:- 100% RT & 100% DPT
 - (d) Fillet welds:- random 10% DPT
- 1.23.4 Forgings (Wheel, Gears, Pinions, Axies, Hooks & Hook Trunion)
- 1.23.5 All forgings greater than or equal to 50mm dia. or thickness shall be subjected to Ultrasonic Testing.
- 1.23.6 DPT/MPI shall be done after hardfacing and machining.
- 1.23.7 Wire Rope shall be tested as per relevant standard.
- 1.23.8 Reduction Gears shall be tested for reduction ratio, backlash & contact pattern. Gear Box shall be subjected to No load run test to check for oil leakage, temp., rise, noise and vibration.
- 1.23.9 The cranes shall be completely assembled at shop for final testing. All tests for dimension, deflection, load, overload, hoisting motion, cross travel etc. as per IS-3177 shall be carried out at shop.
- 1.23.10 All Electric Hoist shall be tested as per IS-3938 and Chain Pulley Blocks shall be tested as per IS-3832.

1.24 OTHER CRANES AND HOISTS

- 1.24.1 **Hooks**
 - i) All tests including proof load test as per relevant UI shall be carried out.



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- 1.24.2 MPI / DPT shall be done after proof load test 1.24.3 **Steel Castings** i) DPT on machined surface shall be carried out. 1.24.4 Girders end carriage, crab, gear box and rope drum i) The plates of thickness 25 mm and above shall be ultrasonically tested. ii) NDT requirements on weldments shall be as follows : Butt welds in tension 100% RT & 100% DPT (a) : (b) Butt welds in Compression 10% RT & 100% DPT ٠ 100% RT & 100% DPT (c) Butt welds in rope drum : (d) Fillet welds 10% DPT 1.24.5 Forgings (Wheel, Gears, Pinions, Axles, Hooks & Hook Trunion) All forgings greater than or equal to 50 mm dia or thickness shall be subjected to ultrasonic testing. 1.24.6 DPT/MPI shall be done after hard facing and machining 1.24.7 Wire rope shall be tested as per relevant standard. 1.24.8 Reduction Gears shall be tested for reduction ratio, backlash & contact pattern, Gear Box shall be subjected to No load run test to check for oil leakage temp rise, noise and vibration 1.24.9 The cranes shall be completely assembled at shop for final testing. All tests for dimension, deflection, load, overload, hoisting motion, cross travel etc. as per IS-3177 shall be carried out at shop. All electric hoist shall be tested as per IS-3938 and chain pulley blocks shall be 1.24.10 tested as per IS-3832. 1.25 CONDENSER ON LOAD TUBE CLEANING SYSTEM 1.25.1 **Ball Recirculation Pump** i) All rotating parts shall be dynamically balanced. ii) Pump casing shall be subjected to hydraulic test at 1.5 times the shut off head or twice the maximum working pressure whichever is higher.
 - iii) Complete pump assembly shall be subjected to shop performance test at supplier's works.

1.25.2 Ball Sorter / Fabricated Body (housing)



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- In the case of fabricated design, all butt welds shall be subjected to 10% radiographic / ultrasonic examination. All welds shall be examined by 10% magnetic particle testing method to ensure freedom from surface and subsurface defects.
- ii) Body shall be subjected to hydraulic pressure test at 1.5 times the design pressure.
- iii) Performance test shall be carried out on ball sorter assembly.

1.25.3 Strainer

- i) Strainer mesh shall be checked for chemical composition and mesh size.
- ii) Strainer body shall be subjected to hydraulic pressure test at 1.5 times the design pressure.
- iii) Strainer assembly shall be checked for its function.
- 1.25.4 The complete system and the individual equipment shall be subjected to performance testing at Site to demonstrate successful operation and performance to meet the design conditions. The tests shall also include hydraulic test, function test, check for interlocks and sequential operation. Site test shall also include test to establish pressure drop across the strainer section.

1.25.5 Piping and Fittings

- Non Destructive Examination is mandatory as per ASME B31.1 & Regulation 360(d) of IBR./ EN 13480 standards. Piping and fabricated fittings shall be subjected to following NDT.
 - (a) Butt welds of piping shall be subjected to 10% RT and 10% DP Test. Butt welds of Segmental flanges shall be checked by 100% RT and DPT.
 - (b) Fillet welds with load transfer shall be subjected to 100% MPE/DPT and fillet welds without load transfer shall be subjected to 10% MPE/DPT.
- ii) For IBR class 1 piping: 10% RT, For ID<=102 and 100% RT for ID>=102.
- iii) For IBR class 2 piping: 10% RT, for all dia.
- iv) 100% MT/PT carried out for fillet weld of critical system.
- v) All NDE is before PWHT.

1.25.6 Coating / Lining

- 1.25.6.1 Coating shall be checked for DFT and adhesion. Further, Contractor shall furnish his practice for testing of coating to ensure the uniformity and freedom from pinholes.
- 1.25.6.2 Rubber lined items shall be hydraulically tested before rubber lining. All rubber lining is to be subjected to following tests as per IS-4682 Part-I or acceptable equivalent:
 - i) Adhesion test



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- ii) Check for resistance to bleeding
- iii) Measurement of thickness
- iv) Shore hardness test
- v) Visual examination and spark test at 5 kv/mm of thickness.

1.25.7 Valves

Conventional gate/ globe / check/ ball valves shall be tested as per relevant standard.

1.25.8 Acceptance Tests for STG

After erection of the TG equipment at site acceptance test will be conducted in accordance with ASME power test code PTC 6 or equivalent. A detailed test procedure will be prepared and submitted to the purchaser for approval at least 6 months prior to testing. All instruments and accessories for the test will be arranged by the Bidder.

The tests will include but not limited to the following: --

- a) Heat rate guarantee tests.
- b) Output capability test.
- c) Demonstration of capability of the system to operate with 1% make up at V.W.O., 100%, 80% and 60% MCR.
- d) Aux. Power consumption test

In addition, other performance guarantee tests as detailed in Volume IB will be carried out at site.



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CHAPTER – 4

PROJECT MANAGEMENT

METHOD OF EXECUTING THE PROJECT

The entire work of project execution shall cover complete civil works, electrical & mechanical system as a single EPC contract responsibility for timely execution and performance of the plant. The Bidder shall design, engineer, manufacture, and supply, erection, testing & commission the plant for generation of 2×800 MW nominal rating.

The EPC Bidder shall be responsible for overall management of the project including contract scheduling, planning, monitoring, expediting at sub-Bidder's works etc., in order to ensure that the contract schedule is maintained.

1.00.0 RESPONSIBILITY

- 1.01.0 The Bidder shall identify a separate and independent project management team headed by a Project Manager for the execution of this Project. The Project management team shall cover the areas listed below:
 - a) Planning and Monitoring
 - b) Engineering Management
 - c) Contracts Management
 - d) Quality Assurance Services
 - e) Construction Management
 - f) Spares Management
 - g) Commissioning Management
 - h) Resource control
 - i) Manufacturing and Production Control

Detailed responsibilities in the above areas except Quality Assurance Services are given below. The Bidder shall comply with the requirements of Quality Assurance Services detailed in Volume-III of the Technical Specification.

2.00.0 ORGANIZATION

2.01.0 Organization Chart

The Bidder shall describe how his management organization will meet the requirements of this Technical Specification. The Bidder shall furnish a detailed organization chart for the project management team, clearly identifying the key personnel in each of the areas mentioned at 1.01.00 above. The expected number of executives, managerial and supervisory staff at different levels shall also be indicated separately for headquarters, central co-ordination cell and site organization indicating names, qualification and experience.



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During construction phase, the Bidder shall notify any proposed changes to senior staffing numbers or arrangements to the Owner for approval.

2.02.0 Headquarters

The headquarters of the project management team shall be headed by a senior level executive designated as the Project Manager who shall be responsible to Owner for the execution of the Project.

Separately, designated leaders shall be identified for each of the areas mentioned under 1.00.00 who, in, will report to the Project Manager for all matters related to the contract.

2.03.0 Central Co-ordination

The central co-ordination cell shall preferably be based at or near site and shall have sufficient technical personnel to co-ordinate technical matters and to quickly resolve day-to-day queries or references made by Owner Engineer without having the need to refer to his headquarters each time.

2.04.0 Site Organization

The site should have a competent Construction Manager for all site operations with sufficient level of authority to take site decisions. The organization chart for site should indicate the various levels of experts to be posted for supervision in the civil, mechanical, electrical, control & instrumentation fields for construction, erecting, testing & commissioning of the Project.

2.05.00 Management of Health & Safety

The Bidder shall provide the following before Effective Date of the Contract.

- A management structure for co-coordinating health and safety from the design stage through construction and final commissioning.
- A management system for ensuring arrangements for safety training, safety meetings and reporting of accidents.
- A method of assessing health and safety requirements during construction.
- A safety plan for the construction phase.

3.00.00 GENERAL REQUIREMENTS OF PROGRAMMES AND SCHEDULES

The programs supplied by the Bidder as part of the Contract shall fully interrelate design, manufacture, erection and commissioning. Events shall be identified in all programs and agreed with the Owner / Purchasers Engineer. Events shall indicate points in the programs at which a significant stage has



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been reached and which is of sufficient status for reporting to management. All programs containing scheduled dates including those for Design, Manufacturing and for Site Erection shall be adhered to by the Bidder and shall not be changed except as may be agreed by the Owner / Owner's Engineer.

The Bidder shall designate a Planning Representative who shall be readily available at all reasonable times to the Owner / Owner's Engineer and who shall be of sufficient status to have free access to the Bidder's management staff and to the Bidder's and sub contractors work / shops, site works etc. and shall be able to represent the Bidder on all matters of planning and progress.

- 3.01.00 Form of Programs
- 3.01.01 Bar Charts

Bar charts shall be submitted on standard metric sheets and shall be drawn to microfilm standards to permit reduction to A3 size. They shall have a date scale at the top and plant / areas of work sections identified at the left hand side. All floats shall be shown and where logical connections exist between activities, they shall be indicated. All details should be compatible with SAP, which is available with owner.

3.01.02 Networks

Networks shall be drawn in the form of arrow or precedence diagrams with clearly defined plant / areas of work indexed at the left hand side. Where more than one sheet is used, the activities shall be cross-referenced to other sheets for ease of identification.

3.01.03 Computer Printouts

Each network submitted shall be supported by a manual or computer analysis which shall contain an activity list sorted on activity number and including activity description, duration, calendar, float predecessors and logical connections, target start and finish dates.

3.01.04 Schedules of Dates

Where appropriate, schedules of dates shall be submitted in support of Network activities. Gantt charts or detailed work schedules. These shall be to a standard format, preferably A4 size, for ease of filing and indexing and should clearly show the work / area of plant concerned at the bottom of the sheet with an identifying number and date.

3.01.05 Time Units

In all programs where time units are identified, calendar dates shall be used. For dating purposes the week shall start on Monday.

3.01.06 Abbreviations



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A list of all standard abbreviations used on each network or bar chart shall be displayed on each individual sheet of the programme.

- 4.00.00 IMPLEMENTATION SCHEDULE
- 4.01.00 The schedule for the completion of the 2 x 800 MW Super Critical Coal Based Uppur Thermal Power Project of TAMILNADU GENERATION AND DISTRIBUTION CORPORATION shall be as follows:

Milestone Period in days from the Effective Date

Commissioning

days for the unit

4.02.00 The Bidder shall include a Level-1 (L-1) network showing the major activities and various milestones to achieve the above mentioned completion schedule. The proposed schedule is enclosed in the bid.

To achieve the targets shown in L-1 network, the Bidder shall furnish to the Owner, various schedules as defined below.

4.02.01 Engineering Schedules

These schedules shall cover various design submissions indicating different engineering activities to be performed. Such schedules shall be furnished by the Bidder for each and every plant / systems / equipment item covered in the scope of this Technical Specification.

4.02.02 Manufacturing and Delivery schedule

The Bidder shall submit to the Engineer his manufacturing and delivery schedules for all equipment within sixty (60) days from the date of signing of the contract. Such schedules shall be in line with the detailed network for all phases of the work of the Bidder. Such schedules shall be reviewed, updated and submitted to the Owner/ Owner's engineer, once in every two months thereafter, by the Bidder. Schedules shall also include the materials and equipment purchased from outside suppliers. In the dispatch programme, the Bidder shall indicate a schedule of estimated programme, tonnage's specifically identifying various oversize dimensioned consignments (ODC). All dispatch details and item lists shall be made available to both Owner & site immediately after shipping.

4.02.03 Erection Schedule

The Bidder shall provide the Owner all the information covering erection sequence, testing and commissioning activities. These schedules may be based on the recommended erection procedures and shall be subject to discussions/agreements with the Owner subsequent to the signing of the Contract.



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4.03.00 The Bidder shall provide the Owner all such schedules in electronic media within a time schedule to be agreed between Owner and Bidder. The Bidder's project management software shall be compatible with that of the Owner and the input data shall be furnished to the Owner in a form compatible with Owner's project management software.

5.00.00 DETAILED RESPONSIBILITIES

The Bidder shall provide effective management of the Contract, which shall be compatible with the Owner's requirements as set out in this Technical specification. He shall allow access to his works and those of his subcontractors at all reasonable times to permit the Owner/Owner's Engineers participation if the Owner/Owner's Engineer considers it necessary in monitoring the contract. He shall also work with other contractors who interface with the contract in order to ensure the smooth development of the project completion. Such participation up to its completion shall not, in any way affect the Bidder's obligations to complete the works in accordance with the contract.

- 5.01.00 Planning & Monitoring
- 5.01.01 Planning

The Bidder shall prepare a Master Network schedule in the form of PERT network consisting of at least 500 activities. The network shall be prepared on a work breakdown structure.

The Master network shall identify milestones of key events for each system/package in the areas of engineering procurement, manufacture and dispatch and erection and commissioning. The master network shall represent the Level-1 plan and will form the basis for development of detailed second and third tier execution plans.

The master network shall be mutually discussed and finalized and incorporated in the Contract. The master network shall clearly indicate the responsibility of the Bidder and project management team. The master network shall also identify a complete list of inputs to be furnished by the Owner, which may be required for proper interfacing and tie-up. Scheduled dates for providing such inputs shall also be indicated, which will be mutually discussed and finalized.

The Bidder shall not change the Master Network without the prior approval of the Owner. In the event that the Owner approves a revision to the Master network the Bidder shall submit a revised master network within two weeks thereafter. This programme shall fully comply with the requirements of the technical specification and where necessary, reflect changes to the sequence or progress of the works directed by the Owner, or as proposed by the Bidder and accepted by the Owner. Such an agreed revised programme shall become the overall contract programme for the outstanding works.

5.01.02

Monitoring & Progress Reporting, management information system



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The progress reports would be issued every month, one from the head office of the Bidder and another from the site office. Reports shall include such schedules, charts and drawings, as the Owner/Owner's engineer considers necessary for adequately monitoring the contract. The reports shall be made available to the Owner/Owner's engineer at least five working days prior to scheduled progress review meeting.

The progress report issued from the head office should necessarily include the following sections:

Report on key milestones

Management summary indicating critical areas with details of actions initiated and effect of any on the project.

Action needing attention of the Owner/Owner's engineer.

Detailed package wise status of engineering submissions, quality plan submissions and approval, procurement manufacture and dispatch.

The monthly report generated from the site office should necessarily include.

Report on key milestones.

Management summary indicating critical areas with details of action initiated and effect if any on the project.

Action needing attention of the Owner/Owner's engineer.

Details relating to the receipt of the equipment at the port, port clearance, transport, receipt at site, erection and commissioning.

In addition to the above, as the project execution progresses, the Bidder shall also be responsible for generating more frequent report on progress in critical areas so that actions can be expedited. The exact format and contents of the progress reports shall be agreed at the time of signing of the contract.

5.02.00 Engineering Management

The Bidder, based on the master network schedule for the project (L-1), shall prepare an exhaustive list of engineering activities for the equipment/system covered in his scope and a detailed programme of accomplishing the same within the time frame specified in the master network schedule. The schedule will form the Level-2 (L-2) network for engineering activities.

Based on (L-2) network, the Bidder shall further develop the Lewel-3 (L-3) network for engineering activities, which will indicate schedule for data availability, drawing availability, drawing release date and document submission dates.



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Detailed (L-2) and (L-3) networks shall be finalized sequentially by the Bidder within one month from the date of signing of the contract.

The engineering management team shall also co-ordinate all interface engineering activity between the Bidder and the equipment sub-vendors so as to ensure the correctness and completeness of related engineering documentation before the same is submitted to the Owner.

On receipt of award of contract/LOI, the EPC contractor have to submit the detailed Billing Break Up (BBU) with proportionate rate for each system in line with their offer finalized for the entire contract EPC price within 30 days for the approval of CE/Projects/TANGEDCO/HQ. The billing break-up shall cover the entire scope of works without any omissions of works/systems. This approved billing break up will be followed for release of payment as per payment clause in Commercial Volume I has to be obtained.

Also Master schedule (L1 Net work) has to be submitted within 30 days alongwith BBU for the approval of CE/Projects/TANGEDCO/HQ and this schedule will be kept as binding for completion of each system for supply & Erection and commissioning against this EPC contract.

5.03.00 Contracts Management

Based on the master network schedule the Bidder shall submit L-2 programs of manufacture and dispatch. In addition, the master network shall also include periods considered for site activities viz, erection, commissioning etc. These L-2 programs shall be finalized in One (1) months time from the date of signing of the contract. The Bidder shall also submit site mobilization plan.

The Bidder shall also submit L-3 programs for the manufacturing and dispatch of the various items. These networks shall also show the customer hold point (CHP) which have to be cleared by the Owner's Engineer before further manufacture can take place. These L-3 programs for the manufacture and dispatch shall clearly identify responsibilities of the Bidder, Sub-Bidder and Owner. These networks shall be submitted within one (1) month of the date of finalization of the various sub-contracts by the Bidder.

In case all the manufacturing is being done by the Bidder, then the L-2 programs shall be themselves amplified to cover details of the manufacture, inspection, clearance by Owner / Owner's Engineer and dispatch.

The Bidder shall also submit the program for procurement of bought-out items and shipping schedule Owner's approval.

- 5.04.00 Construction Management
- 5.04.01 Within one (1) month of the signing of the Contract, the Bidder shall submit a programme of construction/erection/commissioning, either in continuation with the manufacture and dispatch or separately for the implementation. These programs shall be amplified showing when the civil drawings shall be released by him and construction of civil works shall be completed by him to



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facilitate start of erection and subsequent activities and shall form the basis for site execution and detailed monitoring the three monthly rolling programme with the first month's programme being tentative based on the site conditions shall be prepared based on these L-3 programs. The Bidder shall also be involved along with the Owner to tie up detailed resource mobilization plan over the period of time of the contract matching with the performance targets.

The L-3 programme shall be jointly finalized by the site in-charge of the Bidder with the Owner's project coordinator as well as the site-planning representative. The erection programme will also identify the sequential erectable tonnages that are required for various equipment, which shall be taken care of in the dispatch programs.

Erection and commissioning of the equipment shall also be done under the supervision of experts from the respective equipment / system supplier.

5.04.02 Construction Methods, Logistics and Equipment

Bidder's Proposals

The Bidder shall furnish a write-up describing his proposed sequence of erection of major plant items and his proposed construction methods supplied by diagrams and drawings, as necessary. The sequence of operations shall incorporate the designers' health and safety requirements. The Bidder shall relate movement of major Bidder's equipment to the construction programme time scale. The Bidder shall furnish his delivery methods and routes to the site and identify special or abnormal loads or cargoes with dimensions.

Bidder's Equipment

The Bidder shall detail in his write-up a;; Bidder's equipment to be used on site including cranes, fixed workshop equipment and vehicles. The information shall include size and capacity and indicate the duty for which they are required. The Bidder shall describe the usage intended for each crane.

Bidder's Proposals

The Bidder's proposals with regard to construction methods, logistics and equipment confirming the above proposals shall be submitted along with his construction management programme.

- 5.05.00 Spares management
- 5.05.01 The Bidder shall provide a suitable spares management system.
- 5.05.02 It is the responsibility of the Bidder to ensure availability of spares during the period of testing and commissioning and all spares to meet Bidder's obligations under the Defects Liability Period.



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- 5.05.03 The Bidder shall provide a spare storage facility which shall be equipped with suitable lifting and handling devices where needed. The storage facility shall be designed for long term storage of spares.
- 5.05.04 Bidder shall define in his write-up the spares management system and the storage facilities provided.
- 5.05.05 Bidder shall define in his write-up the management system and the storage facilities provided.
- 5.06.00 Resource Control

To enable the Owner to asses that the Bidder's proposals are adequate to meet the contract programme requirements, the Bidder shall describe his resource management system for the contract in his write-up.

- 5.07.00 Production Control and Manufacture
- 5.07.01 Manufacturer's Standards

The Bidder shall take in the write-up the standards to which manufactured equipment/components are offered where the Technical Specification has not specified any requirement.

5.07.02 Places of Manufacture

The manufacture and places of manufacture, testing and inspection of the various parts of the Bidder's works shall be stated in the write-up.

5.07.03 Sub-Contractors

The Bidder shall submit in his write-up, a list of all items that he deems necessary to be sub-contracted. The Bidder's orders to the Sub-Contractors shall quote the Owner's contract reference and station name, and instruct the sub-contractors to quote that number and name and also the order number in all correspondence.

5.07.04 Progress Reports

During the design and manufacturing stages in the Bidder shall submit to the Owner/Owner's Engineer reports and information on the progress and manufacture by himself and by the Sub-Contractors of all plant and materials required for the execution of the works. The reports shall be based on the plant manufacturing programs.

The detailed procedure and requirements for progress reporting will be agreed with Owner/Owner's Engineer during the early phase of the works, as part of regular contract/project status reporting.

5.07.05 Access for progress monitoring



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The Owner's Engineer or his nominated representative shall be entitled at all reasonable times to visit all premises where design and manufacturing of the plant is being carried out in order to monitor and verify progress.

- 5.08.00 Commissioning Management
- 5.08.01 For commissioning of the various equipment/system covered under the scope of contract. Owner will form an organization structure that may consist of the following committees. The Bidder shall nominate his representative on one or more of the Committee as decided by the Owner.
 - Steering committee
 - Commissioning Panel
 - Working Parties
 - Testing Teams
- 5.08.02 Commissioning documents shall be prepared by the Contactor in the following manner and submitted for Owner's approval.
 - a) Paper

This document shall be prepared for the various equipment/systems under commissioning and shall have the following objectives to fulfill and shall be submitted for Owner's approval at least 3 months before the actual commissioning.

- 1. Establish design data against which plant performance will be compared.
- 2. Set out the testing objectives and proposals.
- 3. Define the documentation required.
- b) Testing / Commissioning Schedule

These shall be prepared for the various equipment/system under consideration and shall contain sections like detailed testing method, programme, safety, individual responsibility and result.

c) Standard check lists

Standard check lists shall be prepared for use at the completion of erection to ensure correct erection, testing and to a limited extent operation for repetitive items.

d) Instrument Proving Schedules

These schedules shall be prepared for proving various instruments associated with all equipment/packages.

Schedules and lists under items (b), (c) and (d) above shall be submitted at least (6) months before the actual commissioning of the equipment/systems.

5.08.03 Test Reports



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After the completion of commissioning activity of equipment systems, the Bidder shall prepare the test reports which shall include all the relevant information related to various commissioning checks, tests carried out, any deviations/commissions noticed with respect to the intended design requirements, sequence of various commissioning checks, tests carried out, any deviations/commissions noticed with respect to the intended design requirements sequence of various commissioning activities as actually adopted vis-à-vis as recommended in the procedures, programme schedules achieved and any other such information as required. These test reports shall be submitted in requisite number of copies to the Owner and this should be duly signed jointly by the Owner/Owner's Engineer and the Bidder/Equipment supplier, who are involved during the commissioning activities.

6.00.00 OWNER'S RIGHTS

The Owner reserves the right to evaluate and audit the Bidder's management systems and controls in the following areas: Contract Management, Management Information, Programme Management, Resource management, Quality Assurance, Design, Production and Manufacture, Industrial Relations, Erection. Testina. Commissioning, Sub-contract Control Site and management. The Bidder shall provide all necessary assistance to enable the Owner carry out such audits and evaluations. Such audits and evolutions shall not in any way relive the Bidder of any of his liabilities and responsibilities under the contract. A corrective action programme shall be agreed and implemented in respect of any deficiencies revealed by such monitoring, without any cost implication to the Owner and impact on the time schedule for the project.

7.00.0 PROJECT PROGRESS REVIEW MEETINGS

Periodic project progress reviews will be held at least once every month at venues mutually agreed. These meetings will be attended by of the Bidder along with the consultants/Resident engineer of the owner and their leading sub-contractors. Action will be placed on the concerned agencies and decisions will be taken to expedite/speed up the progress. Minutes of such meetings will be issued and circulated to all concerned for reference and action. The Bidder shall be responsible for ensuring that actions placed on such meetings are carried out in time.

In addition to the above, a suitable frequency and forum of periodic meeting between the Bidder and the Owner/Owner's Engineer will be decided upon as part of erection co-ordination procedure.



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बी एय हे राज		SPECIFICAT	TON No: PE-TS-425-554-A001
BHEL	2X800 MW TANGEDCO UPPOR TPP BTG	SECTION :	I
	VENTILATION SYSTEM	SUB-SECTIO	ON : C 2C
	PAINTING SPECIFICATIONS	REV. 00	DATE: 17-04-2018

SECTION: I

SUB-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 IS:1303	:	Colours for ready mixed paints and enamels 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)



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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.



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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	Sa 21⁄2	Sa 21⁄2	SP10	2
metal				
Commercial	Sa2	Sa2	SP6	3
Blast				
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 21/2

Primer paint shall be Zinc Silicate of approved brand. Dry film thickness of each primer coat shall be 15-25 $\mu m.$

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

11011010		
	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.



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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 $+ 5^{\circ}$ C and the relative humidity shall not exceed 80%. The temperature of the work piece shall be at least 3°C 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



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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.



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(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 $2\frac{1}{2}$. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness $25 \,\mu$ m 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 μ m.

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° C as per clause 6.1 & 6.3. However

Surface Preparation



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Blasting according to SIS 055900 grade Sa $2\frac{1}{2}$. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm may be used.

Prime Coat

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

Intermediate Coat

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

Finish Coat

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

6.5 Special Coating

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

(i) At Works

Surface Preparation

Blasting according to SIS 055900 grade Sa $2\frac{1}{2}$ 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.



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

(i) At Works

Surface Preparation

Blasting according to ISO 8501-1:1958 grade Sa-2½. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 μ m 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 $2\frac{1}{2}$ to ISO 8501-1:1988. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 μ m 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 $< 400^{\circ}$ C

Surface Preparation

Blasting according to Sa $2\frac{1}{2}$ to ISO 8501-1:1988. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 μ m shall be used.



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Parts exposed to temperature above 400[°]C at works (Steam pipes, pressure tubes and parts for the HRSG, such as heating surfaces, heaters and superheaters, reheaters etc)

Temporary Primer

Varnish

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

(i) At Works

Surface Preparation

Blasting according to Sa $2\frac{1}{2}$ and ISO 8501-1:1988. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 μ m 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%, 75μ m.

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.



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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.



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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°C pH range 4.5-9.5

Blasting according to Sa 2¹/₂ 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%, 75μ m.

Intermediate Coat

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



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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 21/2 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.	ITEM/SERVICE	COLOUR	IS-5	COLOUR	IS-5
NO.				(BAND)	
1.	Structures, platforms,	Dark	632	-	-
	galleries, ladders and	Admirality			
	handrails	Grey			
2.	Boiler casing, ducting	Nut Brown	413	-	-



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SL.	ITEM/SERVICE	COLOUR	IS-5	COLOUR	IS-5
NO.				(BAND)	
3.	Crane				
3.1	Crane structure	Golden	356	Black	-
		Yellow			
3.2	Trolley & hook	Crimson	540	-	-
4.	Fans, pumps, motors,	Light Grey	631	-	-
	compressors				
5.	Tanks (without insulation				
	and cladding)				
5.1	Outdoor	Aluminium	-	-	-
5.2	Indoor	Light grey	631	-	-
6.	Vessels & all other	Light grey	631	-	-
	proprietary equipment				
	(without insulation &				
_	cladding)				
7.	Switchgear	Light grey		-	-
		(Powder			
0		coated)	004/70		
ð.	Control & relay panels		631/70	-	-
		(Powder	1650		
0	Turbinoc	Light Grov	621		
9. 10	Concrators & Excitor	Light Grov	631	-	-
10.	Transformere		-		
12	Machinery quards		537		
12.	Pipipa (without insulation		557		-
13.	and cladding)				
13.1	Water System				
13.1	Poilor food	Soo Croop	217		
а	Doller leed	Sea Green	217	-	-



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SL.	ITEM/SERVICE	COLOUR	IS-5	COLOUR	IS-5
NO.				(BAND)	
b	Condenstae	Sea Green	217	Light Brown	410
С	DM Water	Sea Green	217	Light Orange	557
d	Soft Water	Sea Green	217	French Blue	166
е	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	Aluminium	-	-	
	and pipe lines				
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	221
				green	
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	309	Light grey	631
		yellow			
17.2	Hydrogen	Canary	309	Signal red	537
		yellow			
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



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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.



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(बेएवडॅरल)	2X800 MW TANGEDCO UPPUR TPP BTG	SPECIFICATION	No: PE-TS-425-554-A001
BHH		SECTION : I	
	VENTILATION SYSTEM TECHNICAL SPECIFICATION	SUB-SECTION	: C-3
	(ELECTRICAL PORTION)	REV. 00	DATE: 17-04-2018
	, , ,		
	Sterion. I		
	SUB-SECTION: C-3		
	TECHNICAL SPECIFICATION (ELECT	RICAL PORTIO	N)

TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED 2X800 MW SUPERCRITICAL COAL BASED UPPUR TPP

VENTILATION SYSTEM TECHNICAL SPECIFICATION (ELECTRICAL PORTION)



BHARAT HEAVY ELECTRICALS LIMITED POWER SECTOR PROJECT ENGINEERING MANAGEMENT, NOIDA, U.P., INDIA



ELECTRICAL EQUIPMENT SPECIFICATION FOR VENTILATION SYSTEM

2 x 800 MW Supercritical Coal Based Uppur Thermal Power Project

SPECIFICATION NO. VOLUME NO. : II-B SECTION: C REV NO. : OD SHEET: 1

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SPECIFIC TECHNICAL REQUIREMENTS: ELECTRICAL

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:

- a) Services and equipment as per "Electrical Scope between BHEL and Vendor".
- b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The same shall be provided by the bidder without any extra charge.
- c) Supply of mandatory spares as specified in the specifications of mechanical equipments.
- d) Electrical load requirement for Elevator.
- e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
- f) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer/BHEL approval without any commercial and delivery implications to BHEL
- g) Various drawings, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All documents shall be subject to customer/BHEL approval without any commercial implication to BHEL.
- h) Motor shall meet minimum requirement of motor specification.
- i) Vendor to clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.
- j) Cable BOQ worked out based on routing of cable listing provided by the vendor for "both end equipment in vendor's scope" shall be binding to the vendor with +10 % margin to take care of slight variation in routing length & wastages.

2.0 EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR ELECTRICAL & TERMINAL POINTS:

Refer "Electrical Scope between BHEL and Vendor".

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 copy of this sheet "Electrical Equipment Specification for "VENTILATION SYSTEM" and sheet "Electrical Scope between BHEL and Vendor" with bidder's signature and company stamp.
- b) Electrical load requirement in the load data format.
- c) If there is any conflict, customer motor specification will prevail over BHEL motor specification.
- 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.



TECHNICAL SPECIFICATION FOR VENTILATION SYSTEM (ELECTRICAL PORTION)

4.0 List of enclosures :

- a) Electrical scope between BHEL & vendor (Annexure –I)
- b) Technical specification for motors.
- c) Quality plan for motors.
- d) Electrical Load data format (Annexure -II)
- e) BHEL cable listing format (Annexure –III)
- f) Sub vendor list for motors (Annexure-IV)
- g) Technical specification for LT switchgear
- h) Technical specification for motors
- i) Technical specification LV cables
- j) Technical specification control cables
- k) Technical specification cabling
- 1) Technical specification for earthing & lighting protection

LOA	AD TITLE	RATI NAM PLAT	NG (KW / A) E CONT. E DEMAND (MCR)	UNIT (U)/STN (S)	RUNNING	STANDBY 8	VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME >5 SEC (Y)	LOCATION	BOARD NO.	CA SIZE CODE	BLE NOs	BLOCK CABLE DRG. No.	CONT ROL CODE	REMA RKS	LOAD No.	VERIFICATI ON FROM MOTOR DATASHEE T (Y/N)	KKS NO
	1	2	3	4	5	6	7	8	9 1	10	11	12	13	14	15	16	17	18	19	20	21
											A	ANNEXURI	E-II				-				
NOTES:	1. COLUMN 1 T 2. ABBREVIATI	O 12 & 18 S⊢ ONS :* :*	IALL BE FILLE VOLTAGE COI * FEEDER COD	D BY DE (7 0E (8)	7 TH 7):- ():- U	E RE (ac) /	EQUI A=11 IDIR	SITIO KV, ECT	ONE B=6 ION/	R (C 6.6 K AL S	DRIGIN (V, C=: START	ATING AGENC 3.3 KV, D=415 V ER, B=BI-DIREC	Y); REMAIN , E=240 V (1 CTIONAL ST	ING COLU PH), F=1 ARTER, §	JMNS ARI 10 V S=SUPPL`	E TO BE	FILLED ((cc): G= R, D=SU	UP BY PI 220 V, H PPLY FE	EM (ELE) =110 V, 、 EDER (C	CTRICAL)/ CUS J=48 V, K=+24V CONTACTER C	STOMER /, L=-24 V ONTROLLED)
			JOB NO.		_					4	425		ORI	GINATIN	G AGEN	CY			PEM (ELECTRICAL)
ŀ			PROJECT 1	ITL	E	_		2X8	300 NTII	MW AT		JR TPS VSTEM						A FILLE		DN N	
			DEPTT. / SE	ЕСТ	ION			4 L I		N	IAX		SHEET 1	OF 1	REV. 00		DAT	S SIGN.	& DATE	E	

CABLE SCHEDULE FORMAT

ANNEXURE III

				CABLE SCOPE				TENTATIVE
				(BHEL PEM/				CABLE
UNITCABLENO	FROM	TO	PURPOSE	VENDOR)	REMARKS	CABLESIZE	PATHCABLENO	LENGTH

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

- For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.
- 2. The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT_CAB_SCH_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.
- 3. The field properties shall be as under:
 - a. UNITCABLENO: A/N, up to sixteen (16) characters; each cable shall have its own unique, unduplicated cable number. In case this rule is violated, the cable cannot be taken up for routing.
 - b. FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - c. TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - d. PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication/ measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - e. REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
 - f. CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
 - g. PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.
- 4. One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).
- 5. The cables shall be described as per the scheme listed below:

А	NN	Α	NNN
I			I
Cable	No. of cores	Cable code	Cable size
Voltage Code (see B below)	(e.g. 01,03,3H, 07)	(See C below)	(e.g. 035,185,2.5, 0.5)

(A) SYSTEM VOLTAGE CODES:

(ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V (dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

- (B) <u>CABLE VOLTAGE CODES:</u>
 - A = 11KV (Power cables)

Rev O

18 April 2017

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

B = 6.6KV (Power cables) C = 3.3KV (Power cables) D = 1.1KV (LV & DC system power & control cables) E = 0.6KV (0.5 sq. mm. Control cables)

(C) <u>CABLE CODES</u>

<u>PVC Copper</u>	
A = Armoured FRLS	B = Armoured Non-FRLS
C = unarmoured FRLS	D = Unarmoured Non-FRLS
<u>PVC Aluminium</u>	
E = Armoured FRLS	F = Armoured Non-FRLS
G = unarmoured FRLS	H = Unarmoured Non-FRLS
XLPE Copper	
J = Armoured FRLS	K = Armoured Non-FRLS
L = unarmoured FRLS	M = Unarmoured Non-FRLS
XLPE Aluminium	
N = Armoured FRLS	P = Armoured Non-FRLS
Q = unarmoured FRLS	R = Unarmoured Non-FRLS
S = FIRE SURVIVAL CABLES	
T = TOUGH RUBBER SHEATH	
U = OVERALL SCREENED	
V = PAIRED OVERALL SCREENED	

W = PAIRED INDIVIDUAL SCREENED

Y = COMPENSATING CABLES

I = PRE-FABRICATED CABLES

Z = JELLY FILLED CABLES

ANNEXURE-IV

SUB-VENDOR LIST

The list of approved make of the LT Motors are as mentioned below:

	ABB
	BHARAT BIJLEE LTD.
	CROMPTON GREAVES
	GE-POWER
LV MOTORS (NON FLAME PROOF)	
	KIRLOSKAR ELECTRIC CO LTD.
	LAXMI HYDRAULICS PVT. LTD
	MARATHON
	NGEF
	RAJINDRA ELECT INDUSTRIES
	SIEMENS
LV MOTORS (FLAME PROOF)	RAJINDRA ELECT INDUSTRIES

However, the final list of makes for the LT Motors is subjected to BHEL/Customer approval, during contract stage, without any commercial implications.



FOR

LV MOTORS

SPECIFICATION NO.
PE-SS-999-506-E101
VOLUME NO. : II-B
SECTION : D
REV NO. : 00 DATE : 29/08/2005
SHEET : 1 OF 1

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO.: PE-SS-999-506-E101 Rev 00



FOR

SPECIFIC	ATIC	DN N	10.		
PE-SS-	999-	506-l	E101		
VOLUME	NO.	:	II-B		
SECTION		:	D		
REV NO.	: 00	DA	TE : :	29/08/2	2005
SHEET	: 1	OF	4		

1.0 **INTENT OF SPECIFIATION**

TITLE :

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.

य <i>ई एन</i>	TITLE : GENERAL TECHNICAL REQUIREMENTs	SPECIFICATION NO. PE-SS-999-506-E101
i,E	FOR	VOLUME NO. : II-B SECTION : D
	LV MOTORS	REV NO. : 00 DATE : 29/08/2005 SHEET : 2 OF 4

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.
- 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.



TITLE :

FOR

LV MOTORS

SPECIFICATION NO.									
PE-SS-999-506-E101									
VOLUME NO. : II-B									
SECTION : D									
REV NO. : 00 DATE : 29/08/2005									
SHEET : 4 OF 4									

- 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.

			CUSTOME	R :		PROJECT	SPECIFICATION :							
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	AHTI	QUALITY PLAN	BIDDER/			QUALITY PLAN			SPECIFICATI			l		
			VENDOR			NUMBER PED-506-00-Q-006. REV-01			TITLE					
	9	SHEET 1 OF 2	SYSTEM			ITEM AC ELECT. M	IOTORS BELOW 55KW	V (LV)	SECTION VOLUME III					
SL.	COMPONENT/OPERA	TION CHARACTERISTICS	CAT.	TYPE/	EXTENT OF	REFERENCE	ACCEPTANCE	FORMAT	AGE	NCY		REMARKS		
NO.		CHECK		METHOD OF	CHECK	DOCUMENT	NORM	OF RECORD						
				CHECK					Р	w	v			
1	2	3	4	5	6	7	8	9		10		11		
1.0					1000/			50	~					
1.0	ASSEMBLY	1.WORKMANSHIP	IVIA	VISUAL	100%	MANUF 5 SPEC	MANUF S SPEC	-DO-	2	-	-			
		2 DIMENSIONS	МΔ	-00-	-00-	MEG DRG /	MEG DRG /	-DO-	2	_	_			
		2.Dimentoronto		20	20	MEG SPEC	MEG SPEC	20	-					
		3.CORRECTNESS	MA	VISUAL	100%	MFG.SPEC./	MFG.SPEC.	-DO-	2	-	-			
		COMPLETENESS				RELEVANT IS	RELEVANT IS							
		TERMINATIONS/												
		MARKING/COLOUR												
		CODE												
2.0			МΔ		SAMPLE	MANUER'S	BHEL SPEC		2	_	_			
2.0		1.01 WEE	1017 (VICONE	O/ WIT EE	SPEC/BHEI	SAME AS	LOG DOOK	2					
						SPEC./RELEVANT	COL.7							
						STANDARD								
3.0	TESTS	1 ROUTINE	МА	-DO-	100%	IS-325/	SAME AS	TEST	2	1		NOTE -1		
0.0		TEST INCLUDING		20		BHEL SPEC./	COL.7	REPORT	_			&		
		SPECIAL TEST				DATA SHEET						NOTE-3		
		AS PER BHEL												
		SPEC.								1				
					1000/							NOTE		
			MA		100%			INSPN.	2	1	-	NOTE -1		
								REPURI		1				
		ORIENTATION		VISUAL		SHEET	& RELEVANT IS			1		NUTE-3		
							GIVELEVANT 10							
										1				
	BHEL		PARTICUL	ARS	BIDDER/VE	NDOR			_					
			NAME						_					
			SIGNATUR	?E										
			Lorona I OL	· -					1					

	बिएवड एन मिर्मुमा	QUALITY PLAN	CUSTOME BIDDER/ VENDOR SYSTEM	R : :		PROJECT TITLE QUALITY PLAN NUMBER PED-506- ITEM AC ELECT M	SPECIFICATION : NUMBER : SPECIFICATION : TITLE :					
SL.	COMPONENT/OPERA	TION CHARACTERISTICS	CAT.	TYPE/	EXTENT OF	REFERENCE	ACCEPTANCE	FORMAT	AGENCY REMARKS			
NO.		CHECK		METHOD OF CHECK	CHECK	DOCUMENT	NORM	OF RECORD	P	w	v	
1	2	3	4	5	6	7	8	9		10		11
	NOTES:	3.NAMEPLATE DETAILS	МА	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2	1	-	
		1 ROUTINE TESTS ON SAMPLING PLAN SH 2 WHERE EVER CUST 3 FOR EXHAUST/VENT	100% MOTO IALL BE MU OMER IS IN TILATION FA	DRS SHALL BE DO TUALLY AGREED VOLVED IN INSPE N MOTORS OF R	ONE BY THE UPON ECTION, (1) S ATING UPTC	VENDOR. HOWEVE SHALL MEAN BHEL A 0 1.5KW , ONLY ROU	R, BHEL SHALL WITN AND CUSTOMERS BC TINE TEST CERTIFIC 	NESS ROUTINE	E TES' R. BE FU	TS ON	I RAN	DOM SAMPLES. THE
	Legends for	or Inspection agency										
	1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER)											
	V. VERIFY	SS										
	BHEL	1	PARTICUL	ARS	BIDDER/VE	NDOR	1	1				1
			NAME						1			
			SIGNATUR	RE					1			
			DATE						BIDD)ER'S/	VEND	ORS COMPANY SEAL

			CUSTOME	R:		PROJECT				SPECIFICATION :					
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	HHH	QUALITY PLAN	BIDDER/	:		QUALITY PLAN			SPECIFICATION :						
			VENDOR			NUMBER PED-506-00-Q-007, REV-03			TITLE						
	SHEET	1 OF 9	SYSTEM			ITEM: AC ELEC	T. MOTORS 55 KW & /	ABOVE (LV & MV)	SECTION		VOLUME III				
SL.	COMPONENT/OPERATION	CHARACTERISTIC	CAT.	TYPE/	EXTENT OF	REFERENCE	ACCEPTANCE	FORMAT	AGEN	NCY	-	REMARKS			
NO.		CHECK		METHOD OF	CHECK	DOCUMENT	NORM	OF RECORD	-						
				CHECK					Р	vv	v				
1	2	3	4	5	6	7	8	9		10		11			
1.0	RAW MATERIAL & BOUGHT OU	JT U			- ·		Ū	,							
	CONTROL														
1.1	SHEET STEEL, PLATES,	1.SURFACE	MA	VISUAL	100%	-	FREE FROM	LOG BOOK	3	-	-				
	SECTION, EYEBOLTS	CONDITION					BLINKS,								
							WAVINESS								
							ETC								
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANFR'S	MANFR'S	-DO-	3	-	-				
						DRG./SPEC	DRG./SPEC								
		3 PROOF LOAD	МА	MECH TEST	-DO-	-DO-	-DO-	INSPEC	3	-	2				
		TEST (EYE	100 (20	20	20	REPORT	Ŭ		-				
		BOLT)													
1.2	HARDWARES	1.SURFACE	MA	VISUAL	100%		FREE FROM	-DO-	3	-	-				
		CONDITION					EVENNESS								
							ETC.								
		2.PROPERTY	MA	VISUAL	SAMPLES	MANFR'S	RELEVENT	SUPPLIERS	3	-	2	PROPERTY CLASS			
		CLASS				DRG./SPEC	IS/SPEC.	TC & LOG				MARKING SHALL BE			
						BOOK									
												VENDOR			
1.3	CASTING	1.SURFACE	MA	VISUAL	100%		FREE FROM	LOG BOOK	3	-	2				
		CONDITION					CRACKS,								
							BLOW HOLES								
							EIC.		1		1				
		2.CHEM. &	ма	CHEM & MECH	1/HEAT NO	MANER'S	RELEVENT	SUPPLIER'S	3	-	2	HEAT NO. SHALL BE			
		PHY. PROP.		TEST		DRG./SPEC	IS/	TC	Ŭ		-	VERIFIED			
									1		1				
					1000/										
		3.DIMENSIONS	MA	MEASUREMENT	100%	MANUFR'S	MANUFR'S	LOG BOOK	3	-	2				
						DKG.	DKG.		1		1				
1.4	PAINT & VARNISH	1.MAKE, SHADE.	MA	VISUAL	100%	MANFR'S	MANFR'S	LOG BOOK	3	-	2				
		SHELF LIFE &			CONTINUOUS	DRG./SPEC	DRG./SPEC		-		-				
		TYPE							1		1				
									1		1				
	BHFI	I	PARTICUI	ARS	BIDDER/VEND	l OR		l	+	I	I	1			
			NAME			UN									
			SIGNATUR	RE					1						
			DATE	DATE							BIDDER'S/VENDORS COMPANY SEAL				

				CUSTOME	R :		PROJECT				SPECIFICATION :				
							TITLE			NUM	BER :				
<u>IIII QUA</u>		QUALITY PLAN	BIDDER/	:		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION :						
			05.0	VENDOR					TITLE						
0		SHEET 20		SYSTEM			ITEM: AC ELECT	. MOTORS 55 KW & A	BOVE (LV & MV)	SECI	ION				
SL.	COMPONENT/OPERAT	ION	CHARACTERISTIC	CAT.		CHECK		NORM		AGEN	AGENCY		REMARKS		
NO.			ONEON		CHECK	ONEON	DOCOMENT		OF RECORD	P W	w	v			
1	2		3	4	5	6	7	8	9	10		-	11		
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED		
			2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	MFG. DRG. SPEC.	RELEVANT IS	SUPPLIER'S TC	3	-	2			
			3. DIMENSIONS	MA	MEASUREMENT	100%	-DO-	MANUFR'S DRG.	LOG BOOK	3	-	2			
			4.INTERNAL FLAWS	CR	UT	-DO-	ASTM-A388	MANUFR'S SPEC. BHEL SPEC.	-DO-	3	2	1	FOR DIA OF 55 MM & ABOVE		
1.6	SPACE HEATERS, COI TORS, TERMINAL BLO CABLES, CABLE LUGS CARBON BRUSH TEMI DETECTORS, RTD, BT	NNEC- CKS, S, P. D'S	1. MAKE & RATING	МА	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		•	PARTICUL	ARS	BIDDER/VEND	OR		•	1		•	•		
				NAME											
				SIGNATUR	E										
				DATE						BIDDER'S/VENDORS COMPANY SEAL					

				CUSTOME	R :		PROJECT				SPECIFICATION :				
	(बाएपइ एन)						TITLE				NUMBER :				
	HHEL		QUALITY PLAN	BIDDER/	BIDDER/ :			QUALITY PLAN			SPECIFICATION :				
				VENDOR			NUMBER PED-506-00-Q-007, REV-03			TITLE					
	-	SHEET 3 (OF 9	SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION VOLUME III					
SL.	COMPONENT/OPERAT	TION	CHARACTERISTIC	CAT.	TYPE/	EXTENT OF	REFERENCE	ACCEPTANCE	FORMAT	AGEN	VCY		REMARKS		
NO.			CHECK		METHOD OF	CHECK	DOCUMENT	NORM	OF RECORD	-					
					CHECK					۲	vv	v			
1	2		3	4	5	6	7	8	9		10		10		11
					-	-									
1.7	OTHER INSULATING MATERIALS LIKE SLEE BINDINGS CORDS, PA	EVES, PERS,	1. SURFACE COND. ETC.	MA	VISUAL	100%	-	NO VISUAL DEFECTS	INSPT. REPORT	3	-	2			
	PRESS BOARDS ETC.		2. OTHER CHARACTERISTICS	MA	TEST	SAMPLE	MANUF'S	MANUF'S	LOG BOOK	3	-	2			
							SPEC.	SPEC.	AND OR SUPPLIER'S TC						
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		
			3. ACCEPTANCE TESTS	MA	ELECT. & MECH TESTS	-DO-	MANUF'S SPEC./ RELEVANT IS	RELEVANT IS	SUPPLIER'S TC	3	-	2	THE BOKS HEIGHT		
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		
			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	BY BHEL/CUSTOMER.		
	BHEL		1	PARTICUL	ARS	1	BIDDER/VEND	DOR	1		I	1	1		
				NAME											
				SIGNATUR	RE										
										BIDD	ER'S/	VEND	ORS COMPANY SEAL		