

**TAMILNADU GENERATION & DISTRIBUTION CORPORATION
LIMITED**

1x800 MW TANGEDCO NORTH CHENNAI TPP

TECHNICAL SPECIFICATION

FOR

AIRCONDITIONING SYSTEM

SPECIFICATION NO.: - PE-TS-423-553-A001 (REV-01, NOV 2017)



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



TITLE:
**TECHNICAL SPECIFICATINS FOR
AIR CONDITIONING SYSTEM**

SPECIFICATION No: PE-TS-423-553-A001

SECTION

REV. 01

DATE: NOV 2017

SHEET : 1 OF 2

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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 **AIR CONDITIONING SYSTEM** as per details in different sections / volumes of this specification and various pre award agreements for **1X800 MW TANGEDCO NORTH CHENNAI TPP**.
- 1.2 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve the contractor of the responsibility of providing such facilities to complete the supply, erection and commissioning, performance and guarantee/demonstration testing of **AIR CONDITIONING SYSTEM**.
- 1.3 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to highest standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgement is not in full accordance herewith.
- 1.4 The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing. Similarly, the extent of supply also includes all items required for completion of the system and not withstanding that they may have been omitted in drawings / specifications or schedules.
- 1.5 The general term and conditions, instructions to tenderers and other attachment referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification is subject to compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.
- 1.6 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under Vol-III of the specification **within 10 days of receipt of tender documents**. In absence of any such clarifications, in case of any contradictory requirement, the more stringent



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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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**AIRCONDITIONING SYSTEM
PROJECT INFORMATION WITH WIND AND
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**PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN
CRITERIA**



1X800 MW COAL BASED NORTH CHENNAI THERMAL
POWER PROJECT STAGE III

EPC TENDER SPECIFICATION FOR BTG PACKAGE



CHAPTER 2
PROJECT INFORMATION

1.1 GENERAL

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

1.2 LOCATION

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

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

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

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

1.3 PROJECT INFORMATION

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



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



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

1.4 ACCESS TO SITE

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

1.5 PLANT RATING, CAPACITY, AVAILABILITY, PLF

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

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

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

The capacity of the unit is selected so as to deliver the rated output even after ageing that will occur between overhauls, as a result of deposition of salts in turbine blades, wear and tear etc. The plant load factor (PLF) being considered is 85%.

1.6 SOURCES OF FUEL

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

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

The steam generator shall be designed for the following conditions:

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



1X800 MW COAL BASED NORTH CHENNAI THERMAL
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EPC TENDER SPECIFICATION FOR BTG PACKAGE

1.7 Coal Analysis

1.7.1 Coal Quality parameter

a) Domestic Coal

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



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b) Imported Coal

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



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

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

1.7.2 Specification of LDO

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

1.7.3 Specification of HFO

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

1.8 Fuel Transportation

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



1X800 MW COAL BASED NORTH CHENNAI THERMAL POWER PROJECT STAGE III

EPC TENDER SPECIFICATION FOR BTG PACKAGE



1.9 SOURCE OF WATER

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

1.10 SOURCE OF EQUIPMENT

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

1.11 POWER EVACUATION PLAN

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

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



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during detail engineering. Each ESP hopper shall be supported at four corners by providing four columns from the ground.

- viii. In design of boiler /ESP support structures dynamic piping loads need not be considered acting simultaneously with wind or seismic loads. Increase in permissible stresses shall be allowed in load combinations where dynamic piping loads are considered and shall be as permitted under seismic load conditions.

D. Wind Loads

Wind loads for all structures shall be based on IS: 875 (Part 3). Basic wind speed shall be 50m/sec. A step function of pressure with height under different exposure conditions shall be used. For steel structures exceeding 25m height, diagonal wind analysis shall be carried out.

E. Seismic Loads

The seismic zone shall be Zone - III as per IS: 1893. Importance factor (1.75) shall be taken as Table 2 of IS: 1893: Part-4 & Response Reduction Factor will be taken from Table 7 of IS: 1893 - 2002 with 100% of mass participation. Ductile detailing in accordance with IS: 13920 shall be adopted for all concrete structures which is mandatory for Zone -III. Response spectrum method shall be used for seismic analysis using atleast 5 modes of vibration.

Zone factor - 0.16

Importance factor – 1.75

F. Temperature Loads

For temperature loading, the total temperature variation shall be considered as 2/3 of the average maximum annual variation in temperature. The average maximum annual variation in temperature for this purpose shall be taken as the difference between the mean of the daily minimum ambient temperature during the coldest month of the year and mean of daily maximum ambient temperature during the hottest month of the year. The structure shall be designed to withstand stresses due to 50% of the total temperature variation.

Suitable expansion joints shall be provided in the longitudinal direction wherever necessary. The maximum distance of the expansion joint shall be as per the provisions of IS: 800 and IS: 456-2000 for steel and concrete structures respectively.

G. Equipment Loads

Loads of all equipment like water Tanks, Cooling Equipment, Motors, fan drive pulleys, Pumps, Monorails, Ventilation duct, air inlet & exhaust duct, Electrical control and relay panels, Cable load, Pipe load (static and dynamic), Tanks, AHU, Batteries, Air Washer, etc. shall be considered over and above the imposed loads. Equipment loads shall be considered as given by equipment supplier. Equipment loads, which are of permanent nature, shall be treated as dead loads. However, where the uniform floor live load adequately accounts for the equipment moving weight, the weight of such equipment as a dead load shall not be considered.



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TECHNICAL SPECIFICATIONS



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SPECIFIC TECHNICAL REQUIREMENT



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1 FUNCTION

The purpose of the system is to provide Air-conditioning system for different areas of 1x800 TANGEDCO NORTH CHENNAI TPP under the scope of BHEL.

2 SYSTEM DESCRIPTION

2.1 AC PLANT-1

AC plant-1, in main power house building is provided to cater the air conditioning requirements of the following areas:-

- Central Control Room.
- Control Equipment Rooms.
- Shift in-charge/engineers room and other areas at 17 M main control room.
- UPS (Uninterrupted Power Supply) room.
- Steam and water analysis system rooms (SWAS) (if SWAS room is not in the vicinity of the control room areas the same shall be air conditioned through split AC's / Fan Coil Units (FCU).

The AC plant comprises two (2) nos. (1 W + 1 S) screw Chilling machines. The condenser cooling water shall be circulated through these units by means of 2 nos. (1 W +1 S) horizontal centrifugal pump sets and 2 nos. (1 W + 1 S) FRP cooling towers. The chilled water produced by the chilling units shall be circulated to the air handling units (AHU) ((2W + 1S) for area at 17 and (1W +1S) for area at 8.5 M) located adjacent to air-conditioned areas as above in Power House by means of 2 nos. (1 W +1 S) horizontal centrifugal pump sets. The conditioned air from AHUs is distributed to the air-conditioned areas by galvanized sheet steel ducting and extruded aluminium grilles / diffusers. For area at 17 M the return air shall be led back to the AHU Room through return air duct.

Controls for the AC & Ventilation (common) shall be DDCMIS based.

2.2 AC PLANT-2

AC PLANT-2, to cater the air conditioning requirements of ESP control room:-

The AC plant comprises 2 nos. (1 W+1 S) water cooled direct expansion type, with reciprocating/scroll/screw compressor, condensing unit. The condenser cooling water shall be circulated through these units by means of 2 nos. (1 W +1 S) horizontal centrifugal pump sets and 2 nos. (1 W + 1 S) FRP cooling towers. The refrigerant produced by the chilling units shall be circulated to the air handling units (AHU) (1W + 1S) located adjacent to air-conditioned areas. The conditioned air from AHUs shall be distributed to the air-conditioned areas by galvanized sheet steel ducting and extruded aluminium grilles / diffusers. The return air shall be collected above the false ceiling and led back to the AHU rooms which acts as mixing plenum for return and fresh air.

2.3 AC PLANT-3

AC PLANT-3, to cater the air conditioning requirements of Service building:-

To cater air conditioning requirement of various areas in Service building be considered for air conditioning.

The AC plant comprises water cooled direct expansion package type Air conditioning system with (1W + 1S) configuration. The condenser cooling water shall be circulated through these units by means of 2 nos. (1 W +1 S) horizontal centrifugal pump sets and 2 nos. (1 W + 1 S) FRP cooling towers. The conditioned air from indoor unit of package AC shall be distributed to the air-conditioned areas by galvanized sheet steel ducting and extruded aluminium grilles / diffusers. The return air shall be

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collected above the false ceiling and led back to indoor unit room of package ACs which acts as mixing plenum for return and fresh air.

2.4 AC PLANT-4

AC PLANT-4, to cater the air conditioning requirements of other areas:-

Split type air conditioners (air cooled) shall be provided to cater to the air conditioning requirements of Compressor house control room areas having workstation for auxiliary plant. (Only those aux. control rooms which are under scope of BHEL). Local isolator / MCB shall be provided with split units.

Hand operated remote and other accessories as specified. Local Distribution Boards containing Switch / MCB shall be provided for Split Air Conditioners, and FCUs. Each split unit shall also be provided with suitable rating stabiliser.

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

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

Further refer relevant clauses of section C2-A, customer specifications for other technical details.

3 DESIGN CRITERIA**SYSTEM DESIGN CRITERIA - AIR CONDITIONING SYSTEM**

3.1 The outside design conditions considered are as follows:-

	Summer	Monsoon	Winter
DBT (°C)	39.4	28.3	18.3
WBT (°C)	27.8	26.7	13.9
RH (%)	41	88	60

3.2 The inside design conditions to be maintained are as follows:-

Temperature : 22 + 1°C

Relative humidity : 50 + 5%

3.3 For winter heating load calculation, 50% of combined light load and eqpt. /Panel load as available in the room shall be considered.

3.4 Fresh air requirement for air-conditioning shall be considered as under:

- For control room/ control equipment room/UPS room etc. 35/M³/hr/person or 1.5 air changes per hour whichever is higher.

3.5 A margin of 10% shall be considered for the capacity of equipment like Chiller, chilled water pumps, AHU and cooling tower.

3.6 Lighting load, minimum 2 W / Sq ft. or actual whichever is higher shall be considered.

3.7 The Occupancy shall be considered as One (1) person in 3 sq.m in general/office areas, for One (1) person in 1.5 sq.m in conference room and One (1) person in 20 sq.m in control room, CER etc.

3.8 Air and water velocity:-

i)	Main ducts: -	7.5m/sec
ii)	Branch duct: -	6.0m/sec
iii)	Grills/Diffuser: -	2.0m/sec
iv)	Louvers for air inlet: -	2.5m/sec

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- v) Water velocity in piping: - 2.5m/sec
- vi) Water velocity in piping: - 1.5m/sec
(Gravity flow/pump suction)
- vii) AHU (Face velocity):- 2.5m/sec

For other design parameters refer relevant clauses of section C2-A, customer specifications.

3.9 All windows in the air conditioned area shall be provided with light colored venetian blinds.

3.10 Tentative heat dissipation data:-

Sl. No.	Area	Heat dissipation (in KW)
1	CCR, CER, Shift in-charge/engineers room and other areas at 17 M main control room	139
2	UPS (Uninterrupted Power Supply) room at 8.5 M	45
3	SWAS room	5
4	ESP control room bld.	15

Note:- Heat dissipation data given above is tentative only, final heat dissipation data shall be provided during detailed engineering.

4 SYSTEM CAPACITY AND CONFIGURATION:-**For AC Plant-1:-**

2x180 TR Actual capacity water cooled Screw chiller (1W + 1S) shall be provided.

For AC Plant-2:-

2x40 TR Water cooled condensing unit (1W + 1S) shall be provided.

5 LAYOUT CONSIDERATIONS AND EQUIPMENTS TO BE PROVIDED FOR DIFFERENT AC PLANTS:-**AC PLANT-1**

- a) The central chilled water plant, Condenser Water & Chilled Water Pumps for AC Plant-1 shall be housed in AC Plant Room at 0.0 M level in E-F-2-4 Bay Power House Building.
- b) The AHUs/FCUs for this AC Plant would be located as under:
 - 3 AHUs (3 x 50 %) for areas at 17.0 m i.e CCR, CER, computer rooms, shift in-charge, etc. located in AHU Room at 24.0 M level of Power House Building in BC Bay.
 - 2 AHUs (2 x 100 %) for areas at 8.5.0 m i.e UPS panel room, etc. located in AHU Room at 8.5 M level of Power House Building in EF Bay.
 - FCU for SWAS (dry panel room) as per the requirement.
- c) The Cooling Towers, Make-up water Storage Tank, Expansion Tank shall be located at 32.0 M level in E-F Bay.
- d) Two (2) Nos Screw chiller (1W+ 1SB) complete with all accessories as described here in after.
- e) Two (2) Nos. Horizontal Split Casing Centrifugal Condenser Water Pump Sets (1 W + 1 SB) each complete with all accessories as described here in after.
- f) Two (2) Nos. Horizontal Split Casing Centrifugal Chilled Water Pump Sets (1W + 1 SB) each complete with all accessories as described here in after.
- g) Two (2) Nos. Fibre glass reinforced plastic (FRP) construction Cooling Towers (1W + 1 SB), each CT complete with all accessories i.e. fan, motor, basin, nozzles, level switch, make up connection, drains, piping, valves & fittings, strainer, ladder and supporting structure etc.
- h) Pan type humidifier in each AHU room.
- i) Pre-filters (inside the pre-filter section of the AHUs at suction side)
- j) Fine filters (shall be provided at discharge of AHUs and fresh air fan).
- k) One No. MS (spray galvanized) chilled water expansion tank complete with valve, Level Gauge, Level Switch, Make-up connection, overflow and drain etc.

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- l) Make up water tank made of MS (spray galvanized) complete with valves, level gauge, level switch, make up connection, over flow and drain etc.
- m) Acoustic insulation for initial length of 6 m from the AHU outlet.
- n) 2x50% Duty fresh air fan with pre-filter & fine filter in AHU Room.

AC PLANT-2

Water cooled DX condensing unit shall be located on terrace.

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

- AHU Room at 8.5 M level of Power House Building in E-F Bay.

The Cooling Towers, Make-up water Storage Tank, Expansion Tank, shall be located at terrace.

- a) Two (2) Nos (1W + 1 SB) sheet metal DX type (double skin) air handling units of sectionalized construction each complete with all accessories as described hereinafter, to match the AC load of ESP control room.
- b) Pan type humidifier in each AHU room.
- c) Pre-filters (inside the pre-filter section of the AHUs at suction side)
- d) Fine filters (shall be provided at discharge of AHU and fresh air fan).
- e) Acoustic insulation for initial length of 6m from the AHU outlet.
- f) 2x50% Duty fresh air fan with pre-filter & fine filter in AHU Room

AC PLANT-3

Water cooled package air condition system shall be provide at each floor of service building.

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

- a) The Cooling Towers, Make-up water Storage Tank shall be located at terrace of service building.
- b) Two (2) Nos. Horizontal Split Casing Centrifugal Condenser Water Pump Sets (1 W + 1 SB) each complete with all accessories as described here in after.
- c) Two (2) Nos. Fibre glass reinforced plastic (FRP) construction Cooling Towers (1W + 1 SB), each CT complete with all accessories i.e. fan, motor, basin, nozzles, level switch, make up connection, drains, piping, valves & fittings, strainer, ladder and supporting structure etc.
- d) Pan type humidifier in each AHU/PU room.
- e) Make up water tank made of MS (spray galvanized) complete with valves, level gauge, level switch, make up connection, over flow and drain etc.
- f) Acoustic insulation for initial length of 6m from the AHU outlet.
- g) 2x50% Duty fresh air fan with pre-filter in AHU/PU Room.

6**SPECIAL CONSIDERATION**

- a) Water flow rate for chilled water pump selection: 0.7 cmh/TR
- b) Water flow rate for condenser water pump selection: 1.0 cmh/TR
- c) Condenser water pumps, chilled water pumps, AHUs and FCUs shall have further 10% margin on their flow capacities.
- d) Further design margins in various equipment shall be as per relevant clauses of section C2-A, customer specifications.
- e) All equipment shall be of high quality and high efficiency meeting the stipulated power consumption as defined elsewhere in the specifications.
- f) The minimum COP and IPLV of Screw chiller shall be as per ECBC guidelines.

7**AC EQUIPMENT DETAILS**



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7.1 WATER COOLED CHILLER PACKAGE

Each chilling package (Screw/Scroll) shall comprise of the following:

- a) Screw compressors (suitable for Refrigerant R-134a/R407C) with motors complete with suction and discharge shut off valves, oil pumps, high pressure cut-out, low pressure cut-out, oil pressure cut-out, built-in automatic capacity control etc.
- b) One (1) No. shell and tube type water cooled condenser and integrally finned copper tubes complete with hot gas inlet, liquid outlet, relief and purge connection for refrigerant and water inlet, water outlet, drain connection etc.
- c) One (1) No. shell and tube type water chiller and seamless copper tubes, plain from outside, integrally surface enhanced complete with liquid inlet and vapour outlet connection for refrigerant and water inlet, water outlet, drain connection etc.
- d) MS heavy class (IS 1239) seamless refrigerant piping, valves and fittings, inter-connecting compressor, condenser and chiller.
- e) MS structural frame work with anti-vibration pads.
- f) Initial fill of refrigerant and compressor lube oil
- g) insulation of suction line and chiller
- h) 150 mm dial type pressure gauges at the inlet and outlet of the condenser and chiller respectively
- i) 150 mm dial type temperature gauges at the inlet and outlet of condenser and chiller respectively
- j) Controls comprising the following: -
 - All controls for Screw/Scroll chiller are sensor based as part of Screw/Scroll chiller package.
 - Water flow switch at the outlet of the each condenser and chiller
- k) Refer to clause 2.1.10.8.1 and other relevant clauses of section C2-A, customer specifications.
- l) Accessories (valves, pressure gauges, water flow switches, controls and instruments etc.) shall be provided with each screw/scroll chiller as per customer approved P&ID.

7.2 CENTRIFUGAL PUMP FOR CHILLED AND CONDENSER WATER LINE

Each Chilled/condenser water circulating pump set shall comprise of the following:-

- a) Horizontal split casing centrifugal pump of adequate capacity to match the package chiller / system requirement. Each condenser water circulating pump set shall comprise of the following:-
- b) One No. adequately sized TEFC sq. cage induction motor suitable for 415 V, 3 phase, 50 Hz AC supply.
- c) One set of base plate, coupling guard, anti-vibration pads, and foundation bolts etc.
- d) Valves, strainer, Instruments, other fittings etc.
- e) Other details shall be as per technical specification clause number 2.1.10.8.4.
- f) All the pumps shall have 10% margin on capacity and head over the actual requirement.
- g) Accessories (valves, pressure gauges, water flow switches, controls and instruments etc.) shall be provided with pump as per customer approved P&ID

7.3 COOLING TOWER

- a) Induced draft fibre glass reinforced plastic (FRP) construction Cooling Towers, each CT complete with all accessories i.e. fan, motor, FRP basin, nozzles, level switch, make up connection, drains, piping, valves & fittings, strainer, ladder and supporting structure etc.
- b) Cooling tower shall be designed as under:-
 - Design wet bulb: 27.8° C.
 - Approach: 4° C.
- c) Refer to clause 2.1.10.8.6 and other relevant clauses of section C2-A, customer specifications.



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7.4 AIR HANDLING UNIT

Each air-handling unit shall comprise of the following: -

- a) The casing of AHU shall be of double skin construction, DIDW type. Double skin sandwich panels (inside and outside) shall be fabricated using minimum 0.80 mm (22 SWG) galvanised steel, with 25 mm thick polyurethane (PUF) foam insulation of minimum 40 kg/m³ density in between 16G galvanised steel sheet channel shall be used as reinforcing to give structural strength.
- b) Fan section complete with forward / backward curved multi-bladed centrifugal fan mounted on a shaft with adjustable motor base.
- c) One No adequately sized TEFC sq. cage induction motor suitable for 415 V, 3 phase, 50 Hz AC supply with drive package comprising fan pulley, motor pulley, V-belt and belt guard.
- d) Cooling coil section (integral with filter section) with suitably sized chilled water cooling coil made of copper tubes and aluminium fins along with valves for isolation.
- e) Pre filter, fine filter and HEPA filter along with DPG, shall be provided for main control room control equipment room, UPS room of main plant building and ESP control room only, however other areas like service building shall be provided with pre and fine filters.
- f) Pre filters shall be provided the suction of each individual AHUs whereas fine and HEPA filters shall be provided at discharge of individual AHUs or plenum of duct.
- g) Controls comprising
 - One No. 3 way mixing valve with actuator
 - One No. Proportionating type thermostat / temperature & RH sensor.
 - Pressures switch at the discharge of AHU to modulate VFD
- h) AHUs shall be provided with 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%.
- i) Motors shall be installed inside the AHU.
- j) Accessories (valves, pressure gauges, water flow switches, controls and instruments etc.) shall be provided with pump as per customer approved PID
- k) Drain piping from the AHUs up to nearest drain point.
- l) Serrated rubber pads for vibration isolation.
- m) Refer to clause 2.1.10.8.2 and other relevant clauses of section C2-A, customer specifications.

7.5 STRIP HEATER PACKAGE AND HUMIDIFICATION PACKAGE

- a) One common set of electrical strip heaters package of suitable capacity complete with contactor, air-stat, humidistat (room or mounted on strip heater control box), safety thermostat, heater box with insulation etc. for winter heating and monsoon reheat, mounted inside the AC plenum/duct for each AHU Room.
- b) One No. Pan humidification system comprising heater, humidistat, water tank, low level switch over flow, draining, make up connection, float valves etc for each AHU Room.
- c) Temp gauge, temp element, RH and temp sensor shall also be provided and the same shall be hooked with DDCMIS system.
- d) Refer to relevant clause of section C2-A, customer specifications

7.6 SHEET METAL WORK

- a) GSS supply and return air Ducting (as per IS-277) with 275 gms/sqm of zinc coating complete with vanes, damper, hangers / supports etc. Insulation of supply air AC duct and return air duct, piping, fitting etc. shall be provided as per clause number 2.1.10.3 (y) of customer technical specification.
- b) Supply air diffusers / grilles (Frame and Louvers of Diffuser/Grilles shall be of extruded aluminium of 1.2 mm thick section, duly powder coated) with volume control dampers. Return air Diffusers will have no Volume control Damper.



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c) Other details shall be as per customer technical specification clause number and 2.1.10.8.7.

7.7 INSULATION

Refer to clause 2.1.10.3 (y) and other relevant clauses of section C2-A, customer specifications.

7.8 PIPING VALVES ETC

Refer to relevant clauses of section C2-A, customer specifications

7.9 FRESH AIR FAN

2x50% Duty fresh air fan with pre-filter & fine filter in all AHU Rooms.

Other details shall be as per technical specification clause number 2.1.10.8.17

7.10 ONLINE NON-CHEMICAL WATER TREATMENT EQUIPMENT

Online non-chemical type scale preventer shall be provided at header of cooling tower make line to avoid scaling.

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

7.11 AIR FILTERS

Refer to clause 2.1.10.8.5 and other relevant clauses of section C2-A, customer specifications.

7.12 CONDENSER WATER PIPING

Refer to clause 2.1.10.8.8 and other relevant clauses of section C2-A, customer specifications.

7.13 CHILLED WATER PIPING

a) Chilled water piping with insulation interconnecting chiller, air-handling units and pumps sets complete with valves and fittings such as elbows, tees, reducers, flanges etc.

b) Other details shall be as per technical specification clause number 2.1.10.8.8.

7.14 DRAIN WATER PIPING

Drain water piping out of MS pipes conforming to IS-1239, Part I, heavy grade and galvanised as per IS:4736, from various equipments like chillers, pumps, AHUs, cooling tower area etc. up to the nearest drain point. (Within the room & for Cooling tower up to nearest drain point or rain water pipe on the roof).

7.15 TANKS

Make up water tank and expansion tank shall be made of HDPE / MS (with inner surface spray galvanised.) complete with valves, level gauge, level switch, make up connection, over flow and drain etc. however expansion shall be insulated as per clause number 2.1.10.3 (y) of customer technical specification.

7.15 FIRE DAMPERS

The supply and return air ducts shall be provided with solenoid type fire damper at locations where duct pass through walls & floors for ease of isolation, maintenance and as well as for emergency operation. The operation of these automatic dampers shall be interlocked the fire alarm system. Fire rating for the fire dampers shall be minimum 90 minutes.

7.16 ELECTRICAL ITEMS

Refer to relevant clauses of section C2-A, customer specifications and section C-3, electrical portion of specifications.

7.17 C&I ITEMS



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Refer to relevant clauses of section C2-A, customer specifications and section C-4, C&I portion of specifications.

7.18 For other items refer to relevant clauses of section C2-A, customer specifications

8 CONTROL PHILOSOPHY

SYSTEM CONTROL FOR CENTRAL AC PLANTS

- a) The operation of the AC plant-1, 2 & 3, and associated AHUs shall be done from the DDCMIS based control panel. The AC Plant compressor can be started only when its associated cooling tower fan, condenser & chilled water pumps are in operation.
- b) Chiller Package shall be provided with skid mounted microprocessor based control panel.
- c) The operation of the Split air conditioners shall be done from local MCB.
- d) All the drives of the AC system shall have the provision of manual starting.
- e) DDCMIS shall suitably interface with microprocessor based control units of chiller units.
- f) Water chilling unit control system shall be designed to have a constant chilled water outlet from evaporator at all load condition by means of controlling ON-OFF thermostat (one for each compressor). The closure of liquid line solenoid valve and tripping of compressor at lower water temperature and opening of solenoid valve and starting of compressor at high set (water Temperature) point shall be automatic through the thermostat. Between the above set points the compressor capacity shall be controlled automatically through cylinder "load- unload" mechanism activated through the suction pressure or return chilled water temperature.
- g) Water chilling unit shall be equipped with superheat control of water chilling unit through thermostatic expansion valve, which gets its impulse from temperature element connected with suction line after chiller outlet.
- h) High discharge pressure cut-out and oil pressure (OP) differential cut-out shall be of manual reset type and low pressure cut-out shall be automatic reset type. The OP cut-out shall trip the compressor in case of low oil pressure.
- i) Facility toggle to close the liquid refrigerant line solenoid valve shall be provided to shut the compressor by the operation of the low pressure cut-out (after the refrigerant has been pumped to the condenser).
- j) On-off type anti-freeze thermostats, one for each chiller shall be provided in addition to the controlling on-off thermostat for safety purpose and shall act in the event of failure of on-off thermostat to close the liquid line solenoid valve and also to trip the compressor simultaneously.
- k) Compressor starting/running shall be interlocked with the low/adequate flow at the outlet of each chiller and each condenser and as well as with pressure in the inlet of the condensers. In addition closure or open status of various valves shall be used for interlock, alarm and control of Air Conditioning System.
- l) The standby condenser water pumps, standby chilled water pumps & standby AHU shall be started automatically when the working equipments are stopped/tripped. Auto/Manual selecting and working/Standby selecting facility for the pumps/AHU/fresh air fan shall be provided.
- m) Operation of Air conditioning system shall be interlocked with the required minimum pressure and temperature of cooling water at inlet to the condenser. Status indication of cooling water pumps & associated cooling towers shall be provided in the control panel of air conditioning plant.
- n) Microprocessor based control System with local TFT display for individual chiller unit and DDCMIS based control system shall be provided for overall monitoring, control & operation, loading, Unloading of chiller units, dampers, valves, control valves, Solenoid valves, Field instruments etc.

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- o) DDCMIS shall have redundant soft interfacing (not in daisy serial link) with each individual chiller's microprocessor based control system & GIU, and HW signals required for command, status, local/remote operation, interlock & protection of complete Air Conditioning package.
- p) DDCMIS Remote I/O panel for the TG building shall house 1 set of hot redundant processor panel with 2 nos GUI in local.
- q) ESP building shall be of Microprocessor based control System for individual compressor/ chiller unit and DDCMIS shall be provided for overall monitoring, control & operation, loading, Unloading & auto standby start of compressors, Solenoid valves, Field instruments etc.
- r) DDCMIS shall have redundant interfacing (not in daisy serial link) with each individual Chiller unit's microprocessor based control system, and HW signals required for command, status, local/remote operation, interlock & protection of complete ESP Air conditioner & ventilation package as per the specification Vol II, Sec 2, part 2.3, cl: 2.3.18 - 11.
- s) DDCMIS Remote I/O panel for the ESP building shall house 1 set of redundant processor with 1 no GUI in local.

AHU CONTROL

- a) Control of the inside room temperature and humidity shall be by controlling the chilled water flow by means of motor operated three way modulating valve and the modulating valve shall get its signal from the modulating thermostat.
- b) Humidity sensor located in the return air duct shall actuate the pan humidifier to obtain the desired degree of humidification.
- c) Separate humidity & temperature sensor shall be provided and interlocked in steps with winter heater / re-heater / strip heaters for monsoon and winter re-heating or heating as the case may be.
- d) Heater banks shall be interlocked with the running of AHU, temperature of return air, humidity of return air and safety thermostat (Geyserstat-located in front of the each heater in the supply air duct).

MISCELLANEOUS CONTROL REQUIREMENTS

- a) Separate emergency local stop push button shall be provided for each pump, compressor, fans etc. of AC system.
- b) Status shall be provided of each pump, compressor, fans etc. of AC system on MMI system at control room.
- c) All the alarms related to failure of equipment's, tripping of equipment's, source of failure / reason due to which the equipment is stopped / tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, compressor, AHU, etc.
- d) The AC Plant shall be provided with the following safety controls.
 - High discharge pressure cut-out (HP)
 - Low suction pressure cut out (LP)
 - Oil pressure cut-out (OP)
 - Condenser water flow switch
 - Chilled water flow switch
 - Anti-freeze thermostat (AFT)
 - Air-stat / safety thermostat with heaters of the AHUs.
 - Overload trip of cooling tower fan motor.
 - Over load trip of condenser cooling water, chilled water and water softening plant pump motors.
- e) The AC Plant shall be provided with the following operating controls.
 - Automatic capacity control system
 - Automatic unloaded starting device
 - Operating Thermostat
 - Unloading solenoid valves (if applicable)
 - Way flow control valve at the AHUs.



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- AHU fan (chilled water, cooling water CT Fan and chiller) motor shall be provided with overload trip.
 - Strip heaters shall be provided with high Temperature and “no air flow cut out”.
 - Humidity & Temperature indicator/sensor in control equipment room for monitoring shall be provided and the system will be hooked up with DDCMIS.
 - MCB shall be provided for operating Split Air-Conditioners.
- f) All the instruments / equipment's / electrical items shall be provided & designed with maximum star rating as available in line with energy conservation policies notified by BEE, GOI at the time of supply as per the specification.

SYSTEM CONTROL FOR CENTRAL AC PLANTS

The basic function of the system is as follows: -

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

SYSTEM OPERATION

- All drives would operate in two modes (Local / Remote). In Local mode, it will operate through push button station with ON/OFF indication.
- In Remote mode, it will operate through OWS (DDCMIS)
- All motorised butterfly valve, 3-way mixing valve, duct heaters and pan humidifier will be operate as per system logic depending upon necessary field input signals.
- The control scheme for the AIR-CONDITIONING SYSTEM shall be implemented in DDCMIS & shall be based on OEM recommended logic scheme.

9

GENERAL

- 1) Basis of design all calculations including heat load calculations for summer seasons, equipment selection criterion, layout drawings/ schemes/G.A. dwg and documents like data sheet/ technical particulars etc are subject to Customer approval during detail engineering stage.
- 2) Vendor to furnish characteristic curves for all major equipment offered indicating duty point during detailed engineering.
- 3) All drawings and documents shall be computer based.
- 4) All commissioning spares & consumables for trouble free operation shall be provided Vendor to include level gauge & level switch for each tank for alarm & trip of the pumps. Also include one no. Pressure switch for each pump
- 5) Quality Requirements in the Technical Specification are indicating minimum requirements for inspection and testing. Vendor shall note that quality plan is subject to Customer & BHEL-



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

- 6) Indicative list of makes is enclosed elsewhere in the specifications, however these equipments / items shall be subject to Customer & BHEL approval during detail engineering Stage.
- 7) Inserts or any support arrangement for fixing ducting, fans, piping etc. shall not be provided by BHEL. Necessary supports may be taken from nearest structure / walls / roofs / floors etc. by Vendor.
- 8) Fixing frame works for diffusers and grilles in the scope of Vendor.
- 9) Efficiency of centrifugal fan and pump shall not be less than 70%.
- 10) Anchor fastener shall be used by vendor for fixing duct pipes etc. wherever applicable.
- 11) 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.
- 12) Drain piping within room up to the drain point to be provided by the Vendor.
- 13) Vendor to furnish schedule of power and control cables. Vendor to furnish cable termination details interconnection drawings etc. during detail engineering stage.
- 14) The tools and machine required for erection of equipment shall be arranged by Vendor.
- 15) Tools & tackles as required for regular maintenance shall be supplied by Vendor.
- 16) Instruments required for performance testing of various equipment / system of the package shall be arranged by Vendor at site.
- 17) Instrument for testing shall be calibrated by Air-conditioning plant supplier before taking up testing.
- 18) Temperature gauges shall be provided with thermo wells and fixing arrangement.
- 19) Pressure gauges shall have provision for air venting. Three way valves shall be used which shall have air venting provision.
- 20) Matching sockets / stubs (weld type) for flow switches and other instruments shall be supplied.
- 21) 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%.
- 22) Besides the system performance as above, bidder shall guarantee major technical parameters of various equipments as per design basis / details furnished.
- 23) 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.
- 24) For motorized fire damper / 3 Way valve actuators / motorised valves, power supply shall be derived by vendor from respective control panels. BHEL shall not provide any feeder for them. Suitable transformer shall be provided by bidder (if required) to derive the power input. Further distribution through junction box / distribution board shall be in vendor scope and shall have provision for isolation of individual fire damper/ valves.

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- 25) Tender drawings enclosed form the part of specification and the bidder shall check the space requirements for installing the equipment as per the specification and layout requirements given in the specifications.
- 26) Bidder should suitably group the signals coming from various instruments etc. & the same shall terminate in local JB, from Local JB common cable to PLC / panel / MCC shall be selected. Any Electrical / C&I items and accessories like junction box, glands etc. shall be included by vendor in his scope. Only those items shall be provided free of cost which are categorically listed in the Electrical scope sheet of technical specification.
- 27) 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.
- 28) 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.
- 29) 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.
- 30) The drawings/ documents submitted by vendor shall be complete in all respects with revised drawing submitted incorporating all comments. Any incomplete drawing submitted shall be treated as non- submission with delays attributable to vendor's account. For any clarification/discussion required to complete the drawings, the bidder shall himself depute his personal to BHEL / Customer's place any number of time as per the requirement for across the table discussions/ finalizations/ submissions of drawings.
- 31) Sealing of duct opening, grouting of foundation / foundation bolts etc. including special type of grouting like GPX2 etc. are in the scope of Air-conditioning system vendor.
- 32) Flat, platform type RCC / PCC foundation shall be provided for installing Chiller/ PUMP, AHU and FAN etc. Vendor shall fix the equipment using anchor fasteners to secure the equipment obtain parameters related to vibration and noise.
- 33) 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.
- 34) RCC foundation of cooling tower shall be provided by BHEL. However, steel beam / joist etc as required shall be supplied by air-conditioning plant supplier.
- 35) Air-conditioning plant supplier to furnish drawings/ documents as per the dwg. / documents distribution as per project requirement.
- 36) 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.
- 37) All electrical equipment shall be suitable for the power supply fault levels and other climatic conditions indicated in project information / synopsis / specifications enclosed.
- 38) The bidder's proposal shall be for equipment in accordance with the tech. Specification.
- 39) The bidder shall furnish complete tech. Particulars in data sheet and schedules as specified elsewhere in the specification.
- 40) Necessary duct mounted Booster fan (if required) to maintain the static pressure for Precision AC shall be provided without any implication.
- 41) VFD driven motor shall be provided along with the VFD panel in bidder's scope.

10**EXCLUSIONS**

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

- a) Construction of AC plant room, air handling unit room, foundations for AC equipments.
- b) False ceiling, drop ceiling.



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

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Codes and Standards

Design, manufacture, inspection and testing of the equipment covered by the specification shall unless otherwise specified conform to the latest edition of the standards and codes as specified under clause 03.00.00, 04.07.00 and other relevant clauses of section C2-A, customer specifications.



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**AIRCONDITIONING SYSTEM
CUSTOMER SPECIFICATIONS**

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CUSTOMER SPECIFICATIONS



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CUSTOMER SPECIFICATIONS
TECHNICAL REQUIREMENT

SPECIFICATION No: PE-TS-423-553-A001	
SECTION : I	
SUB-SECTION : C 2A	
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SUB-SECTION: C 2A

CUSTOMER SPECIFICATIONS
TECHNICAL REQUIREMENT



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AIR CONDITIONING AND VENTILATION SYSTEM



2.1.10 AIR CONDITIONING AND VENTILATION SYSTEM

2.1.10.1 General

The air conditioning and ventilation system shall be provided so as to achieve inside design conditions for proper performance of equipment and personnel. The extent of supply under this contract includes all items required to complete the intent of the contract notwithstanding the fact that such items may have been omitted from the specification or drawings. The air conditioning and ventilation system shall also meet the requirements specified elsewhere in the specification.

2.1.10.2 Codes and Standards

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

2.1.10.3 Design Criteria for Air conditioning system

- a. Dry bulb temperature 47°C. For other details of ambient conditions, refer published documents for meteorological data for Plant site.
- b. Inside design conditions to be maintained in all air-conditioned areas.
Dry bulb temperature: 22+ 1.0°C
Relative humidity: 50+ 5%
- c. A minimum design margin of 10 % shall be considered while sizing AC Plant and related equipment like chillers, chilled water pumps and AHUs for each area. Solar load, all internal loads due to equipment, lighting, fresh air, occupants etc shall be considered while calculating the heat load.
- d. Margins for calculating heat load:
 - i. 12.5%, 10% & 10% margins on sensible heat, latent heat & overall heat respectively is to be considered while calculating heat load.
 - ii. For winter load calculations, 50% of the equipment load as available in the room is to be considered.
- e. All windows in the air conditioned area shall be provided with light coloured venetian blinds.
- f. Fresh air quantity of 1.5 air change/hour or 35m³/hr per person or suitable to maintain over pressure of 2 MMWC whichever is higher shall be considered.
- g. False-ceiling shall be provided in all air conditioning areas.
- h. For chemical lab, the air-conditioning system shall be designed for 100% outdoor air (the room air is exhausted and not recirculated through the A/C unit). 2 x 100 % Split units are acceptable for chemical lab.



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- i. To reduce the air-conditioning load the exposed roof slabs (Including beams and column etc.) of air-conditioning areas , air handling units room and Packaged Air conditioners (PAC) rooms shall be insulated with 50 mm thickness fibre glass insulation of density 48 kg/m³ finished with 26 swg aluminium cladding.
- j. AHU room's walls ,Packaged Air Conditioners room's walls and first 6 meters of supply air duct from AHU/PAC air outlet shall be acoustically insulated with 25 mm thick fiberglass crown 150 of density 48 kg/m³ and shall be covered with 26G aluminum perforated sheet. Perforation area shall be 30% of free area.
- k. Lighting load of 2 Watts per Ft² or actual which ever is higher shall be considered for heat load calculations.
- l. The occupancy for general/ office area shall be minimum one person per 3 Sq.M and for conference room the same shall be one per 1.5 Sq.M. In the control rooms, control equipment rooms etc, the occupancy may be one person per 20 Sq.M (Minimum).
- m. The Air-conditioning spaces shall be maintained at positive pressure of 2mmwc to avoid any infiltration of dust.
- n. Plant for all air-conditioned areas shall operate continuous (24 hours a day, 7 days a week except during loss of normal power failure).
- o. Motor operated valves shall be provided as per system requirement for chilling machines, pumps, cooling towers in order to facilitate remote operation of entire air- conditioning plant and to select standby unit.
- p. Noise Criteria – Design noise level shall be of NC 35-45 within Control room, Control equipment room, Instruments and Electronic room and offices.
- q. Design Criteria for Air Inlet Louver – Face velocity of the louver shall be 2.5 m/s (max.).
- r. Design Criteria for Volume Control Damper – Velocity across the Damper shall not exceed 10 m/s.
- s. Duct Design Criteria – Velocity shall be 7.5 m/s. (max.) for main duct, 6.0 M/s. (max.) for branch duct and 2.0 m/s. for the diffusers/grills.
- t. Coil face area of Air handling Units shall be designed considering a face velocity of not more than 2.5 M/ Sec.
- u. Water piping shall be sized for a maximum velocity of 2.5m/sec. However gravity flow/pump suction line shall be sized for a maximum water velocity of 1.5 m/sec.



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- v. Refrigerant suction, discharge/hot gas lines & liquid lines shall be sized such that the total pressure drop is equivalent to not more than 1.1 deg C in saturation temperature of refrigerants. However, refrigerant velocity shall not be greater than 0.5 m/sec in liquid line.
- w. All Carbon steel sheets under air conditioning system shall be hot dip galvanized or spray galvanized unless otherwise specified and minimum zinc deposition shall conform to Class 275 of IS: 277. The air distribution system shall be sized to have a constant frictional drop.
- x. For calculating friction loss in piping system: WILLIAM & HAZEN formula shall be used with C value as 100.
- y. Thermal Insulation Design Criteria

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

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



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

Redundancy of Equipments

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

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

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

2.1.10.4 Design Criteria for Ventilation system

- a. 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's 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.
- b. The number of air changes per hour in evaporative/mechanically ventilated areas shall be as follows:

Sl.No.	Area	Air Changes
1	For all evaporative type ventilation system	8
2	General areas	15
3	Switch gear / MCC rooms.	25
4	Battery rooms & other areas where gaseous fumes are generated	30
5	DG set room	45

- c. However in areas producing lot of heat, the temperature limitation should be the criteria, which is as follows:
- i. Inside dry bulb temperature shall be minimum 5 deg.C below the design ambient dry Bulb temperature during summer for evaporative cooled areas.



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- ii. Inside dry bulb Temperature shall be maximum 3 deg.C above the design ambient dry Bulb temperature during summer for mechanically ventilated areas.
 - iii. 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 25oC.
 - iv. 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.
- d. All ventilation system shall operate on 100% fresh air.
- e. All mechanically ventilated areas like MCC/Switchgear rooms shall be positively ventilated by means of supply air fans, generally in combination with exhaust fan/ roof extractors. Wherever exhaust fan/ roof extractors are not provided, the pressurised condition shall be maintained with gravity operated backdraft dampers. However, as exception, hazardous areas and fumes/odour generating areas such as toilets shall be negatively ventilated by means of exhaust air fans/ roof exhausters and inlet louvers.
- f. 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.
- g. All the equipments of Ventilation system shall be designed for continuous duty for continuous operation of 24 hours a day.
- h. 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.
- i. For maintenance of Air washer unit material handling equipment as per size & type defined in Volume II Section 2, Clause no. 2.1.8 of this specification shall be provided in the Air Washer rooms of Evaporative Ventilation System.
- j. Circulating water capacity for Air washer units shall be minimum 1 cu.m per 1000 cu.m/hr of air flow while for Unitary Filtration Unit, it shall be minimum 0.6 cu.m per 1000 M3 /hr of air flow.
- k. 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.
- l. The air distribution system shall be sized to have a constant frictional drop along its length.
- m. 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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- n. The air washer unit shall be designed for at least 90% saturation efficiency while UAF for 90% saturation efficiency.
- o. For pumps, fans and blowers, continuous motor rating (at 500 deg 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.
- p. For Belt drives, the belts shall be sized for 150% of the rated power and there shall be minimum of two belts per drive.
- q. 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.
- r. For calculating friction loss in piping system, WILLIAM & HAZEN formula shall be used with C - value as 100.
- s. Supply air fans, exhaust air fans/ roof ventilators of each area shall be provided with their local starter panel.
- t. Design Criteria for Back Draft Damper – Velocity across damper shall not exceed 6 m/s.
- u. 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.
- v. Redundancy of Equipments
 - i. Pumps for each Air Washer Unit shall be 2 x 100% Capacity ~~or 3 x 50%~~. For UAF it shall be 2x 100%
 - ii. Fans for each air washer unit shall be 2x50% capacity while for unitary air filtration unit shall be 1x100% capacity.
 - iii. Supply air fans/Exhaust air fans/roof exhausters shall be in multiplicity.

2.1.10.5 Systems to be furnished

2.1.10.5.1 Air Conditioning System

- a. A centralized water cooled chilled water system with screw chilling units shall be provided for the following areas: Main control room areas comprising unit control room, electronic cubicle room, shift in-charge, engineers room, maintenance engineers room, printer room, UPS room, relay room, SWAS (Dry) panel room, conference room, office rooms, record room, analyzer room and static excitation room in TG building.
- b. A separate water cooled direct expansion type air conditioning plant of 2x100% capacity shall be provided for ESP/VFD control room.
- c. Air Cooled Non Ductable Split/Window AC units shall be provided for the following areas



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- i. Operator cabin of TG Hall EOT Crane
 - ii. Any other Control Room
- d. Water Cooled package type AC unit shall be provided in each floor of Service building.

2.1.10.5.2 Ventilation System

- a. TG Building
Evaporative type ventilation system shall be provided for TG building as specified below. Air washer units of double bank spray system shall be distributed along A-row and B-row of the building. Filtered and Cooled air from each air washer unit shall be distributed to various areas through supply air ducting and grills. The TG building shall be provided with adequate number of roof extractors.
- b. ESP Control Room (Non air conditioned areas)
Unitary Air filtration units of single bank spray system using water repellent 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. DG set rooms
 - iii. Mill reject Compressor Room
 - iv. CPU
 - v. Battery and battery charger rooms
 - vi. All MCC rooms & cable vaults
 - vii. Elevator machine rooms
 - viii. All other areas not airconditioned.
 - ix. Toilets

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

2.1.10.6 System description Air Conditioning System

2.1.10.6.1 Centralized Water Cooled Chilled Water System

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



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

- b. The screw chillers shall operate to meet the overall building cooling load requirements throughout the day. The chillers shall operate by a combination of chiller optimization and sequencing. The air conditioning controls shall be designed as to interface with the safety controls of each of the air conditioning equipment along with automatic operation. Selector switches and push buttons shall be provided for manual operation of all air conditioning equipment.
- c. Chilled water flow of 10 cum/hr shall be supplied to Sample Cooler in the Analyzer room from the main air-conditioning chilled water system.
- d. The air handling units shall be draw through type and casing shall be of double skin construction. Fans shall be double inlet double width (DIDW) centrifugal type. Fans shall have forward or backward curved blades. The cooling coil face air velocity shall not exceed 2.5 m/sec.
- e. Strip heaters of suitable capacity with controls shall be provided in the supply air duct plenum.
- f. Humidification package with all necessary controls.
- g. Air distribution system including ducting, grilles, diffusers fresh air unit, fire dampers, volume control dampers, thermal and acoustic insulation for ducts and accessories.
- h. Monorail and hoist for handling the A/C units, pumps, etc.
- i. Required Pre filters, Fine filters and Absolute (Hepa) filters along with differential pressure gauge shall be provided for sensitive areas of main control room i.e unit control room, electronic cubicle room, printer room, UPS room, relay room, SWAS (Dry) panel room, & conference room. Other areas shall be provided with pre filters & fine filters.
- j. The chilling plant and pumps shall be located in a separate room and the A/C plant room layout shall be made such that adequate space is provided for maintenance of chilling units, pumps etc.
- k. Online non- chemical type scale preventer shall be used to avoid formation of scale in the condenser water circuit.

2.1.10.6.2 Water Cooled Direct Expansion System (DX System)

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

- a. The water cooled condensing unit along with Air handling units, condenser cooling water pumps and cooling towers shall be provided. The number of Air handling units, condenser cooling water pumps, cooling towers shall be equal to the number of condensing units. In addition, one common standby condensing unit and the associated equipment shall be provided. The air conditioning



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system shall also include associated air distribution system, condenser water piping, valves and fittings, insulation, strip heaters, humidifier, Differential pressure for filters and all other accessories and controls. A central control panel within air conditioning plant room is to be provided. Local control panel for individual AHU rooms and other areas to be provided. Make up water for the condenser cooling water system to be provided at the air conditioning cooling towers as per required pressure and flow. Fresh air system shall be provided in all the AHU rooms.

- b. The air handling units shall be draw through type and casing shall be of double skin construction. Fans shall be double inlet double width (DIDW) centrifugal type. Fans shall have forward or backward curved blades. The cooling coil face air velocity shall not exceed 2.5 m/sec.
- c. Strip heaters of suitable capacity with controls shall be provided in the supply air duct plenum.
- d. Humidification package with all necessary controls.
- e. Air distribution system including ducting, grillers, diffusers fresh air unit, fire dampers, volume control dampers, thermal and acoustic insulation for ducts and accessories.
- f. Monorail and hoist for handling the A/C units, pumps, etc.
- g. Required Pre filters, Fine filters and Absolute (Hepa) filters along with differential pressure gauge.
- h. The condensing plant and pumps shall be located in a separate room and the A/C plant room layout shall be made such that adequate space is provided for maintenance of condensing units, pumps etc.
- i. Online non- chemical type scale preventer shall be used to avoid formation of scale in the condenser water circuit.

2.1.10.7 System description Ventilation System

2.1.10.7.1 Evaporative Cooling System for Turbine Building

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



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- 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.
- ii. Summer ambient conditions as furnished to be considered.
 - iii. Efficiency of air washer shall be 90% with two banks opposed type spray system
- b. 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.
- c. Air washer shall be double bank spray type mainly consists of an airtight chamber or casing containing air distribution louvers, spray nozzles, a tank for collecting spray water, eliminators with flooding nozzles, pre and fine filters and a pump with piping valves, strainers and specialities for re-circulating water. One (1) level switch in the air washer tank shall be provided to give an alarm in the air washer plant room.
- d. The supplied air will be exhausted through roof exhausters to maintain an overpressure of 1-2mm of water column to reduce dust ingress.

2.1.10.7.2 Unitary Air filtration Unit for ESP Control Building

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

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

2.1.10.7.3 Ambient Ventilation System for other areas

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

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

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

2.1.10.7.4 Specific Requirements

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

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



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- b. For elevator machine room, filtered air shall be supplied by supply air fan. Exhaust shall be through gravity dampers.
- c. Evaporative cooling ventilation fans shall be interlocked with fire protection system, to get the same tripped in the event of fire.
- d. Online non- chemical type scale preventer shall be used to avoid formation of scale in the Airwasher nozzles/ water circuit.

2.1.10.8 Equipment Description

2.1.10.8.1 Chilling Unit/Condensing Unit

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



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Accessories	Purge and drain connections, relief valves, liquid line shut-off valves, refrigerant filling charging, flow switches, Isolating valves, Pressure & temperature indicators at inlet and outlet etc.
Refrigerant	For chilling Unit- R 134a For Condensing Unit - R-22
Steel structure	The complete condensing/ chilling unit shall be mounted on steel structure and shall be provided with necessary vibration isolators
Chiller	
Type	DX type and Shell and tube type
Superheating of	At least 2 deg.C
Design Fouling Factor	Minimum 0.0001 (MKS units)
Fluid	Shell side - Water
	Tube side - Refrigerant
Capacity	To match with respective plant capacity.
Shell material	Mild steel (IS : 2062)
Tube material	Replaceable seamless finned copper

2.1.10.8.2 Air Handling Unit (AHU)

- a. Each AHU shall consist of Casing, Fan impeller section, Cooling coil section, damper section, Steel frame with vibration isolators (minimum efficiency of 85%) for the complete AHU, Isolation dampers at the Suction and discharge of each AHU, Pre-filter at the suction and Fine filters (micro- vee type) in the discharge of each individual AHU/common plenum, Absolute (HEPA type) filters in individual discharge of all AHU's/common plenum of Control room, control equipment room, computer, programmer rooms etc and Heater section in the common discharge of AHUs.
- b. The casing of AHUs shall be of double skin construction. Double skin sandwich panels (inside and outside) shall be fabricated using minimum 22 swg (0.8 mm) galvanized steel, with 25mm thick polyurethane (PUF) insulation of minimum 40Kg./ Cum density in between. 16 gauge galvanized steel hat-channel shall be used as reinforcing to give structural strength.
- c. Face and bypass dampers (motor operated for DX type plant) of opposed blade type shall be provided. Dampers shall be made of 16 gauge G.S sheet metal (class 275 of IS: 277). The area of the bypass section shall be minimum 30% of the coil face area. Damper operating linkage and the operating motor shall be located outside the casing. Each AHU shall be provided with motorized volume control damper at air discharge.
- d. Cooling coil shall be of seamless copper tubes with Aluminium fins and shall be provided with suitable drains and vents connections.



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- e. All filter plenum shall be provided with a walking platform inside the plenum chamber for filter cleaning purpose. Inspection door shall be provided at the plenum chamber and a removable type ladder shall be attached to plenum.
- f. Air handling units/centrifugal fans shall be provided with Variable frequency drive (VFD) and velocity sensor/static pressure sensor in supply air path to adjust air flow automatically. The minimum efficiency of VFD at full load shall not be less than 96%.
- g. Centrifugal Fan

1	Fan impeller	Forward/ backward curved blade & centrifugal type.
2	Impeller material	Mild steel spray galvanised with minimum zinc deposition conforming to Class 275 of IS:277.
3	Fan bearings	Self aligning type, permanently lubricated, heavy duty with a design life of 10,000 operating hours.
4	Critical speed	First critical speed of rotating assembly shall be at least 25% above the operating speed.
5	Drive	Motor driven. With removable belt guard.
6	Static pressure (minimum)	120 mm wc

2.1.10.8.3 Precision Type Packaged Air Conditioners

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

- a. Compressor shall be hermetically sealed Scroll type with drive motor. It shall be suitable for R22/R407c refrigerant. The compressor shall be mounted on springs at the lower most section of packaged unit such that the same is easily accessible for servicing.
- b. The condenser shall be water cooled shell and tube type having replaceable seamless copper tubes with integral fins and removable head. The condenser shall be provided with fusible relief plug and all other accessories as required.
- c. The air handling fan shall be centrifugal type with forward curved blades and complete with belt drive and electric motor. Each PAC shall be provided with motorized volume control damper at air discharge.



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- d. Cooling coils shall be of direct expansion type and made of heavy gauge copper with hydraulically bonded aluminium fins. Rows shall be staggered in the direction of air flow.
- e. Filters shall be non-rusting corrugated metallic wire mesh cleanable type and of adequate area so that the air velocity across the filters shall not exceed 2.5 m/sec. Filter shall be in-built with unit heaving efficiency 95% down to 5 microns.
- f. Refrigerant piping shall be heavy gauge copper or IS:1239 heavy class seamless MS pipe complete with thermostatic expansion valve, liquid line shut-off valve, high and low pressure gauges.
- g. Cabinet Construction:
The frame & panel shall be constructed of Cold rolled cold annealed sheet steel duly powder coated and shall be assembled with pop rivets. The side panels of unit shall be double skinned for increase life span and reduction of noise & vibration. Front panel shall be removable hinge for easy service.
- h. De-Humidification
Specific de-humidification cycle (Split Liquid / Split Suction) shall operate by reducing the operating surface temperature in a section of one of the Refrigeration coil by means of a solenoid valve in the Liquid line / Suction line. Full air flow of the unit will be maintained at all times to ensure consistent air distribution to the conditioned space.
- i. All necessary operating and safety controls shall be provided including the following:
 - i. Controls
The controls shall be of microprocessor based programmable PID (Proportional, integral and derivative control logic) controller. The controller shall have a LCD display screen, which shall be visible from the front of the unit without removing any covers/external panels. This LCD display screen should show the following information / data:
 - 1. Modes of operation (cooling, heating, humidification, de- humidification).
 - 2. Simultaneous displays of set temperature and actual temperature and set Relative Humidity and actual Relative Humidity.
 - 3. Date, time and unit identification display.
 - 4. System component Auto / Manual status display on the controller screen.
 - 5. Backup battery charge status display on the controller screen.
 - 6. Visual system alarm indication (along with mutable audio alarm as well).
 - 7. Alarm display menu (incorporating various system alarms like temperature high / low, humidity high / low, Compressor HP/LP, Wet floor and loss of air flow conditions).
 - 8. 24 Hours temperature and relative humidity graph display menu.
 - 9. Programmable services interval indication display / alarm.

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



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ii. Safety Protections

The unit shall also incorporate the following protections:

1. High pressure trip- Manual reset for each compressor
2. Low pressure trip- Manual reset for each compressor.
3. Single phasing preventers.
4. Reverse phasing
5. Phase imbalancing
6. Phase failure
7. Overload tripping (MPCB) of all components

iii. Safety Interlocks

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

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

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

2.1.10.8.4 Centrifugal Pumps

1	Type	Horizontal Centrifugal, Axially split type casing pump
2	Impeller	Closed type
3	Material of Construction	
	a.Casing	2% Ni Cast Iron : IS:210 Gr. FG-260
	b.Impeller	Bronze IS:318 Gr-2
	c.Wearing rings	Bronze
	d.Shaft	SS 410
	e.Shaft sleeve	SS 316
	f.Lantern ring	Brass / Bronze
	g.Packing	As per manufacturer's standard.
	h.Base Plate	Carbon steel as per IS:2062
	i.Speed	Maximum 1500 rpm

2.1.10.8.5 Air Filters

a. Pre Filter

1	Filter medium :	
	a.	Fibrous material (extruded polyethylene) or felt filter fabric; Dry type with element of 5 ply construction for Fabric type.
	b.	V-fold galvanized wire mesh inter spaced with a flat layer of galvanized wire mesh for Metallic type pre-filters.
2	Frame	



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	a.	GI sheet (minimum 18 gauge thick) or Aluminium alloy of (minimum 16 gauge) supported by galvanised steel wire mesh of 10 mm Square with handles.	
3	Other requirements :		
	a.	Suitable aluminium spacers be provided for uniform air flow;	
	b.	Casing shall be provided with neoprene sponge rubber sealing.	
	c.	Capable of being cleaned by water flushing.	
	d.	Density of filter medium shall increase in the direction of air flow in case of metallic filter.	
4	Efficiency :		
	a.	Average arresstance of 65 - 80 % when tested in accordance with BS:6540/ASHRAE – 52 - 76.	
5		Minimum thickness	50 mm for Fabric type.
6		Face Velocity	Not more than 2.5 m/sec.
7		Pressure drop	Initial pressure drop - Not to exceed 5.0 mm WC at rated flow. Final pressure drop - Upto 7.5 mm WC.
8		Location	
		a) Fabric type	At the suction of each AHUs (AC system)
			At the suction of each Fresh air fan (AC)
			3) At suction of each PAC unit

b. Fine Filters (Microvee type)

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

c. Absolute Filter / Hepa Filter

1	Media	100% sub-microscopic glass fibres.



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

2.1.10.8.6 Cooling Towers

Type	Induced draft, cross or counter flow.
Capacity	110% of rated capacity of each cooling water pump.
Material of construction of Casing & Sump tank	F.R.P
Fan	Cast Aluminium / FRP Propeller type and multi-blade aerofoil construction with adjustable pitch.
Fill	Non-combustible PVC or Equivalent of light grey, cream or white colour.
Louvers	F.R.P / PVC / Aluminium.
Nozzles	Brass with chrome plating/Polypropylene.
Eliminators	In removable sections to reduce the drift loss to 0.2% of water flow.
Supporting structure	Mild steel with spray galvanisation or epoxy painting.
Strainer at water outlet	Plate strainer made of GI /SS wire mesh of 16 gauge.
Bird screen	25 mm square made of GI/SS wire mesh of 16 gauge.
Ladder	Hot dip galvanised steel ladder for each tower.
Distribution Pipe	Galvanised MS pipe.
Accessories	Drain connection with isolation valve Make up connection with ball - float valve, back up gate valve and a bypass with a gate valve for manual operation. Overflow connection Equalizing connection to connect sump of all the towers wherever applicable. Access door in louvers / fan deck.

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



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systems for Administrative building, Switchyard control room, AHP control room and other areas/control rooms.

a. Non- Chemical Type Scale Preventor

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

2.1.10.8.7 Air Distribution System

- a. 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:

Sl.No.	Larger dimensions of Duct	Thickness of GS sheet (mm)	Type of Transverse Joint Connection	Bracing
1	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
2	601 thru 750	0.63 (24 g)	S-drive, 25 mm pocket or 25 mm bar slipson 2.5 m centers	25 x 25 x 3 angles braced at 1.2 m from joints.
3	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.
4	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.



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5	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.
6	2251 and larger	1.25 (18 g)	50 x 50 angle connections or 40mm 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

- b. The longitudinal seams and transverse joints shall be flat and smooth inside the duct. All rectangular ducts shall be flat on face and pittsburgh on corner of duct. Duct pieces shall be joined together by 'S' and drive slip joints or by angle iron flanges. The size of connecting flanges shall be same as that of the bracing angle. The interconnecting flanges shall be connected with 10 mm galvanised bolts and nuts at about 125 mm centres. All flanges shall be connected to the ducts by rivets at about 125 mm centres. The ducts shall be tapped 6 mm across the flanges. All flanged joints shall have 6 mm thick felt packing stuck to the flanges with shellace varnish or approved equal adhesive. The holes in the felt packing shall be burnt through.
- c. Ducts 2250 mm and larger require special field study for supporting. Unless otherwise specified, the ducts with larger side greater than 2250 mm shall be supported by 15mm MS rods and 65x65x5 mm MS angles while those below 2250 mm shall be supported by 10 mm MS rods and 50x50x4 mm MS angles. The MS rods and angles shall be given two coats of redoxide primer paint and final coat of silver colour. The duct support shall be at a distance of not more than 1800 mm. The MS rods shall be hung from the building steel with provision of necessary auxiliary steel members or approved means fixed to the ceiling slab. The auxiliary steel members, hooks, coach screws and all other supporting materials required shall be provided by the bidder. Whereverin 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.
- d. 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



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the ducts or duct and fan connection shall be in line. Canvas or fiberglass shall not be accepted for flexible joints.

- e. 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.
- f. 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.
- g. 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.
- h. 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
- i. All the plenum chambers or connections to fans, dampers etc, shall be constructed in 18 gauge GSS, supported on 40x40x6 mm MS angle frames. All vertical angles shall be rivetted at approximately 125 mm centres to the casing. 'Pecora' or equivalent caulking compound shall be inserted between the base of angle and all masonry construction to which angles are fastened.
- j. 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.
- k. Supply air grilles shall be of mill finished extruded aluminium construction. Grilles shall be provided with volume control dampers of opposed blade type. Supply air grilles shall be of double deflection type. All the required steel/wooden frame work for fixing grilles shall be furnished by the bidder.
- l. All air terminals shall be of mill finish extruded aluminium profile construction.
- m. The proposed ducting scheme, duct sizes, location of supply air grilles etc shown on the enclosed drawings is tentative and subject to finalisation during detailed engineering by the Bidder. 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.
- n. Each branch line shall have dampers to isolate the branch for maintenance purpose.



2.1.10.8.8 Pipe work Valves and Specialities

- a. Unless otherwise specified herein the specification. Piping for sizes smaller than 150 mm NB shall be continuous welded Galvanised steel pipes to IS: 1239 heavy class. Piping for sizes 150 mm and larger shall conform to IS:3589 with minimum 6.35 mm thickness.
- b. Fabricated elbows from pipe (5 piece mitre) shall be furnished for pipe fittings of sizes 200 mm & larger. Locally available long radius ($R=1.5D$) hot bends with thickness same as that of the pipe having butt welding ends as per ASA B-16.9 shall be furnished for pipe fittings of sizes 150 mm up to 65 mm NB. 3000 # ASA standard forged carbon steel pipe fittings to A-105 Gr.II or IS:1875 Class-2 or approved equal with socket welding ends as per ASA-B- 16.11 shall be furnished for pipe fittings of sizes 50 mm NB and smaller.
- c. 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.
- d. 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.
- e. All valves for sizes 65 mm and larger shall be 150 # ASA standard, double flanged, cast iron body to IS:210 Gr.260, stainless steel trim, bolted bonnet, bolted gland, rising stem outside scraw and yoke, back seated, ends flanged (PF) faced and drilled to ASA-B-16.5. All valves for sizes 50 mm and smaller shall be 800 class standard forged carbon steel body construction to ASTM A 105 stainless steel trim, union bonnets, rising stem inside screw, renewable seats ends female screwed to IS:554. The butterfly valves shall be designed as per AWWA C 504 and designed to fit between flanges. The butterfly valves shall be provided with flow control lever, black nitrile rubber integrally moulded seating, disc of aluminium bronze to BS 1400 Gr. AB2/AB1, shafts of stainless steel AISI 410. The butterfly valve shall be rated for 16 bar; body/disc tested at 24 bar and seat at 14 bar.
- f. All the pipe supports, guides, anchors, turn buckles, rods, hangers with secondary structural steel framing shall be furnished and installed by the Seller. The Seller's support shall utilize the Purchaser's steel as far as practicable. Where additional secondary steel is required for the hangers, these shall be furnished. The secondary auxiliary steel required for the hangers and supports shall be welded to the Purchaser's steel structure as directed by the Engineer. Welding shall not be permitted across the bottom flange of main structural members.
- g. 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



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brackets to brick walls shall be avoided. All concrete inserts shall be galvanised and shall be installed on the concrete structure where required for fastening supporting devices.

- h. 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.
- i. 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.
- j. All the drain piping between the drain connections of each equipment upto the Purchaser's common drain point in the equipment room shall be provided by the Bidder. Necessary seal loops as required shall be incorporated in the drain piping.
- k. 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.

2.1.10.8.9 Valves

- a. Valves shall have full size port and Suitable for horizontal and as well as vertical installation.
- b. Valves for regulating duty shall be of Globe type suitable for controlling throughout its lift.
- c. Gate, Globe and stop Check valves shall have bonnet back seat to facilitate easy replacement of packing with the valves in service.
- d. All Safety / relief valves shall be so constructed that the failure of any part does not obstruct the free discharge.
- e. Manual gear operator be provided for valves of size 250 NB and above.
- f. All valves with rising stem shall have position indicators.
- g. All valves shall be provided with locking arrangement.
- h. 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 screw 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.



- i. 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.

2.1.10.8.10 Air Washer Unit

- a. 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.
- b. 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.
- c. 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.
- d. The distribution plate shall be fabricated out of 16G galvanized steel sheet & galvanized steel angle supports with minimum 50% free area.
- e. 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.
- f. The spray nozzles shall be of brass or bronze with chrome plating and shall be self-cleaning type. The nozzle shall be designed to produce fine atomised spray and shall be properly spaced to give a uniform coverage of the air washer section. The pressure drop through the nozzle should be in the range of 1.4 to 2.4 Kg/cm²(g).
- g. The eliminator plates shall be of 24G thick GS sheets class 350 or from 100% virgin PVC of minimum finished thickness of 3 mm. The eliminator section made of GSS shall have minimum six bends. The PVC eliminators shall be UV stabilised using Titanium di-oxide and shall withstand the weathering test as per IS:4892 for 500 hrs. Type test report of the compound testing carried out in any reputed laboratory shall be submitted for approval. All supports, tie rods and space bar shall be of either galvanized steel or PVC construction and shall be complete with suitable drip tray and drain pipe.
- h. An airtight inspection door of 600mm X 700mm size and a water marine light be provided for each air washer unit.



- i. 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
- j. The specification for centrifugal fans shall generally be as indicated below. However, the fan shall be of DIDW type for TG building and SISW / DIDW for and ESP/VFD building. xi. Both inside and outside of all the sections of the metal chamber unit shall be spray galvanized to prevent corrosion. The nuts and bolts used for joining the section shall be stainless steel. The connection pieces shall have at least two (2) coats of rust inhibiting paint.

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

All equipment's, 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.

2.1.10.8.12 Instruments, Protective Devices and Interlock

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

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

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

2.1.10.8.13 Centrifugal Fans for Evaporative cooling plants



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- a. The casing shall be of welded construction fabricated with heavy gauge galvanised sheet steel or MS sheet with spray galvanisation. In case of spray galvanisation 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.
- b. 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.
- c. The bearing shall be self-aligning, heavy duty ball, roller or sleeve bearing. They shall be adequately supported. They shall be easily accessible and lubricated properly from outside.
- d. Inlet guard shall be spun to have a smooth contour. Inlet screen, if provided, shall be of galvanized wire mesh of 25 mm square.
- e. 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.
- f. The first critical speed of the rotating assembly shall be at least 25% above the operating speed.
- g. 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%.
- h. The static pressure of fan shall not be less than 75 mmwc.

2.1.10.8.14 Power Roof Extractors

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

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



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

2.1.10.8.15 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 than 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.

2.1.10.8.16 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.

2.1.10.8.17 Fresh Air Unit for Air Conditioning System

The fresh air unit shall consist of:

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



2.1.10.8.18 Plant Control for Air conditioning system

a. General

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

b. Control Scheme of Air Conditioning System

- i. The Air Conditioning System control system shall be PLC based. The PLC configuration and detailed specification of the same shall be as per Control & Instrumentation requirements specified elsewhere in the specification.
- ii. Each system shall be provided with required I/O modules and two numbers of Operator Work (OWS) Stations. All the functional requirements specified below and general control logic specified under this section shall be implemented in the respective PLCs.
- iii. The basic function of the system shall be to closely control and monitor inside temperature and humidity conditions inside the air-conditioned spaces, to optimize/minimize energy consumption by automated operation, to provide remote centralized monitoring & control for various mechanical facilities including sequential start/stop of the whole HVAC System, automatically calculate record and cooling load for each hour/ day/season, to generate maintenance data & alarms, to maintain records of plant operation & energy consumption for varying loads, duty cycling to operate all the equipment including standby equipment for equal duration, automatic startup of standby equipment in case of failure of operating unit and displaying fault alarm status of the tripped unit, activating/ deactivating water valves to startup/stop water flow through chiller/condenser circuit. For sequential operation /duty cycling, Programmed startup/stop of individual AHU as per operating requirements and for maintaining the room temperature/ RH by controlling the 3 way mixing valves at chilled water line, humidified system and duct heater.
- iv. PLC provided for the Control of AC system shall suitably interface with integral microprocessor based controls of Chiller units.
- v. The PLC based control system of Air Conditioning system shall also interface with Wide Area Network of the Station to be supplied by the Bidder.

c. Water Chilling Plant Control

- i. Microprocessor based controls shall be provided along with facilities to interface with central PLC and to meet the requirement of all system operations and controls.
- ii. Water chilling unit control system shall be designed to have a constant chilled water outlet from evaporator at all load condition by means of controlling ON-OFF thermostat (one for each compressor). The closure of liquid line solenoid valve and tripping of compressor at lower water temperature and opening of solenoid valve and starting of compressor at high



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set point shall be automatic through the thermostat. Between the above set points the compressor capacity shall be controlled automatically.

- iii. Water chilling unit shall be equipped with superheat control of water chilling unit through thermostatic expansion valve, which gets its impulse from temperature element connected with suction line after chiller outlet.
- iv. High discharge pressure cut-out and oil pressure (OP) differential cut-out shall be of manual reset type and low pressure cut-out shall be automatic reset type. The OP cut-out shall trip the compressor in case of low oil pressure.
- v. On-off toggle switch to close the liquid refrigerant line solenoid valve shall be provided to shut the compressor by the operation of the operation of low pressure cut-out (after the refrigerant has been pumped to the condenser).
- vi. Switching of Crank case heaters shall be interlocked with starting and stopping/tripping of compressor motor. Further, the safety thermostat shall switch off the crank-case heater in the event temperature rises above safe limit.
- vii. Provision shall also be made for the manual restarting of the compressor.
- viii. On-off type anti-freeze thermostats, one for each chiller shall be provided in addition to the controlling on-off thermostat for safety purpose and shall act in the event of failure of on-off thermostat to close the liquid line solenoid valve and also to trip the compressor simultaneously.
- ix. Compressor starting/running shall be interlocked with the flow switches to be provided at the outlet of each chiller and each condenser and as well as with pressure in the inlet of the condensers. In addition closure or open status of various valves through limit switches shall be used for interlock, alarm and control of Air Conditioning System.
- x. The standby condenser water pumps, standby chilled water pumps, & standby AHU shall be started automatically when the working equipments are stopped/ tripped. Auto/Manual selector Switches and working/ Standby selector switches for the pumps/AHU/fresh air fan shall be provided in the panel.
- xi. Closure of fire dampers shall raise an annunciation in the panel.
- xii. There shall be provision in control panel for temperature and flow readings in chilled water inlet and outlet line across AHUs to monitor the air conditioning load of each area.
- xiii. Operation of Air conditioning system shall be interlocked with the required minimum pressure and temperature of cooling water at inlet to the condenser through pressure and temperature transmitters. Status indication of Station auxiliary Cooling water pumps & associated cooling towers shall be provided in the control panel of air conditioning plant.



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- d. Air Handling Unit chilled water type
- i. Control of the inside room temperature and humidity shall be by controlling the chilled water flow by means of motor operated three way modulating valve and the modulating valve shall get its signal from the temperature sensor.
 - ii. Humidistat located in the return air duct shall actuate the pan humidifier to obtain the desired degree of humidification.
 - iii. Separate Humidistat and thermostats shall be provided and interlocked in steps with winter heater / re-heater / strip heaters for monsoon and winter re-heating or heating as the case may be.
 - iv. Heater banks shall be interlocked with the running of AHU, temperature of return air, humidity of return air and safety thermostat (Geyserstat located in front of the each heater in the supply air duct)
 - v. AHU shall be started either from its local panel or from the main control panel of AC system by means of Remote/Manual selector switches.
 - vi. The closure of fire dampers, automatic tripping of AHU fans and fresh air fans shall be interlocked with Bidder's fire Detection System.
 - vii. Each AHU shall be provided with temperature indicators and flow indicator in the chilled water piping inlet and outlet to monitor the air- conditioning load of each area.
 - viii. Miscellaneous control requirements
 - ix. Separate emergency local stop push button shall be provided for each pump, compressor, fans etc. of AC system.
 - x. Lamps shall be provided for indicating the status of each pump, compressor, fans etc. of AC system in the main and local panel.
 - xi. All the annunciation related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped / tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, compressor, AHU, PAC etc. in the respective panel.
 - xii. Fully wired, twenty percent (20%) spare annunciation windows shall be provided in all the panels.

2.1.10.8.19 Plant control for Evaporative cooling and Ventilation system



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- a. 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.
 - b. Air Washer Units (AWU) & Unitary Air Filtration Units (UAF)
 - c. 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.
 - d. 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.
 - e. Auto/Manual selector Switches and working/Standby selector switches for the pump shall be provided in the panel.
 - f. A selection switch enabling the running of AWU fan or pump alone shall be provided.
 - g. Miscellaneous control requirements
 - h. Separate emergency local stop push button shall be provided for each pump, fans etc. of Ventilation system.
 - i. Lamps shall be provided for indicating the status of each pump, fans etc. of Ventilation system in the main and local panel.
 - j. All the annunciations related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped / tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, AWU etc. in the respective panel.
 - k. The fans (both supply and exhaust fans) associated with mechanical ventilation system shall be operated locally.
 - l. Fully wired, twenty percent (20%) spare annunciation windows shall be provided in all the panels.
- 2.1.10.8.20 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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- c) Three (3) nos. portable aluminium ladders of various sizes suitable for main control room, etc

10. Welding Sockets

- a) Industrial type 415 V, 63A, 5 Pin welding sockets shall be provided in sufficient number to facilitate extension of power supply to various machine tools, welding sets etc.
- b) Welding socket outlets shall be provided at every 60m distance. The number of welding socket outlets for main technological plant units shall be decided based on requirement, approach etc. Generally the socket outlets shall be provided in such a manner so that using 30m flexible cable with welding set, total plant area (battery limit) can be covered. Up to three switch socket outlets shall be looped per feeder circuit. Sheet metal clad MCCB units shall be provided for feeding power to sockets. TG Building each floor 4 Nos & at Boiler - 4 Nos at four elevations

11. Special Requirement

- a) All outdoor illumination fixtures, unless it is fed from photo cell time switch controlled lighting panel, has to be provided with outdoor type local switches.
- b) In all the air filtration units and air handling units, one marine type lamp (of 100 Watt approx.) shall be supplied the wiring and fixing of the same has to be done by the contractor.

12. Conduits and Accessories

- a) Conduits shall be rigid steel, hot-dip galvanized, furnished in standard length of 3 metres, threaded at both ends.
- b) Conduits upto and including 25 mm shall be of 16 SWG and conduits above 25 mm shall be of 14 SWG. Minimum size of conduits shall be 19 mm.
- c) Each piece of conduit shall be straight, free from blister and other defects and covered with capped bushings at both ends.
- d) Flexible conduits shall be made with bright, cold rolled annealed and electro-galvanized mild steel strips and coated with PVC.

13. Junction Box



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REQUIREMENTS**

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SECTION : I

SUB-SECTION : C 2B

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SECTION: I

SUB-SECTION: C 2B

**CUSTOMER SPECIFICATIONS
PROJECT SPECIFIC GENERAL REQUIREMENTS**

Chapter 6

General Technical Requirement



VOLUME II SECTION 1

CHAPTER 6

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CHAPTER 6
GENERAL TECHNICAL REQUIREMENTS

1.0 INTRODUCTION

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

2.0 BRAND NAME

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

3.0 BASE OFFER & ALTERNATE PROPOSALS

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

4.0 COMPLETENESS OF FACILITIES

4.1 Bidders may note that this is a contract inclusive of the scope as indicated elsewhere in the specification. Each of the plant shall be engineered and designed in accordance with the specification requirement. All engineering and associated services are required to ensure that a completely engineered plant is provided.

4.2 All equipment furnished by the Bidder shall be complete in every respect, with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or those needed for erection, completion and safe operation & maintenance of the equipment and for the safety of the operating personnel, as required by applicable codes, though they may not have been specifically detailed in the respective specifications, unless included in the list of exclusions.

All similar standard components/ parts of similar standard equipment provided, shall be interchangeable with one another.

5.0 CODES & STANDARDS

5.1 In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment / plant / system, all equipment parts, systems and works covered under this specification shall comply with all currently applicable statutory regulations and safety



codes of the Republic of India as well as of the locality where they will be installed, including the following:

- a. Bureau of Indian Standards (BIS)
- b. Indian electricity act
- c. Indian electricity rules
- d. Indian Explosives Act
- e. Indian Factories Act and State Factories Act
- f. Indian Boiler Regulations (IBR)
- g. Regulations of the Central Pollution Control Board, India
- h. Regulations of the Ministry of Environment & Forest (MoEF), Government of India
- i. Pollution Control Regulations of Department of Environment, Government of India
- j. State Pollution Control Board.
- k. Rules for Electrical installation by Tariff Advisory Committee (TAC).
- l. Any other statutory codes / standards / regulations, as may be applicable.

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

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

5.3 Other International/ National standards such as DIN, VDI, BS, etc. shall also be accepted for only material codes and manufacturing standards, subject to the Owner's approval, for which the Bidder shall furnish, along with the offer, adequate information to justify that these standards are equivalent or superior to the standards mentioned above. In all such cases the Bidder shall furnish specifically the variations and deviations from the standards mentioned elsewhere in the specification together with the complete word to word translation of the standard that is normally not published in English.

5.4 As regards highly standardized equipment such as Steam Turbine and Generator, National /International standards such as JIS, DIN, VDI, ISO, SEL, SEW, VDE, IEC & VGB shall also be considered as far as applicable for Design, Manufacturing and Testing of the respective equipment.



In addition, these standards shall be referred for the design of machine foundations, wherever specifically mentioned in the specifications. However, for those of the above equipment not covered by these National / International standards, established and proven standards of manufacturers shall also be considered.

- 5.5 In the event of any conflict between the codes and standards referred to in the above clauses and the requirement of this specification, the requirement of Technical Specification shall govern.
- 5.6 Two (2) English language copies of all-national and international codes and/or standards used in the design of the plant, equipment, civil and structural works shall be provided by the Bidder to the Owner within two calendar months from the date of the Notification of Award.
- 5.7 In case of any change in codes, standards & regulations between the date of bid opening and the date when vendors proceed with fabrication, the Owner shall have the option to incorporate the changed requirements or to retain the original standard. It shall be the responsibility of the Bidder to bring to the notice of the Owner such changes and advise Owner of the resulting effect.
- 6.0 EQUIPMENT FUNCTIONAL GUARANTEE
- 6.1 The Equipment and Auxiliaries shall be capable of continuous operation in frequency range of 47.5 to 51.5 Hz.
- 6.2 The functional guarantees of the equipment under the scope of the Contract is given elsewhere in the technical specification. These guarantees shall supplement the general functional guarantee provisions covered under General Conditions of Contract.
- 6.3 Liquidated damages for shortfall in meeting functional guarantee(s) during the performance and guarantee tests shall be assessed and recovered from the Bidder as specified elsewhere in this specification.
- 7.0 DESIGN OF FACILITIES/ MAINTENANCE & AVAILABILITY CONSIDERATIONS
- 7.1 Design of Facilities
- All the design procedures, systems and components proposed shall have already been adequately developed and shall have demonstrated good reliability under similar conditions elsewhere.
- The Bidder shall be responsible for the selection and design of appropriate equipment to provide the best co-ordinate performance of the entire system. The basic requirements are detailed out in various clauses of the Technical Specifications. The design of various components, assemblies and subassemblies shall be done so that it facilitates easy field assembly and dismantling. All the rotating components shall be so selected that the natural frequency of the complete unit is not critical or close to the operating range of the unit.
- 7.2 Maintenance and Availability Considerations
- Equipment/facilities offered shall be designed for high availability, low maintenance and ease of maintenance. The Bidder shall specifically state the design features incorporated to achieve high



degree of reliability/ availability and ease of maintenance. The Bidder shall also furnish details of availability records in the reference plants stated in his experience list.

Bidder shall state in his offer the various maintenance intervals, spare parts and man-hour requirement during such operation. The intervals for each type of maintenance namely inspection of the furnace, inspection of the entire hot gas path and the minor and major overhauls shall be specified in terms of fired hours, clearly defining the spare parts and man-hour requirement for each stage.

Lifting devices i.e. hoists and chain pulley jacks, etc. shall be provided by the Bidder for handling of any equipment or any of its part having weight in excess of 500 Kgs during erection and maintenance activities. Lifting devices like lifting tackles, slings, etc. to be connected to hook of the hoist / crane shall be provided by the Bidder for lifting the equipment and accessories covered under the specification.

8.0 DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY BIDDER

8.1 Bidders may note that this is a contract inclusive of the scope as indicated elsewhere in the specification. Each of the plant and equipment shall be fully integrated, engineered and designed to perform in accordance with the technical specification. All engineering and technical services required ensuring a completely engineered plant shall be provided in respect of mechanical, electrical, control & instrumentation, civil & structural works as per the scope. The Bidder shall furnish engineering data/drawings in accordance with the schedule of information as specified in Technical Specification and data sheets.

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

8.3 The documentation that shall be provided by the Bidder is indicated in various sections of specification. The documentation shall include but not be limited to the following:

a. Basic Engineering Documentation

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

- i. System description of all the mechanical, electrical, control & instrumentation & civil systems.
- ii. Technology scan for each system / sub-system & equipment.
- iii. Selection of appropriate technology / schemes for various systems/ Selection subsystems including techno-economic studies between various options.
- iv. Optimization studies including thermal cycle optimization.



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- v. Sizing criteria of all the systems, sub-systems including various piping systems/ equipment/ structures/ equipment foundations along with all calculations justifying and identifying the sizing and the design margins.
- vi. Schemes and Process & Instrumentation diagrams for the various systems/ sub-system with functional write-ups.
- vii. Operation Philosophy and the control philosophy of the Main Plant and other plants.
- viii. General Layout plan of the power station incorporating all facilities General in Bidder's as well as those in the Owner's scope. This drawing shall also be furnished in the form of floppy discs to the Owner for engineering of areas not included in Bidder's scope.
- ix. Basic layouts and cross sections of the main plant building (various floor elevations), boiler, fuel oil area and other areas included in the scope of the Bidder.
- x. Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.
- xi. The successful bidder shall furnish within three (3) weeks from the date of Notification of Award, a list of contents of the Plant Definition Manual (PDMs) including techno-economic studies, which shall then be mutually discussed & finalised with the Owner.
- xii. After approval of Plant Definition Manual / Design Basis Report, Bidder shall furnish detailed technical specification of all system / packages of the Plant.

b. Detail Engineering Documentation

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



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- vii. Detailed design calculations for components, system/sub-system, piping etc., wherever applicable including sizing calculations for all auxiliaries as per criteria specified elsewhere in specification.
- viii. Boiler pressure part schedule and sizing calculations. Boiler performance data and boiler design dossier.
- ix. Transient, hydraulic and thermal stress analysis of piping and Transient, system wherever applicable & input and output data along with stress analysis isometrics showing nodes
- x. Thermal cycle information (heat balance diagrams, boiler performance calculations, condenser and heat exchanger thermal calculations etc.).
- xi. Characteristic Curves / Performance Correction Curves. Hydraulic & Mechanical design calculations for condensers & heaters.
- xii. Comprehensive list of all terminal points which interface with Owner's facilities giving details of location, terminal pressure, and temperature, fluid handled & end connection details, forces, moments etc.
- xiii. Power Supply single line diagram, block logics, control schematics, electrical schematics, etc.
- xiv. Protection system diagrams and relay settings.
- xv. Interconnection diagrams.
- xvi. Cable routing plan.
- xvii. Instrument schedule, measuring point list, I/O list, Interconnection & wiring diagram, functional write-ups, and installation drawings for field mounted instruments, logic diagrams, control schematics, wiring and tubing diagrams of panels and enclosures etc. Drawings for open loop and close loop controls (both hardware and software). Motor list and valve schedule including type of actuator etc.
- xviii. Alarm and annunciation list and alarms & trip set points.
- xix. Sequence and protection interlock schemes.
- xx. Type test reports and power system stability study report.
- xxi. Control system configuration diagrams and card circuit diagrams and maintenance details.
- xxii. Detailed software manuals & source software listing.
- xxiii. Detailed flow chart for digital control system.



- xxiv. Mimic diagram layout.
- xxv. Civil Task drawings (for the Engineering by Owner), Design and Drawings for the Civil & Structural works in the scope of the Bidder.
- xxvi. Model study reports wherever applicable.
- xxvii. Functional & guarantee test procedures and test reports.
- xxviii. Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.
- xxix. Documentation in respect of commissioning as listed out elsewhere in this specification.
- xxx. The Bidder while submitting the above documents / drawings for approval / reference as the case may be, shall mark on each copy of submission the reference letter along with the date vide which the submissions are made.

8.3.1 Instruction Manuals

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

8.3.2 Erection Manuals

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

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



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

8.3.3 Operation & Maintenance Manuals

- i. The operating and maintenance instructions together with drawings (other than shop drawings) of the equipment, as completed, shall be in sufficient detail to enable the Owner to operate, maintain, dismantle, reassemble and adjust all parts of the equipment. They shall give a step by step procedure for all operations likely to be carried out during the life of the plant / equipment including, operation, maintenance, dismantling and repair including periodical activities such as chemical cleaning of the generator. Each manual shall also include a complete set of drawings together with performance/rating curves of the equipment and test certificates wherever applicable. The contract shall not be considered to be completed for purposes for taking over until these manuals have been supplied to the Owner.
- ii. If after the commissioning and initial operation of the plant, the manuals require any modification / additions / changes, the same shall be incorporated and the updated final instruction manuals shall be submitted to the Owner for records.
- iii. A separate section of the manual shall be for each size/ type of equipment and shall contain a detailed description of construction and operation, together with all relevant pamphlets and drawings.
- iv. The manuals shall include the following :
 - a) List of spare parts along with their drawing and catalogues and procedure for ordering spares.
 - b) Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation.
 - c) Where applicable, fault location charts shall be included to facilitate finding the cause of mal-operation or break down.
- v. Detailed specifications for all the consumables including lubricant oils, greases, chemicals etc. system/equipment/assembly/sub- assembly - wise required for the complete plant.
- vi. On completion of erection, a complete list of bearings / equipment giving their location, and identification marks etc. shall also be furnished to the Owner indicating lubrication method for each type/category of bearing.

8.3.4 Plant Handbook

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

1. Design and performance data.



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2. Process & Instrumentation diagrams.
3. Single line diagrams.
4. Sequence & Protection Interlock Schemes.
5. Alarm and trip values.
6. Performance Curves.
7. General layout plan and layout of main plant building and auxiliary buildings.
8. Important Do's & Don't's
9. The plant handbook shall be submitted within twelve (12) months from the date of award of contract. After the incorporation of Owner's comments, the final plant handbook complete in all respects shall be submitted three (3) months before start-up and commissioning activities.

8.3.5 Project Completion Report

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

8.3.6 Drawings

- a. All the plant layouts shall be made in computerized 3D modeling system. The Purchaser reserves the right to review the 3D model at different stages during the progress of engineering. The layout drawings submitted for Purchaser's review shall be fully dimensioned and extracted from 3D model after interference check.
- b. All documents submitted by the Bidder for Owner's review shall be in electronic form (soft copies) along with the desired number of hard copies as per Annexure-I. The soft copies to be supplied shall be either in CDs, or through direct transfer via E-mail, etc. depending upon the nature/volume/size of the document. The drawings submitted for approval could be in the Image form.
- c. Final copies of the approved drawings shall be submitted on CD-ROM along with the requisite number of hard copies as per Annexure-I.
- d. The completed plant documentation including integrated 3-D model with equipment drawings, data sheets, P&ID, BOQ, schematics, logic diagrams, test reports and quality plan, etc. attached to the respective equipment's / systems in the 3D model shall be furnished to Purchaser, along with the design review software which shall include interference check and walk-through animation, loaded on suitable hardware (server and work station). The software shall include facility for obtaining hard copies of all the drawings/documents on standard plotter / printer. The requisite hardware and software shall be supplied and commissioned by the Contractor at Purchaser's Engineering Office Complex as per mutually agreed schedule.
- e. All documents/text information shall be in latest version of MS Office.
- f. All drawings submitted by the Bidder including those submitted at the time of bid shall be in sufficient detail indicating the type, size, arrangement, weight of each component for packing and shipment, the external connection, fixing arrangement required, the dimensions



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required for installation and interconnections with other equipment and materials, clearance and spaces required between various portions of equipment and any other information specifically requested in the drawing schedules.

- g. Each drawing submitted by the Bidder (including those of sub-vendors) shall bear a title block at the right hand bottom corner with clear mention of the name of the Owner, Consultant, name of the Project, system designation, the specifications title, the specification number, drawing/document number and revisions. If standard catalogue pages are submitted the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.
- h. The drawings submitted by the Contractor (or their sub-vendors) shall bear Purchaser's drawing number in addition to contractor's (their sub-vendor's) own drawing number. Purchaser's drawing numbering system shall be made available to the successful bidder so as to enable him to assign Purchaser's drawing numbers to the drawings to be submitted by him during the course of execution of the Contract
- i. The Bidder shall also furnish a "Master Drawing List" which shall be a comprehensive list of all drawings/ documents/ calculations envisaged to be furnished by him during the detailed engineering to the Owner. Such list should clearly indicate the purpose of submission of these drawings i.e. "FOR APPROVAL" or "FOR INFORMATION ONLY".
- j. Similarly, all the drawings/ documents submitted by the Bidder during detailed engineering stage shall be stamped "FOR APPROVAL" or "FOR INFORMATION" prior to submission.
- k. The furnishing of detailed engineering data and drawings by the Bidder shall be in accordance with the time schedule for the project. The review of these documents/ data/ drawings by the Owner will cover only general conformance of the data/ drawings/ documents to the specifications and contract, interfaces with the equipment provided by others and external connections & dimensions which might affect plant layout. The review by the Owner should not be construed to be a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. The review and/ or approval by the Owner / Project Manager shall not relieve the Bidder of any of his responsibilities and liabilities under this contract.
- l. After the approval of the drawings, further work by the Bidder shall be in strict accordance with these approved drawings and no deviation shall be permitted without the written approval of the Owner.
- m. All manufacturing, fabrication and execution of work in connection with the equipment / system, prior to the approval of the drawings, shall be at the Bidder's risk. The Bidder is expected not to make any changes in the design of the equipment /system, once they are approved by the Owner. However, if some changes are necessitated in the design of the equipment/system at a later date, the Bidder may do so, but such changes shall promptly be brought to the notice of the Owner indicating the reasons for the change and get the revised



- drawing approved again in strict conformance to the provisions of the Technical Specification.
- n. Drawings shall include all installations and detailed piping layout drawings. Layout drawings for all piping of 65 mm and larger diameter shall be submitted for review/ approval of Owner prior to erection. Small diameter pipes shall however be routed as per site conditions in consultation with site authority/representative of Owner based on requirements of such piping indicated in approved / finalized Flow Scheme / Process & Instrumentation Diagrams and/or the requirements cropping up for draining & venting of larger diameter piping or otherwise after their erection as per actual physical condition for the entire scope of work of this package.
 - o. Assessing & anticipating the requirement and supply of all piping and equipment shall be done by the Bidder well in advance so as not to hinder the progress of piping & equipment erection, subsequent system charging and its effective draining & venting arrangement as per site suitability.
 - p. As Built Drawings After final acceptance of individual equipment/system by the Owner, the Bidder will update all original drawings and documents for the equipment/ system to “as built” conditions.
 - q. Drawings must be checked by the Bidder in terms of its completeness, data adequacy and relevance with respect to engineering schedule prior to submission to the Owner. In case drawings are found to be submitted without proper endorsement for checking by the Bidder, the same shall not be reviewed and returned to the Bidder for re- submission. The Bidder shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data/drawings at site which are needed as an input to the engineering. The Bidder shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Owner’s scope and submit all necessary drawings/ documents for the same.
 - r. The Bidder shall submit adequate prints of drawing/data/document for Owner’s review and approval. The Owner shall review the drawings and return one (1) copy to the Bidder authorizing either to proceed with manufacture or fabrication, or marked to show changes desired. When changes are required, drawings shall be re-submitted promptly, with revisions clearly marked, for final review. Any delays arising out of the failure of the Bidder to submit/rectify and resubmit in time shall not be accepted as a reason for delay in the contract schedule.
 - s. All engineering data submitted by the Bidder after final process including review and approval by the Owner shall form part of the contract documents and the entire works covered under these specification shall be performed in strict conformity with technical specifications unless otherwise expressly requested by the Owner in writing.

8.4 Engineering Information Submission Schedule



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

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

The Engineering Information Schedule shall be updated month wise.

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

8.5 Engineering Progress and Exception Report

8.5.1 Report giving the status of each engineering information including

- (a.) A list of drawings/engineering information which remains unapproved for more than four (4) weeks after the date of first submission
- (b.) Drawings which were not submitted as per agreed schedule.

8.5.2 The draft format for this report shall be furnished to the Owner within four (4) weeks of the award of the contract, which shall then be discussed and finalized with the Owner.

8.6 Technical Co-Ordination Meetings(TCM)

8.6.1 The Bidder shall be called upon to organize and attend monthly Design/ Co- ordination Meetings with the Owner/Owner's representatives, Project Consultant during the period of contract. The Bidder shall attend such meetings at his own cost at mutually agreed venue as and when required and fully co-operate with such persons and agencies involved during the discussions.

8.6.2 The Bidder should note that Time is the essence of the contract. In order to expedite the early completion of engineering activities, the Bidder shall submit all drawings as per the agreed Engineering Information Submission Schedule. The drawings submitted by the Bidder will be reviewed by the Owner as far as practicable within three (3) weeks from the date of receipt of the drawing .The comments of the Owner shall then be discussed across the table during the above co-ordination Meetings wherein best efforts shall be made by both sides to ensure the approval of the drawing.

8.6.3 The Bidder shall ensure availability of the concerned experts / consultants/ personnel who are empowered to take necessary decisions during these meetings. The Bidder shall be equipped with necessary tools and facilities so that the drawings/documents can be resubmitted after incorporating necessary changes and approved during the meeting itself.



- 8.6.4 Should any drawing remain unapproved for more than six (6) weeks after it's first submission, this shall be brought out in the monthly Engineering Progress and Exception Report with reasons thereof.
- 8.6.5 Any delays arising out of failure by the Bidder to incorporate Owner's comments and resubmit the same during the TCM shall be considered as a default and in no case shall entitle the Bidder to alter the Contract completion date.
- 8.7 **Design Improvements**
- The Owner or the Bidder may propose changes in the specification of the equipment or quality thereof and if the parties agree upon any such changes the specification shall be modified accordingly.
- If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any changing the price and/or schedule of completion before the Bidder proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.
- 8.8 **Equipment Bases**
- A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base, unless otherwise specifically agreed to by the Owner. Each base plate which support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.
- 8.9 **Protective Guards**
- Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards shall be designed for easy installation and removal for maintenance purpose.
- 8.10 **Lubricants, Servo Fluids and Chemicals**
- 8.10.1. The Bidder's scope includes all the first fill and one year's topping, requirements of consumables such as oils, lubricants including grease, servo fluids, gases and essential chemicals etc. Consumption of all these consumables during the initial operation and final filling after the initial operation shall also be included in the scope of the Bidder. Bidder shall also supply a quantity not less than 10% of the full charge of each variety of lubricants, servo fluids, gases, chemicals etc. used which is expected to be utilised during the first year of operation. This additional quantity shall be supplied in separate Containers.
- 8.10.2. As far as possible lubricants marketed by the Indian Oil Corporation shall be used. The variety of lubricants shall be kept to a minimum possible.
- Detailed specifications for the lubricating oil, grease, gases, servo fluids, control fluids, chemicals etc. required for the complete plant covered herein shall be furnished. On completion of erection, a complete list of bearings/ equipment giving their location and identification marks shall be furnished to the Owner along with lubrication requirements.



8.11 Lubrication

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

8.12 Material of Construction

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

8.13 Rating Plates, Name Plates & Labels

8.13.1 Each main and auxiliary item of plant including instruments shall have permanently attached to it in a conspicuous position, a rating plate of non- corrosive material upon which shall be engraved manufacturer's name, equipment, type or serial number together with details of the ratings, service conditions under which the item of plant in question has been designed to operate, and such diagram plates as may be required by the Owner.

8.13.2 Each item of plant shall be provided with nameplate or label designating the service of the particular equipment. The inscriptions shall be approved by the Owner or as detailed in appropriate section of the technical specifications.

8.13.3 Such nameplates or labels shall be of white non-hygroscopic material with engraved black lettering or alternately, in the case of indoor circuit breakers, starters, etc. of transparent plastic material with suitably coloured lettering engraved on the back. The name plates shall be suitably fixed on both front and rear sides.

8.13.4 Items of plant such as valves, which are subject to handling, shall be provided with an engraved chromium plated nameplate or label with engraving filled with epoxy. The name plates for valves shall be marked in accordance with MSS standard SP-25 and ANSI B 16.34 as a minimum.

8.13.5 Hanger/ support numbers shall be marked on all pipe supports, anchors, hangers, snubbers and restraint assemblies. Each constant and variable spring support shall also have stamped upon it the designed hot and cold load which it is intended to support. Suitable scale shall also be provided to indicate load on support/hanger.

8.13.6 Valves, steam traps and strainers shall be identified by Owner's tag number of a metal tap permanently attached to non-pressure parts such as the yoke by a stainless steel wire. The direction of flow shall also be marked on the body.

8.13.7 Safety and relief valves shall be provided with the following :

- (a.) Manufacturer's identification.
- (b.) Nominal inlet and outlet sizes in mm.
- (c.) Set pressure in Kg/cm² (abs).
- (d.) Blowdown and accumulation as percentage of set pressure.
- (e.) Certified capacity in Kg of saturated steam per hour or in case of liquid certified capacity in litres of water per minute.



- 8.13.8 All such plates, instruction plates, etc. shall be bilingual with Hindi inscription first, followed by English. Alternatively, two separate plates one with Hindi and the other with English inscriptions may be provided.
- 8.13.9 All segregated phases of conductors or bus ducts, indoor or outdoor, shall be provided with coloured phase plates to clearly identify the phase of the system
- 8.14 Tools and Tackles
- The Bidder shall supply with the equipment one complete set of all special tools and tackles and other instruments required for the erection, assembly, disassembly and proper maintenance of the plant and equipment and systems (including software). These special tools will also include special material handling equipment, jigs and fixtures for maintenance and calibration / readjustment, checking and measurement aids etc. A list of such tools and tackles shall be submitted by the Bidder along with the offer.
- The price of each tool / tackle shall be deemed to have been included in the total bid price. These tools and tackles shall be separately packed and sent to site. The Bidder shall also ensure that these tools and tackles are not used by him during erection, commissioning and initial operation. For this period the Bidder should bring his own tools and tackles. All the tools and tackles shall be of reputed make acceptable to the Owner.
- 8.15 Welding
- If the manufacturer has special requirements relating to the welding procedures for welds at the terminals of the equipment to be performed by others the requirements shall be submitted to the Owner in advance of commencement of erection work.
- 8.16 Colour Code for all Equipment/ Piping/ Pipe Services
- All equipment/ piping/ pipe services are to be painted by the Bidder in accordance with Owner's standard colour coding scheme, which will be furnished to the Bidder during detailed engineering stage.
- 8.17 Protection and Preservative Shop Coating
- 8.17.1 Protection
- All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either metallic or a non-metallic protection device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather, should also be properly treated and protected in a suitable manner. All primers/paints/coatings shall take into account the hot humid, corrosive & alkaline, subsoil or over ground environment as the case may be.
- 8.17.2 Preservative Shop Coating
- All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. All surfaces which will not be easily accessible after the shop assembly, shall be treated beforehand and protected for the life of the equipment. All surfaces shall be thoroughly cleaned of all mill scales, oxides and other coatings and prepared in the shop. The surfaces that are to be



finish-painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Transformers and other electrical equipment if included shall be shop finished with one or more coats of primer and two coats of high grade epoxy. The finished colours shall be as per manufacturer's standards, to be selected and specified by the Owner at a later date.

- 8.17.3 Shop primer for all steel surfaces which will be exposed to operating temperature below 95 degrees Celsius shall be selected by the Bidder after obtaining specific approval of the Owner regarding the quality of primer proposed to be applied. Special high temperature primer shall be used on surfaces exposed to temperature higher than 95 degrees Celsius and such primer shall also be subject to the approval of the Owner.
- 8.17.4 All other steel surfaces which are not to be painted shall be coated with suitable rust preventive compound subject to the approval of the Owner.
- 8.17.5 All piping shall be cleaned after shop assembly by shot blasting or other means approved by the Owner. Lube oil piping or carbon steel shall be pickled.
- 8.17.6 Painting for Civil structures shall be done as per relevant part of technical specification.

9.0 CENTRAL DOCUMENTATION FACILITY

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

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

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

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



10.0 QUALITY ASSURANCE PROGRAMME

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

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

10.2. General Requirements - Quality Assurance

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

10.2.2 Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards



mentioned therein and quality practices and procedures followed by Bidder's/ Sub-Bidder's/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media e.g. Compact Disc or E-mail in addition to hard copy, for review and approval. After approval the same shall be submitted in compiled form on CD-ROM.

- 10.2.3 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Bidder's "Site Quality Control Organisation", during various stages of site activities starting from receipt of materials/equipment at site.
- 10.2.4 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Owner's approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved Quality Plans, Owner shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Owner's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Owner in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Owner along with technical justification for approval and dispositioning.
- 10.2.5 No material shall be despatched from the manufacturer's works before the same is accepted, subsequent to pre-dispatch final inspection including verification of records of all previous tests/inspections by Owner's Project Manager/Authorised representative and duly authorised for despatch by issuance of Material Despatch Clearance Certificate (MDCC).
- 10.2.6 All material used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties; chemical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details.
- 10.2.7 The Bidder shall submit to the Owner Field Welding Schedule for field welding activities in the enclosed format. The field welding schedule shall be submitted to the Owner along with all supporting documents, like welding procedures, heat treatment procedures, NDT procedures etc. at least ninety days before schedule start of erection work at site.
- 10.2.8 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the Owner. All welding/brazing procedures shall be submitted to the Owner or its authorised representative for approval prior to carrying out the welding/brazing.
- 10.2.9 All brazers, welders and welding operators employed on any part of the contract either in Bidder's/sub-Bidder works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Owner.



- 10.2.10 Welding procedure qualification & Welder qualification test results shall be furnished to the Owner for approval. However, where required by the Owner, tests shall be conducted in presence of Owner/authorised representative.
- 10.2.11 For all pressure parts and high pressure piping welding, the latest applicable requirements of the IBR (Indian Boiler Regulations) shall also be essentially complied with. Similarly, any other statutory requirements for the equipment/systems shall also be complied with. On all back-gauged welds MPI/LPI shall be carried before seal welding.
- 10.2.12 Unless otherwise proven and specifically agreed with the Owner, welding of dissimilar materials and high alloy materials shall be carried out at shop only.
- 10.2.13 No welding shall be carried out on cast iron components for repair.
- 10.2.14 All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.
- 10.2.15 All non-destructive examination shall be performed in accordance with written procedures as per International Standards, The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination). NDT shall be recorded in a report, which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job.
- All plates of thickness above 40mm & all bar stock/Forging above 40mm dia shall be ultrasonically tested. For pressure parts, plate of thickness equal to or above 25mm shall be ultrasonically tested.
- 10.2.16 The Bidder shall list out all major items/ equipment/ components to be manufactured in house as well as procured from sub-contractors bought out items (BOI). All the sub-Bidder proposed by the Bidder for procurement of major bought out items including castings, forging, semi-finished and finished components/equipment etc., list of which shall be drawn up by the Bidder and finalised with the Owner, shall be subject to Owner's approval. The Bidder's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified sub-contractors enclosed and shall be submitted to the Owner for approval within the period agreed at the time of pre-awards discussion and identified in review category prior to any procurement. Monthly progress reports on sub- Bidder detail submission / approval shall be furnished. Such vendor approval shall not relieve the Bidder from any obligation, duty or responsibility under the contract.
- 10.2.17 For components/equipment procured by the contractors for the purpose of the contract, after obtaining the written approval of the Owner, the Bidder's purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the sub-Bidder shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the vendor's quality control organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc. Such quality plans of the successful vendors shall be finalised with the Owner and such approved



Quality Plans shall form a part of the purchase order/contract between the Bidder and sub-Bidder. Within three weeks of the release of the purchase orders /contracts for such bought out items /components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the Owner on the monthly basis by the Bidder along with a report of the Purchase Order placed so far for the contract.

- 10.2.18 Owner reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Bidder's or their sub-Bidder's quality management and control activities. The Bidder shall provide all necessary assistance to enable the Owner carry out such audit and surveillance.
- 10.2.19 The Bidder shall carry out an inspection and testing programme during manufacture in his work and that of his sub-Bidder's and at site to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identity and acceptability of all materials parts and equipment. Bidder shall carry out all tests/inspection required to establish that the items/equipment conform to requirements of the specification and the relevant codes/standards specified in the specification, in addition to carrying out tests as per the approved quality plan.
- 10.2.20 Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Owner to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the Bidder in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.
- 10.2.21 For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.
- 10.2.22 Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Owner/ authorised representative.
- 10.2.23 Burn in and Elevated Temperature Test Requirement for Electronics Solid State Equipment
All solid state electronic systems/equipment shall be tested as a complete system/equipment with all devices connected for a minimum of 168 hours (7 Days) continuously under energized conditions prior to shipment from manufacturing works, as per the following cycle.

Elevated Temperature Test Cycle

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

During the elevated temperature test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat



dissipating components/modules shall be monitored. The temperature rise inside the cubicle should not exceed 10 deg.C above the ambient temp. at 50 deg.C.

Burn in Test Cycle

The 48 hours elevated temperature test shall be followed by 120 hours of burn in test as above except that the temperature shall be reduced to the ambient temperature prevalent at that time. During the above tests, the process I/O and other load on the system shall be simulated by simulated inputs and in the case of control systems, the process which is to be controlled shall also be simulated. Testing of individual components or modules shall not be acceptable.

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

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

10.3. QA Documentation Package

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

- 10.3.1 Each QA Documentation shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document. The QA Documentation file shall be progressively completed by the Supplier's sub- supplier to allow regular reviews by all parties during the manufacturing.

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

10.3.2 Typical contents of QA Documentation is as below:-

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



- g. CHP / Inspection reports duly signed by the Inspector of the Owner and Bidder for the agreed Customer Hold Points.
- h. Certificate of Conformance (COC) wherever applicable.
- i. MDCC

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

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

- (a.) If the result of the review carried out by the Inspector is satisfactory, the Inspector shall stamp the quality document (or applicable section) for release.
- (b.) If the quality document is unsatisfactory, the Supplier shall endeavour to correct the incompleteness, thus allowing to finalize the quality document (or applicable section) by time compatible with the requirements as per contract documents. When it is done, the quality document (or applicable section) is stamped by the Inspector.
- (c.) If a decision is made despatch, whereas all outstanding actions cannot be readily cleared for the release of the quality document by that time. The supplier shall immediately, upon shipment of the equipment, send a copy of the quality document Review Status signed by the Supplier Representative to the Inspector and notify of the committed date for the completion of all outstanding actions & submission. The Inspector shall stamp the quality document for applicable section when it is effectively completed. The submission of QA documentation package shall not be later than 3 weeks after the despatch of equipment.

10.3.5 Transmission of QA Documentation

On release of QA Documentation by Inspector, one set of quality document shall be forwarded to Corporate Quality Assurance Department and other set to respective Project Site of Owner. For the particular case of phased deliveries, the complete quality document to the Owner shall be issued not later than 3 weeks after the date of the last delivery of equipment.

10.4. Project Manager's Supervision

10.4.1 To eliminate delays and avoid disputes and litigation, it is agreed between the parties to the Contract that all matters and questions shall be referred to the Project Manager and without prejudice to the provisions of 'Arbitration' clause in Section General Conditions of Contract, the Bidder shall proceed to comply with the Project Manager's decision.

10.4.2 The work shall be performed under the supervision of the Project Manager. The scope of the duties of the Project Manager pursuant to the Contract, will include but not be limited to the following:

- (a.) Interpretation of all the terms and conditions of these documents and specifications.



- (b.) Review and interpretation of all the Bidder's drawing, engineering data, etc:
- (c.) Witness or his authorised representative to witness tests and trials either at the manufacturer's works or at site, or at any place where work is performed under the contract.
- (d.) Inspect, accept or reject any equipment, material and work under the contract.
- (e.) Issue certificate of acceptance and/or progressive payment and final payment certificates
- (f.) Review and suggest modifications and improvement in completion schedules from time to time, and
- (g.) Supervise Quality Assurance Programme implementation at all stages of the works.

10.5. Inspection, Testing And Inspection Certificates

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



- 10.5.6 In all cases where the contract provides for tests whether at the premises or works of the Bidder or any sub-Bidder, the Bidder, except where otherwise specified shall provide free of charge such items as labour, material, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Project Manager /Inspector or his authorized representatives to carry out effectively such tests on the equipment in accordance with the Bidder and shall give facilities to the Project Manager/Inspector or to his authorized representative to accomplish testing.
- 10.5.7 The inspection by Project Manager / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Bidder in respect of the agreed Quality Assurance Programme forming a part of the contract.
- 10.5.8 To facilitate advance planning of inspection in addition to giving inspection notice as specified at clause no 10.5.3- of this chapter, the Bidder shall furnish quarterly inspection programme indicating schedule dates of inspection at Customer Hold Point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.
- 10.5.9 All inspection, measuring and test equipment used by Bidder shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Bidder shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by the Owner. Wherever asked specifically, the Bidder shall re-calibrate the measuring/test equipment in the presence of Project Manager/Inspector.
- 10.6. Associated document for quality assurance programme:
- I. List of items requiring quality plan and sub supplier approval. (Annexure-III).
 - II. Status of items requiring Quality Plan and sub supplier approval. (Annexure- IV).
 - III. Field Welding Schedule (Annexure-V).
 - IV. Manufacturing Quality Plan (Annexure-VI).
 - V. Field Quality Plan (Annexure-VII).
- 11.0 PRE-COMMISSIONING AND COMMISSIONING FACILITIES
- (a.) As soon as the facilities or part thereof has been completed operationally and structurally and before start-up, each item of the equipment and systems forming part of facilities shall be thoroughly cleaned and then inspected jointly by the Owner and the Bidder for correctness of and completeness of facility or part thereof and acceptability for initial pre-commissioning tests, commissioning and start-up at Site. The list of pre-commissioning tests to be performed shall be as mutually agreed and included in the Bidder's quality assurance programme as well as those included elsewhere in the Technical Specifications.
- (b.) The Bidder's pre-commissioning/ commissioning/start-up engineers, specially identified as far as possible, shall be responsible for carrying out all the pre-commissioning tests at Site. On completion of inspection, checking and after the pre-commissioning tests are satisfactorily over, the commissioning of the complete facilities shall be commenced during which period the complete facilities, equipment shall be operated integral with sub-systems and supporting equipment as a complete plant. It will be the responsibility of the Bidder to assess and furnish a list of all commissioning spares required for successful commissioning



of all the equipment covered under the contract. Such a list shall be furnished by the Bidder within 12 months from the date of LOA, separately for each equipment and shall be reviewed by the Owner and discussed for mutual agreement. The commissioning spares will be so identified as not to allow the trial operation to suffer for want of such commissioning spares. The identification of commissioning spares will not in any way relieve the Bidder of any of his responsibilities of satisfactory performance under the provisions of other conditions of contract. All the commissioning spares shall be deemed to be included in scope of the Bidder as a part of the respective equipment package at no extra cost to the Owner.

- (c.) All piping system shall be flushed, steam blown, air blown as required and cleanliness demonstrated using acceptable industry standards. Procedures to accomplish this work shall be submitted for approval to the Owner six months prior to the respective implementations. The Owner will approve final verification of cleanliness.
- (d.) The time consumed in the inspection and checking of the units shall be considered as a part of the erection and installation period.
- (e.) The check outs during the pre - commissioning period should be programmed to follow the construction completion schedule. Each equipment/system, as it is completed in construction and turned over to Owner's commissioning (start-up) Engineer(s), should be checked out and cleaned. The checking and inspection of individual systems should then follow a prescribed commissioning documentation [SLs (Standard Check List) / TS (Testing Schedule) / CS (Commissioning Schedule)] approved by the Owner.
- (f.) The Bidder during initial operation and performance testing shall conduct vibration testing to determine the 'base line' of performance of all plant rotating equipment. These tests shall be conducted when the equipment is running at the base load, peak load as well as lowest sustained operating condition as far as practicable.
- (g.) Bidder shall furnish the commissioning organization chart for review & acceptance of Owner at least eighteen months prior to the schedule date of synchronization. The chart should contain :
 - 1. Bio data including experience of the Commissioning Engineers.
 - 2. Role and responsibilities of the Commissioning Organisation members.
 - 3. Expected duration of posting of the above Commissioning Engineers at site.

11.1 Initial Operation

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



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

11.2 Guarantee Tests

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



12.0 TAKING OVER

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

13.0 TRAINING OF OWNER'S PERSONNEL

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

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

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

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

13.2 The scope of services under training shall also necessarily include training of Owner's Engineering personnel covering a training module of upto 52 man months. This shall cover all disciplines viz, Mechanical, Electrical, C&I, & QA etc. and shall include all the related areas like Design familiarization, training on product design features and product design softwares of major equipment and systems, engineering, manufacturing, erection, commissioning, training on operating features of equipment, quality assurance and testing, plant visits and visits to manufacturer's works, exposure to various kinds of problems which may be encountered in fabrication, manufacturing, erection, welding etc. An indicative module of the training requirement of Owner's Engineering personnel is attached as Annexure-II.

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

13.3 Bidder shall furnish in his offer, details of training module(s) covering above requirements which shall be subject to Owner's approval. Consolidated training period included above (i.e. 35 and 52 man months respectively for O&M and Engineering) is indicative only. Owner reserves the right to



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

- 13.4 Clause 13.2 & 13.3 shall be applicable for domestic bidders. For foreign bidders refer Vol I, Section 2, GCC.
- 13.5 Exact details, extent of training and the training schedule shall be finalised based on the Bidder's proposal within two (2) months from placement of award.
- 13.6 In all the above cases, wherever the training of Owner's personnel is arranged at the works of the manufacturer's it shall be noted that the lodging and boarding of the Owner's personnel shall be at the cost of Bidder. The Bidder shall make all necessary arrangements towards the same.
- 13.7 Take off prices (product wise) should be indicated by the Bidder in the Bid Proposal Sheets. Owner reserves the right to include or exclude these item(s) during place of Award. All expenses except travelling expenses shall be borne by the contractor.

14.0 SAFETY ASPECTS DURING CONSTRUCTION AND ERECTION

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

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

15.0 NOISE LEVEL

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

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

16.0 PACKAGING AND TRANSPORTATION

All the equipment & spares shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. Each spare shall be clearly marked or labelled on the outside of the packing with its description. When more than one spare part is packaged in a single case, a general description of the contents shall be shown on the outside of such a case and other packages must be suitably marked and numbered for the purpose of identification. All cases, containers or packages, are liable to be opened for such examination as may be considered reasonable by the Engineer. In case of



equipment supplied with grease/lubricants from imported origin, the supplied shall clearly indicate the indigenous equivalent of the grease/lubricant and source of supply so as to enable the Owner to procure these items from indigenous sources. While packing all the materials, the limitation from the point of view of the sizes of railway wagons available in India should be taken account of. The Bidder shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The Bidder shall ascertain the availability of Railway wagon sizes from the Indian Railways or any other agency concerned in India well before effecting dispatch of equipment. Before dispatch it shall be ensured that complete processing and manufacturing of the components is carried out at shop, only restricted by transport limitation, in order to ensure that site works like grinding, welding, cutting & pre-assembly to bare minimum. The Owner's Inspector shall have right to insist for completion of works in shops before dispatch of materials for transportation.

17.0 ELECTRICAL ENCLOSURE

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

18.0 INSTRUMENTATION AND CONTROL

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

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

a)	Temperature	Degree centigrade (deg C)
b)	Pressure	Kilograms per square centimeter (Kg/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.

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



- 18.3 All electronic modules shall have gold plated connector fingers and further all input and output modules shall be short circuit proof. These shall also be tropicalized & components shall be of industrial grade or better.
- 19.0 ELECTRICAL NOISE CONTROL
- The equipment furnished by the Bidder shall incorporate necessary techniques to eliminate measurement and control problems caused by electrical noise. Areas in Bidder's equipment, which are vulnerable to electrical noise shall be hardened to eliminate possible problems. Any additional equipment, services required for effectively eliminating the noise problems shall be included in the proposal. The equipment shall be protected against ESD as per IEC-801- 2. Radio Frequency interference (RFI) and Electro Magnetic Interference (EMI) protection against hardware damage and control system mal-operations/errors shall be provided for all systems.
- 20.0 INSTRUMENT AIR SYSTEM
- The instrument air supply system as supplied by the Bidder for various pneumatic control & instrumentation devices like pneumatic actuators, power cylinders, E/P converters, piping / tubing etc. shall be as per the details furnished elsewhere.
- Each pneumatic instrument shall have an individual air shut - off valve. The pressure-regulating valve shall be equipped with an internal filter, a 50 mm pressure gauge and a built-in filter housing blow down valve.
- 21.0 TAPPING POINTS FOR MEASUREMENTS
- Tapping points shall include probes, wherever applicable, for analytical measurements and sampling.
- For direct temperature measurement of all working media, one stub with internal threading of approved pattern shall be provided along with suitable plug and washer. The Bidder will be intimated about thread standard to be adopted. The following shall be provided on equipment by the Bidder. The standard which is to be adopted, will be intimated to the Bidder.
- (a.) Temperature test pockets with stub and thermowell
 - (b.) Pressure test pockets
- 22.0 ELECTRONIC MODULE/COMPONENT DETAILS
- The Bidder shall have to furnish all technical details including circuit diagrams, specifications of components, etc., in respect of each and every electronic card/module as employed on the various solid state as well as microprocessor based systems and equipment including conventional instruments, peripherals etc. It is mandatory for the Bidder to identify clearly the custom built ICs used in the package. The Bidder shall also furnish the details of any equivalents of the same.
- 23.0 ENVIRONMENTAL MONITORING & CONTROL MEASURES
- Bidder to note that MOEF has declared Manali area as critically polluted area and also imposed certain restrictions on consideration of development of projects.
- Concerned authorities have been addressed to have self-monitoring system (for Air, Water & Land) so as to ascertain the level of compliance of standards prescribed by MOEF and also to furnish the action plan ie., for the establishment of self-monitoring system. It is also directed to undertake



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

Environmental Clearance:

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

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



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EPC TENDER SPECIFICATION FOR BTG PACKAGE

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

Hence, it is stated that the implementation of Environmental measures including self-monitoring system (for air, Water and land) as per the EC granted, especially in the following areas have to be ensured by the bidder without any exception:

Continuous Air quality monitoring stations

Online monitoring system

Effluent Treatment plant

Sewage treatment plant

Optimum use of land area

100% Ash collection & utilisation

Green Belt Development.



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ANNEXURE-I

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



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ANNEXURE-II

(Total within 52 man months)

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



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



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



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PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
	Selection of nos., type and arrangement of bearings, load calculation on bearings, bearing oil flow calculation Selection, design and control principle for Turbine governing system Performance calculation Steam path audit Layout principle of various equipment's of TG and its integral system Latest technological advancements			
MANDAYS	45	10	10	
Boiler Feed Pumps	Techno-economic studies for Selection of BFP Configuration and its drive Criteria for selection of boiler Feed Pump parameters Rotor design, strength calculation and rotor dynamic behavior studies wrt critical speed, vibration etc	Familiarization of power plants of various makes of feed pumps Data collection of BFP parameters and configuration Collection of data for analysis of availability of BFP	Manufacturing process of various components of BFP Assembly of BFP Testing, capabilities of BFP at works wrt performance, NPSH, thermal shock, dry run, visual cavitation, string test, axial thrust measurement	
	Impeller design and its hydraulic behavior	O&M history/problems related to BFP	Product development in process	



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PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
	Role of critical para- meters such as NPSH(R), Suction specific speed, running clearances, speed etc. in design of feed pumps	Comparative studies for various types of BFP& its features	Future plan for technology induction	
	Material selection of BFP components Guiding factors for selection of BFP seals Computation of axial thrust under various flows Performance calculation Transient analysis in pump suction piping wrt NPSH margin Latest technological trends in BFP design		R&D work in progress	
MANDAYS	20	5	10	
Condenser	Selection of condenser type and its optimization wrt temp rise across condenser, pressure drop in condenser, surface area etc	Comparative studies of salient features	Manufacturing process of various components of condenser Assembly	
	Techno economic studies for Selection of condenser tube material and other parts depending on water quality Condenser support selection & design	Collection of data for analysis of availability of Condenser O&M history/problems related to condenser	Testing capability at works Product development in process	



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



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PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
MANDAYS	20			
Compressors	Equipment Theory & Maintenance Practice			
MANDAYS	16	-	4	
Condensate Polishing Unit	Equipment Theory & Maintenance Practice			
MANDAYS	15	5	5	
CONTROL & INSTRUMENTATION	Hardware & Software organization of the system Basis of selection of H/W memory sizing Operating system features, interface with other system, openness & inter- operability Upgradability System testing features	Operational feedback		
DDCMIS-Man Machine Interface - Hardware & Operating System				
MANDAYS	24	6		16
DDCMIS-Man Machine Interface System Engineering & Application Software	Specific system customisation	Operation feedback		
	Various system			
	modules & interface with OS			
	Database organization & development			



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PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
	Development of mimics			
	Other application like calculations, logs historical storage functionalities & use			
MANDAYS	40	6		8
DDCMIS - Control System Hardware	Basic design features for system & its modules	Operation feedback	Manufacturing processes special attention to handling of the modules Maintenance facilities	
	System capabilities & system design techniques			
	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		



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



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



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



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PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
Boiler Feed pump H.T. Motor	Design Criteria for the	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
CRITICAL PIPING & POWER CYCLE PIPING	Design familiarization for critical piping of supercritical Plant Optimization study for sizing including pressure drop calculation and selection of single or double lead together with Owner's engineers Design and stress analysis of lines with Expansion Joints together with Owner's engineers	Familiarization with feed back (in super critical plant) on failure analysis and vibration analysis of piping. Study of Feed back regarding hanger setting strategies and practice	Cold Setting of spring hanger Cyclic tests carried on spring hangers. Cyclic tests carried on expansion joints	



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PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
	Design and stress analysis of piping systems with two phase flow involving Owner's engineers Transient analysis and optimum sizing of feed suction piping together with Owner's engineers. Static and dynamic analysis of critical piping including seismic and other occasional load analysis (safety valve blowing condition). A joint activity together with Owner's engineers. Study and collection of data pertaining to special welding requirements (pre and post weld heat treat ment and electrode selection criteria etc.) of materials used in high temp piping system. Study and collection of data on special requirements in case of welding dissimilar metals and electrode selection criteria		Manufacturing process of critical piping components and appreciation of their testing facilities at shop	
MANDAYS	5	2		



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ANNEXURE-III

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

LEGENDS

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

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

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

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

2. QP/INSPN CATEGORY:

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

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

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

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

ANNEXURE-IV

[illegible]



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ANNEXURE-V

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

ANNEXURE-VI

MFGR.'s LOGO		MANUFACTURER'S NAME AND ADDRESS		MANUFACTURING QUALITY PLAN						PROJECT:			
				SUB-SYSTEM:		ITEM :		QP NO.:					
						REV.NO.:		PACKAGE:					
						DATE:		CONTRACT NO.:					
						PAGE: OF....		MAIN-SUPPLIER:					
SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
										M	C	N	
1	2	3	4	5	6	7	8	9	D*	** 10			11
			LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** M: MANUFACTURER/SUB-SUPPLIER C: SUPPLIER/NOMINATED INSPECTION AGENCY, N: THE OWNER P: PERFORM W: WITNESS AND V: VERIFICATION. AS APPROPRIATE, CHP: THE OWNER SHALL IDENTIFIED IN COLUMN						DOC. NO.: REV..... CAT.....				
MANUFACTURER/ SUB-SUPPLIER		MAIN- SUPPLIER						FOR THE OWNER USE					
									REVIEWED BY		APPROV ED BY		APPROVAL SEAL
SIGNATURE													

Chapter 5

Performance Guarantees & LD for shortfall



CHAPTER 5
PERFORMANCE GUARANTEES AND LIQUIDATED DAMAGES FOR SHORTFALL IN
PERFORMANCE AND GUARANTEE TESTS

1.0 GENERAL

- 1.1 The Bidder shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in these specifications.
- 1.2 The guaranteed performance parameters furnished by the bidder in his offer, shall be without any tolerance values. Only such tolerance or allowance on the test results, which are permitted by the agreed test code, will be permitted for instrument inaccuracies. However for steam generator and ESP, no tolerances on account of instrument inaccuracy or any other cause shall be allowed and all margins required, instrument inaccuracies and other uncertainties shall be deemed to have been included in the guaranteed figures.
- 1.3 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 / acceptance test, are listed. The Contractor at site shall conduct the guarantee tests in presence of Purchaser on each unit individually.
- 1.4 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 contract price.
- 1.5 The performance tests shall be performed using only the normal number of Employer 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.
- 1.6 It shall be responsibility of the Contractor to make the plant ready for the performance guarantee tests.
- 1.7 The term "Performance Guarantees" wherever appears in this Section shall have the same meaning and shall be synonymous to "Functional Guarantees".
- 1.8 The term "Performance Tests" wherever appears in this Section shall have the same meaning and shall be synonymous to "Guarantee Test(s)"
- 1.9 The term "TMCR" (Turbine maximum continuous rating) appearing in the Technical Specification shall mean 800 MW electrical power output at generator terminals under 0% cycle make-up at design Condenser pressure.



1.10 The term “BMCR” (Boiler Maximum Continuous Rating) appearing in the Technical Specification shall mean 1.02 times the steam flow at turbine VWO condition(105% TMCR) plus continuous auxiliary steam requirement of unit at TMCR, rounded to next integer divisible by 5.

1.11 Test Instrumentation, Flow Measurement and their Calibration

All instruments required for performance testing shall be of the type and accuracy required by the code prior to the test, the Contractor shall get these instruments calibrated in an independent test Institute approved by the Employer. 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 Employer. The protecting tubes, pressure connections and other test connections required for conducting guarantee test shall conform to the relevant codes.

1.12 Tools and tackles, thermowell (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.

1.13 The Performance test shall be carried out as per the agreed procedure. The detailed 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.

- a. The P&G test procedures shall be submitted for equipment/ 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.
- b. The contractor shall submit for Employer's approval the detailed Performance Test procedure containing the following:
 - i. Object of the test
 - ii. Various guaranteed parameters & tests as per contract.
 - iii. Method of conductance of test and test code.
 - iv. Duration of test, frequency of readings & number of test runs.
 - v. Method of calculation.
 - vi. Correction calculations & curves.
 - vii. Instrument list consisting of range, accuracy, least count, and location of instruments.



- viii. Scheme showing measuring points.
- ix. Sample calculation
- x. Acceptance criteria.
- xi. Any other information required for conducting the test. The Performance test shall be carried out as per the agreed procedure.

1.14 Test Reports

After the conductance of Performance test, the Contractor shall submit the test evaluation report of Performance test results to Employer promptly but not later than one month from the date of conductance of Performance test. Preliminary test reports shall be submitted to the Employer 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 Employer for approval.

- 1.15 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 EMPLOYER. In the event of EMPLOYER agreeing to conductance of such tests after three months, for reasons not attributable to the EMPLOYER, as assessed by the Employer, no factor for ageing shall be considered for computing performance of the equipment. Performance Guarantee Tests on the equipment /systems not covered shall be carried out as per the procedure/test codes specified.

1.16 Test Interruptions

In the event of a test interruption resulting from an Event of Force Majeure or Purchaser-Caused-Delay, Contractor shall be entitled to relief as provided in the contract, provided that (except for certain interruptions of a Availability Test as specified below), the interrupted Performance Test must be started again and test data that were collected during the interrupted test must be ignored.

In the event of test interruptions as a result of Force Majeure or Purchaser-Caused-Delay during an Availability test, where.

- a. The total cumulative interrupted time during the test is more than twenty-four (24) hours.
- b. The total number of interruptions during the test is more than four (4). The test shall not be deemed a successful Performance Test.
Except as provided above, the interrupted test resulting from Force Majeure or Purchaser-Caused-Delay shall be extended by an amount of time equal to the length of



the interruptions, including time to return to steady-state operation; the test data for the period of interruptions shall be excluded from analysis; and the test data that were collected both before and after the interruptions shall be included in the analysis.

1.17 Grid Restriction

Any loss in generation in terms of power (KW) or energy (KWH) during Availability Test due to grid restrictions shall be treated as deemed generation. However, the total cumulative deemed generation shall not exceed 5% of the total generation during the test period failing which the test shall be extended to limit the deemed generation to 5% of the total generation.

1.18 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 Employer and re-conduct the performance guarantee test(s) with Employer's consent. In case the specified performance guarantee(s) are still not met by the contractor even after modification and/or replacement, Employer will accept the equipment/system/plant after levying liquidated damages as per clause 2.0 of this chapter. However, if, the demonstrated guarantee(s) continue to be beyond the Limit, even after the modifications/replacements within ninety (90) days or a reasonable period allowed by the Employer, after the tests have been completed, the Employer will have the right to either of the following (at Employer's discretion):

- i. For Category-I Guarantees
Reject the equipment / system / plant and recover from the Contractor the payments already made

OR

- ii. Accept the equipment /system/ plant after levying Liquidated Damages.
For Category-II Guarantees
Reject the equipment / system/ plant and recover from the Contractor the payments already made. Conformance to the performance requirements under Category-II is mandatory.
- iii. For Category-III Guarantees
Reject the equipment /system/ plant and recover from the Contractor the payments already made.

OR

Accept the equipment/system after assessing the deficiency in respect of the various ratings, performance parameters and capabilities and recover from the contract price an amount equivalent to the damages as



determined by the Employer. Such damages shall, however be limited to the cost of replacement of the equipment/system, replacement of which shall remove the deficiency so as to achieve the guaranteed performance.

2.0 Amount Of Liquidated Damages (LD) Applicable For Category-I Guarantees

Refer Volume-I

3.0 Specific And Limiting Requirements For Steam Generator Efficiency

- a. Guaranteed Steam generator efficiency shall be calculated as per the requirements of ASME PTC 4 (by loss method) and as per stipulations of Clause 8.0 of this chapter.
- b. The guaranteed efficiency quoted by the Bidder shall comply with following limiting parameters with design coal firing:

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

Bidder/Contractor to note that no credit shall be given in the bid evaluation or in the evaluation of the results of the guarantee tests for performance predictions/ guarantees etc. if the values considered by the Bidder/Contractor for parameters indicated at above are lower than those specified above.

- c. For the purposes of guarantees the ambient air temperature and relative humidity shall be taken as 27 degree Celsius and 72% respectively.
- d. Unless otherwise specified, the guarantees shall be based on design coal firing.

4.0 AUXILIARY POWER CONSUMPTION (PA)



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

$$Pa = Pu + TL$$

Pa = Guaranteed Auxiliary Power Consumption.

Pu = Power consumed by the auxiliaries of the unit under test.

TL = Losses of the transformers supplied by bidder based on works test reports.

While guaranteeing the auxiliary power consumption the bidder shall necessarily include all continuously operating auxiliaries under this package. The auxiliaries to be considered shall include but not be limited to the following:

4.1 Steam Generator & its Auxiliaries at 100% TMCR while firing Design Coal

- a. Primary Air (PA) Fans including its lube oil pumps
- b. Coal Feeders.
- c. Seal air fans
- d. Coal mills including its lube oil pumps.
- e. Forced Draft (FD) Fans including its lube oil pumps.
- f. Regenerative Air Preheater including its lube oil pumps.
- g. Electrostatic precipitators (ESP)
- h. Induced Draft (ID) Fans including its lube oil pumps.
- i. Boiler circulation pumps
- j. Scanner air fans

4.2 Steam Turbine Generator & its Auxiliaries at 100% TMCR

- a. Turbine auxiliary oil pump (if applicable)
- b. Turbine control oil pump
- c. Oil Tank Vapour Extractor
- d. Unit lube. oil purification system
- e. Unit control oil purification system
- f. Gland steam exhauster
- g. Seal Oil pump
- h. Seal oil evacuation system
- i. Gas dryer system
- j. Stator water cooling pump
- k. Booster pumps for TDBFP
- l. TDBFP lube. Oil pumps
- m. Oil purifiers of TDBFP
- n. MDBFP Auxiliary Oil pump



- o. Condensate Extraction Pumps (CEP).
- p. Oil pumps for HP & LP bypass system
- q. Condenser air evacuation equipment (Vacuum pumps)
- r. Condenser online tube cleaning pumps
- s. LP drain condensate pump (if applicable)
- t. Chemical Dosing pumps
- u. Closed cooling water pumps (DMCW)

4.3 Balance of Plant

- a. Cycle make-up pumps
- b. Mill Reject system, Duty Factor 0.5
- c. Air conditioning system, Duty Factor 1.0
- d. Ventilation system, Duty Factor 1.0
- e. Plant lighting, Duty Factor 0.6

4.4 Electrical System at 100% TMCR

- a. Generator Transformer losses (at rated Load Condition)
- b. Unit transformers losses (at rated load conditions)
- c. Station transformer losses (at Unit rated load conditions)
- d. Losses in all other transformers (at rated load conditions)
- e. Losses in Bus ducts (at rated load conditions)
 - Isolated Phase Bus Duct
 - Phase segregated busduct
- f. UPS power consumption (at rated load condition)
- g. DC System power consumption (at rated load condition)

4.5 Any Other items which are running continuously.

5.0 GUARANTEES UNDER CATEGORY-I

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

5.1 Steam Generator:

Efficiency of the Steam Generator at 100% TMCR (800MW unit load) with 27 degree Celsius ambient temperature and 72% RH, while firing the design coal, at rated steam parameters, rated coal fineness and rated excess air. (To be demonstrated as per clause 8.0 of this chapter). The guaranteed efficiency shall be based on Heat Input GCV of coal.

5.2 Steam Turbine Generator:



5.2.1 Minimum Gross Turbine Cycle 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). (To be calculated as per the stipulation of cl. no. 10.0 of this chapter). The performance test to be conducted and heat rate to be calculated as per the requirements of code ASME PTC 6.

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

Note: The condenser pressure measurement while conducting the guarantee tests shall be measured at 300 mm above the top row of condenser tubes.

5.3 Electrostatic Precipitator

The ESP efficiency at TMCR condition shall be guaranteed while firing design coal with all fields in service (To be conducted as per the stipulation of cl. no. 11.0 of this chapter).

5.4 Auxiliary Power Consumption

Auxiliary Power Consumption at 100% TMCR unit load. The total auxiliary power consumption for all the steam generator auxiliaries, Electrostatic Precipitator, Turbine Generator Auxiliaries, Equipment cooling water pumps, Mill Reject Handling system, Transformer losses, Plant lighting, bus duct losses etc. required for continuous operation at 100% TMCR under rated steam conditions and with ambient air temperature of 27 degree Celsius & RH of 72%, shall be guaranteed in line with the requirements as stipulated.

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

6.0 Guarantees Under Category II

The Performance Guarantees, conformance to which are mandatory are as follows:

6.1 NOx emission

Contractor shall guarantee that maximum total NOx emission from the unit shall not be more than 260 grams of NOx (from thermal as well as fuel) per giga joule of heat input to the boiler during the entire operating range of steam generator for the range of coals specified. The emission shall be measured during steam generating capacity test. The bidder shall furnish the methodology of measurement and demonstration of variations w.r.t. load upto 50% of total load.

6.2 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.

6.3 ESP Outlet Emission

ESP Outlet emission shall be limited to the following for various coals

- Best Coal at 100% TMCR : <35mg/Nm³
- Design Coal at 100% BMCR : <40mg/Nm³
- Worst Coal at 100% BMCR : <50mg/Nm³

6.4 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 mm WC.

6.5 Design Condenser pressure in mm Hg (abs) measured at 300 mm above the top row of condenser tubes under VWO conditions, 1% make up, design CW temperature and CW flow.

7.0 Guarantees Under Category-III

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

7.1 Noise

All the plant, equipment and systems covered under this specification shall perform continuously without exceeding the noise level over the entire range of output and operating frequency. The equivalent 'A' weighted sound pressure level measured at a height of 1.5 m above floor level in elevation and at a distance of one (1) metre horizontally from the nearest surface of any equipment/machine, furnished & installed under these specification, expressed in decibels to a reference of .0002 microbar shall not exceed 85 dba except for:

- a. Safety valves & associated vent pipes for which it shall not exceed 105 dba.
- b. Regulating drain valves in which it shall be limited to 90 dba.

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.



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.

7.2 STEAM GENERATOR AND AUXILIARIES

7.2.1 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:

- i. The Contractor shall demonstrate capacity output on one coal pulveriser (of Employer'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.
- ii. Further, Contractor shall also demonstrate capacity output on four coal pulverisers (of Employer's choice) of Steam Generator, not less than the 90% of guaranteed value of (a) above, at 100% mill loading with the originally installed grinding elements in nearly worn-out condition or at the end of guaranteed wear life of grinding elements, whichever is earlier.

Capacity test as mentioned above shall be demonstrated at the following conditions occurring simultaneously during testing:

Rated pulverised coal fineness	a. not less than 70% through 200 mesh and b. not less than 99% through 50 mesh screen
Test Coal	Any available coal from the specified range



In case the 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 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 (grind ability) 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 Employer. HGI versus coal pulveriser capacity curve shall be furnished for HGI variation up to a value above which the capacity remain constant.

7.2.2 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.

7.2.3 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.

7.2.4 No fuel oil support shall be required above 30% BMCR

Contractor shall guarantee that oil support for flame stabilization shall not be required beyond 30% 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 Employer's choice) the Steam Generator does not require any oil firing for stable and efficient boiler operation at and above 30% BMCR loads.

7.2.5 Run back capabilities

The contractor shall demonstrate automatic runback capability of the unit (boiler turbine-generator) on loss of critical auxiliary equipment (such as tripping of one ID fan/ FD fan/PA fan/ air heater / BFP/ CEP etc.) ensuring smooth and stable runback operation.



7.2.6 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.

7.2.7 Furnace Exit Gas Temperature (FEGT)

The contractor shall conduct a comprehensive thermal performance test (TPT), by indirect method. Such test should demonstrate that FEGT does not exceed the specified max. Temperature limit.

7.2.8 Steam Temperature Imbalance

The Contractor shall demonstrate that at SH and RH outlets (in case of more than one outlet) the temperature imbalance between the outlets does not exceed 10 deg C under all loads including transients.

7.2.9 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%).

7.2.10 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) of Technical specifications. Above requirement needs to be complied with recirculation of flue gas from downstream of ESP.

7.2.11 Reheater & Superheater attemperation spray water flow

It shall be demonstrated 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 the range specified with HP heaters in service while maintaining the rated SH outlet steam temperature at all loads up to and including BMCR.

It shall also be demonstrated that the RH temperature is maintained at the rated value without any spray water requirement under normal operating conditions (100% TMCR)

7.2.12 Coal Mill Wear Parts Warranty

Life of coal pulveriser wear parts, in hours of operation, for the entire range of coal characteristics specified. (To be demonstrated as per clause 9.0 of this chapter).



7.3 Generator excitation system

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

7.4 Condenser On Load Tube Cleaning System

Life of sponge rubber balls and number of balls lost during 1000 hours of plant operation shall be as indicated by Bidder in the offer and accepted by the Employer.

7.5 Steam condensing plant

- a. Temperature of condensate, at outlet of condenser, shall be demonstrated to be near to saturation temperature corresponding to the condenser pressure at all loads.
- b. Oxygen content in condensate at hot well outlet shall not exceed 0.015 cc/litre over 50-100% load range and shall be determined according to calorimetric Indigo-Carmine method.
- c. 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.
- d. When one half of the condenser is isolated, condenser shall be capable of taking at least 60% T.G. load under TMCR conditions.
- e. 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 Deg. C below the temperature corresponding to absolute suction pressure shall be demonstrated. Correction curves for establishing the capacity at site conditions shall also be furnished.
- f. The air and vapour mixture from air cooling zone of condenser shall be 4.17 deg. C below the saturation temperature corresponding to 25.4 mm Hg (abs) suction pressure. Correction curves for establishing the same at site conditions shall also be furnished.

7.6 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. Dissolved Oxygen content in Deaerator effluent at deaerator outlet without chemical dosing at all loads, not to exceed 0.005 CC/litre determined as per ASTM-D-888 – Reference method-A or Indigo Carmine method.
- d. Difference between saturation temperature of steam entering the deaerator and temperature of feed water leaving the deaerator shall be demonstrated as per guaranteed heat balance diagram for 100% TMCR condition.
- e. Continuous and efficient operation and performance of feed heating plant without undue noise and vibrations at all loads and duty conditions

7.7 HP & LP Bypass System Capability

The HP & LP bypass system should satisfy the following functional requirements under automatic interlock action. It should come into operation automatically under the following conditions:

- a. Generator circuit breaker opening
- b. HP & IP stop valves closing due to turbine tripping
- c. Sudden reduction in demand to house load

Under all above conditions, while passing the required steam flows as per the relevant heat balances, the condenser should be able to swallow the entire steam without increasing the exhaust hood temperature and condenser pressure beyond the maximum permissible values. The same shall be demonstrated.

7.8 Power Cycle Pumps

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

7.9 Condensate Polishing Unit

- a. Effluent quality at outlet of each vessel at its rated design flow and design service length between two regenerations.
- b. Pressure drop across the polisher service vessel in clean and dirty condition of resin at rated design flow.

7.10 Power Cycle Piping

Actual hanger readings under cold and hot condition (at rated parameters) to match with those of design cold and hot hanger readings for MS/CRH/HRH/HP & LP bypass piping system



7.11 Passenger & Goods Elevator

Over load tests, travel and hoist speed checks.

7.12 Mill Reject System

- a. Continuous effective discharge and conveying at the rated capacity of the mill rejects without spillage or blockage in the system.
- b. Power consumption, Capacity and discharge pressure of air compressor shall be demonstrated at shop.
- c. Parallel operation of air compressor shall be demonstrated at site.
- d. Vibration level and noise level of each air compressor, blowers and any other rotating equipment shall be demonstrated at site.

7.13 Equipment Cooling Water System

- a. Vibration, parallel operation and noise level of all the pumps at the rated duty point shall be demonstrated at site
- b. 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.
- c. Pressure drop across the Plate type heat exchanger on the primary & secondary water circuit to be demonstrated at site.

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

7.15 Air Conditioning and ventilation System:

7.15.1 Following shall be demonstrated at shop

- i) 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.



- ii) 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.

7.15.2 Following shall be Demonstrated at Site

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

7.16 Control & Instrumentation System Requirements

7.16.1 Availability Tests

The Bidder shall guarantee 99.7 percent system availability for a continuous period of 180 days. An availability guarantee test shall be conducted to assure this level of availability. If the accrued down time exceeds 0.3 percent of 180 days, during availability test run, a new 180 days test run shall start at the time when the system becomes available again. Loss of availability (unavailable system) shall be defined as the loss of the system's guaranteed accuracy and repeat ability or of any system function, except however, that the loss of a function for not more than five percent of the points shall not be considered loss of availability instead it shall be treated as partial unavailability and the corresponding outage time shall be weighted with respect to the function and the percentage of the points for which the function is unavailable. Loss of each function shall have one weighing factor and unavailability of each equipment, peripheral device or process I/O card etc. shall have another weighing factor. The guaranteed accuracy and repeatability and system parametric requirements specified in clauses on system parametric requirements shall be maintained for the entire 180 days run without any manual recalibration or any other changes made to the DDCMIS.

Downtime shall start upon loss of a system function and shall end upon full restoration of the affected system function. A minimum of one hour's down time shall be charged for each loss of availability in determining system availability.

The Bidder shall submit the Availability Test procedure for Purchaser's approval. The details regarding outage time, weighing factors for various system functions equipment to calculate the down time, test duration etc., shall be discussed and finalized during detail engineering.

7.16.2 Performance Requirement of the Closed Loop Control System

- (i) The closed loop Control System shall permit the performance of the following dynamic load tests while maintaining safe furnace conditions, major process parameters and without endangering other equipment. All tests will be performed with the system in automatic mode:



- Drop 50 percent of maximum load capability from approximately full load at a rate of 10 percent per minutes.
- Drop load from full rated output to the lowest runback limit, at a rate corresponding to the fastest run back rate
- Pick up 50 percent of the maximum load capability from approximately 50 percent load at a rate of 10 percent per minute.

During transient conditions causing deviation of process variables, the control system furnished under the specification shall not permit deviations which exceed those permitted by the manufacturers of the controlled process equipment, for load changes as indicated above. The exact parameters to be monitored for this test are given in the following table- (The Bidder as per the data shall also fill up the deviation limits from main equipment suppliers in the technical data sheet. For the test, more stringent of the two shall be applied). The control loops shall perform to return the controlled variable to the set point in a stable manner without cycling in the shortest possible time and without any loop interactions or cycling of generation when generation matches unit load demand.

PERFORMANCE REQUIREMENTS FOR CLOSED LOOP CONTROL SYSTEM (TABLE-I)

S.no.	Range	Load / Rate of load Change (% of MCR	Maximum Deviation Of Parameters from Set Point				
			Throttle pressure Deviation (kg / cm 2	Flue gas oxygen Deviation (% O2)	Furnace pressure deviation (mmwcl)	S.H. steam temperatur e deviation	R.H. steam temperatur e deviation
A	Steady state condition						
1.	90% to	0	<u>+3.0</u>	<u>+0.5</u>	<u>+3.0</u>	<u>+4.0</u>	<u>+6.0</u>
2.	60% to 90%	0	<u>+3.0</u>	<u>+0.5</u>	<u>+3.0</u>	<u>+4.0</u>	<u>+6.0</u>
B.	Ramp test (change for max. duration of five minutes)						
1.	30% to 50%	<u>+3%</u>	<u>+3.0</u>	<u>+0.6 / -</u>	<u>+7.0</u>	<u>+10.0</u>	<u>+ 10.0</u>
2.	50% to 90%	<u>+5%</u>	<u>+5.0</u>	<u>+0.8 / -</u>	<u>+12.0</u>	<u>+10.0</u>	<u>+14.0</u>
3.	90% to	<u>+10%</u>	<u>+7.0</u>	<u>+1.0 / -</u>	<u>+12.0</u>	<u>+10.0</u>	<u>+14.0</u>
C.	Step load changes						
1.	From 100% to 80%	at the rate of 10% per	<u>+7.0</u>	<u>+1.5 / - 0.5</u>	<u>+20.0</u>	<u>+15.0</u>	<u>+20.0</u>

Notes:

- a. Sufficient time shall be allowed as setting period between conducting the tests.
- b. Plant operating condition, i.e. main equipment status, availability of auxiliaries,



operational and equipment constraints, which can influence the test, shall also be recorded.

- c. Control system shall be running in the coordinated master control (CMC) mode i.e. boiler master, fuel flow, air flow, feed water and turbine load control shall be in automatic mode. Load set point, maximum and minimum load set point, rate of raise / lower of load shall be set through the OWS, keyboard / conventional console.
- d. These tests will be conducted within 30 days of attaining 80% load.

The Bidder shall also guarantee that the control system provided by him will be responsive and stable and will maintain the deviation of controlled variables from set point within the limits specified so that the equipment being controlled will operate as specified over the range required. The controls shall operate automatically, with no assistance from the operator. The controller shall successfully demonstrate the performance of Closed Loop Control Systems before acceptance and taking over of this system by the Purchaser.

- (ii) The following parametric tests shall also be conducted under worst case loading conditions (which is basically equivalent to a trip condition - details of which shall be as approved by Purchaser during detailed Purchasing.

- (a) For control system
 - CPU loading, Cycle time/controller reaction time and memory spare capacity
- (b) For MMIPIS
 - CPU loading, spares duty cycle, spare memory capacity
- (c) Spare duty cycle for system bus
- (d) Various display response time
- (e) System accuracy
- (f) LED update time

- (iii) For the parametric test, the following requirements shall be met

- (a) Processor Spare Duty Cycle (Free Time)
 - Under worst case loading of MMIPIS and system bus each MMIPIS processor shall have 40% free time when measured over any two second period and 50% free time when measured over any one minute period.
 - Under worst case loading conditions of control system control system processor shall have 20% free time when measured over any one minute period.

- (b) System Bus Spare Duty Cycle (Free Time). The Bidder shall furnish all



necessary data to fully satisfy the Purchaser that the processor spare duty cycle figures quoted by the Bidder are realistic and based on configuration and computation capability of the offered system and these shall be actually achieved in the fully implemented system as commissioned at project site.

The system bus shall have min. 50% free time during the worst case loading conditions of control system, MMIPIS and the system Bus, measured over any 2 seconds interval.

(c) Display Response Time

The system shall acknowledge all operator requests in one of the following manner within one second of pressing of the last button:

Commencement of the requested display

OR

Acknowledgment of operator request in a suitable manner.

The display response time as defined above, under the worst case loading conditions shall not be worse than the following:

1	All control related displays	1 sec
2	Point Details Display(Single point)	1-2 secs
3	Bar chart display (20 points, Current data)	1-2 secs
4	Operator guide / plant start-up Guide message display (full Screen of alphanumeric Information and a maximum Of ten numbers of dynamic Data items)	1-2 secs
5	Plant mimic display of fair Complexity with a minimum of 120 numbers of dynamic data Items e.g., values, macros, Line segment, etc.	2-3 secs
6	Group review display (current Values of twenty points)	2-3 secs
7	X-Y plot display (2 X-Y- plots And a single display requiring Both historical as well as Current data)	3-4 secs
8	X-T plot display (Trend of 6 Analog points and a single Display requiring both historical As well as current data)	3-4 secs
9	Plant Summary display (e.g.,Bad point summary, limit check Removed point summary. Assume the whole data base search is Required and the summary	3-4 secs



	display Contains ten points only).	

The response time for screen update after the execution of the control command from the time the command is issued (for example command to start a motor to the time the screen is updated) shall be two seconds (excluding the drive actuation time).

(d) System Accuracy Requirements

The overall system accuracy from signal input terminals to output presentation on LED display and printers for the least accurate input range and maximum scan rate shall be no worse than $\pm 0.2\%$ of full scale of the process range.

(e) LED Updated Rates

All LED displays shall be updated at least every two seconds.

(f) The spare capacities of working and bulk memory shall meet the requirements indicated in the technical specification.

(iv) The operating capabilities of the plant as listed out under relevant clause shall also be demonstrated along with other parameters/ capabilities specified under category-III guarantees. The treatment of these operating capabilities of compliance/ non-compliance shall be the same as given to other Cat.-III guarantees.

8.0 Major Requirements/ Method Of Steam Generator Efficiency Tests

1	Test Code	As per PTC 4
2	Test Loads	105% TMCR (VVO unit Load) 100% TMCR (800 MW unit Load)
3	Test Conditions	Boiler operating with rated excess air, coal fineness and firing design coal.
4	Ambient air condition	27 degree Celsius temperature (Dry bulb) and 72% relative humidity. The reference air temperature for the efficiency guarantee/ testing shall be taken as the temperature of air (i.e. 27 degree Celsius) entering PA and FD fans.
5	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.
6	Measurement and computation of heat losses will include but not be limited to the following: As Per PTC 4	
7	The guaranteed steam generator efficiency shall be without any heat credit.	



8	The Steam Generator efficiency shall be guaranteed based on ambient air temperature of 27 degree Celsius and relative humidity of 72%.
9	Correction to tested efficiency shall be applicable for variation in following parameter only :
i	Ambient air temperature.
ii	Relative humidity of ambient air.
iii	Hydrogen in coal.
iv	Moisture in coal.
v	GCV of coal.
vi	Percentage of ash in coal.
10	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.
11	The Bidder shall furnish the correction curves, for Employer's approval covering the expected ranges of variations for all these parameters for the range of coal specified
12	For all other aspects, not spelt out above, or in the specifications, where BS code stipulates the agreement between the parties concerned before commencement of the test, the Bidder shall get these approved by the Employer. However no correction to SG efficiency on account of variation in turbine cycle parameters, or vice versa shall be allowed.
13	The number, location, type and accuracy of the test grade thermocouples and pressure gauges shall be to Employer's approval
14	The Steam Generator efficiency testing shall be carried out with any combination of mills in operation to Employer's choice, with fineness of pulverized coal not exceeding 70% through 200 mesh.
15	Steam generator efficiency shall be with guaranteed or actual air heater leakages, whichever is higher.

9.0 MAJOR REQUIREMENTS FOR COAL PULVERISER WEAR PART WARRANTY

9.1 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/warranty shall be demonstrated on each pulveriser during the Guarantee Trial Period (GTP).

9.2 Minimum Guaranteed Life for various coal pulveriser wear parts shall be as indicated in Volume II, Section 2, Part 2.1 Mechanical Works, Clause no 2.1.1.73(n).



- 9.3 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/repared, 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, then the part shall be deemed to have outlived its wear life. The 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 9.7 below.
- 9.4 **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 INR 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 INR $(10000 \times 1.5 \times 2000) / 6000$ 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.
- 9.5 **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.
- 9.6 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 9.7 shall be followed.
- 9.7 **Pulveriser Warranty Shortfall Part Settlement (SPS) Procedure (With Example):**
For all wear parts of each vertical coal pulveriser:



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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 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)	$= \frac{S \times (25 - GTP)}{AWL \times GTP}$	$= \frac{5000 \times (25 - 2)}{12500 \times 2}$ = 4.6 = 5.0 (say) (To be rounded off to next higher whole number)

9.8 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.

- 9.9 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.

10.0 Method of Computing Heat Rate:

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

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

The expression "Mis (h1-his)" in the numerator of the formula is not applicable if spray water to superheater is completely internal to the boiler (i.e. tapped from a location downstream of economizer inlet).

Where,

M1 - Quantity of live steam entering the turbine stop valve including any live steam supplied to valve stems, or glands etc. in Kg/hr.

M2 - Quantity of steam from turbine to reheater in Kg/hr.

Mir - Quantity of desuperheating water flowing into reheater system for regulation of steam temperature in Kg/hr.

Mis - Superheater desuperheating spray flow in Kg/hr.

H1 - Enthalpy in kcal/kg of live steam.

H2 - Enthalpy in kcal/kg of steam to reheat.



H3 - Enthalpy in kcal/kg of reheated steam.

h1 - Enthalpy of feed water in kcal/kg at the downstream of the junction of feed flow and bypass flow of HP heaters.

hir - Enthalpy of desuperheating water flowing into reheat system in Kcal/Kg.

his - Enthalpy of superheater desuperheating spray water in Kcal/Kg.

Pg - Unit output after deducting the power consumption by auxiliaries as listed below

- a. Power taken by Excitation system (KW) including transformer losses, as applicable for various guarantee points, in case of static excitation system is offered. (The transformer losses at various points shall be based on factory test to be conducted).
- b. Power required for ventilation of oil and control fluid tanks, if ventilating fans are separately driven (KW).
- c. Power required for lubrication, if lubricating pumps are separately driven (KW).
- d. Power required for control fluid pumps, if control fluid pumps are separately driven (KW).
- e. Power required for hydrogen, seal oil auxiliaries, if separately driven (KW).
- f. Power required for stator water cooling system, if cooling pumps are driven separately (KW).
- g. Power required for motors, heaters etc. of any other auxiliary service for the turbine generator (KW).

It may be noted that the heat balance diagrams and guarantees shall be furnished considering zero spray water quantity for superheater and reheater spray. During Performance Guarantee Testing, in case water is required for superheater and/or reheater temperature control, the contractor shall be entitled to heat rate correction as per correction curves to be submitted by him with his offer

11.0 Method of Computing Test Efficiency of ESP

- 11.1 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.

- 11.2 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 Steam Generator shall be worked out as follows:-

- a. V_m (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 (D_i) shall be weighted mean of the inlet dust burdens for the individual streams i.e.:
- $$(V_{m1} \times D_{i1}) + (V_{m2} \times D_{i2}) + (V_{m3} \times D_{i3}) + (V_{m4} \times D_{i4}) + (V_{m5} \times D_{i5}) + (V_{m6} \times D_{i6})$$

$$D_i = \frac{(V_{m1} \times D_{i1}) + (V_{m2} \times D_{i2}) + (V_{m3} \times D_{i3}) + (V_{m4} \times D_{i4}) + (V_{m5} \times D_{i5}) + (V_{m6} \times D_{i6})}{(V_{m1} + V_{m2} + V_{m3} + V_{m4} + V_{m5} + V_{m6})}$$

Where suffix 1, 2, 3, 4, 5 & 6 represent the six gas stream.

Similarly the test outlet dust burden (D_o) will be calculated based on outlet gas flow.

- c. The weighted test inlet gas temperature (T_i) shall also be worked out in a similar manner i.e.:

$$T_i = \frac{(T_{i1} \times V_{m1}) + (T_{i2} \times V_{m2}) + (T_{i3} \times V_{m3}) + (T_{i4} \times V_{m4}) + (T_{i5} \times V_{m5}) + (T_{i6} \times V_{m6})}{(V_{m1} + V_{m2} + V_{m3} + V_{m4} + V_{m5} + V_{m6})}$$

- d. The measured test efficiency shall be :

$$E_m = \frac{D_i - D_o}{D_i} \times 100 (\%)$$

- e. The corrections for the variation in flue gas flow, inlet dust burden and ESP inlet flue gas temp. Shall be based on the above computed test values and the procedure indicated in the next para.

Note: 5th & 6th gas stream if applicable

- 11.3 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: -

a. $E_c = 1 - e^z$

Where E_c = Corrected test efficiency to guarantee point conditions.

$$Z = C \cdot \ln(1 - E_g) \text{ and}$$

$$C = \frac{1}{Ca \cdot Cb \cdot Cc \text{ etc.}}$$

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.

b. $E_g = 1 - e^y$

Where

$$Y = (V_m/V_g)^{0.5} \ln(1 - E_m)$$

E_g = Measured test efficiency corrected to the specified guarantee point flow.

V_g = Specified Guarantee point gas flow (m³/sec).

V_m = Measured gas flow (m³/sec).

E_m = Measured test efficiency

$\ln$ = Logarithm, natural base.

The correction curves should be realistic for expected range of operation and variation in characteristics specified.

The test efficiency shall be the average of at least two corrected test efficiencies.

11.4 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.

12.0 METHOD OF COMPUTING 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 ESP. 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:-



- i) 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.
- ii) 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.
- iii) 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.
- iv) 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 (iii) 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.
- v) Measured corona power consumption for one pass (say ESP-A) = $(W2-W1)$
- vi) Measured corona power of all six pass = Corona power of (ESP-A + ESP-B + ESP-C + ESP-D + ESP-E + ESP-F).
- vii) Number of fields shall be as per the PG test of ESP as detailed elsewhere.

13.0 Turbine Generator Performance/ Acceptance Test

- 13.1 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) and 800 MW (100% TMCR) output corresponding to the conditions stipulated under Clause 2.1.3.31 of Volume II, section-2 (Turbine Generator and Auxiliaries). Power consumed by the auxiliaries mentioned under clause 4.0 of this chapter 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.
- 13.2 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 Employer's approval. All the instruments including the flow nozzle shall be calibrated by the contractor before and after the test, in a reputed international institute as approved by the Employer.

However, post-test calibration of flow nozzle shall not be mandatory. These calibrations shall be performed in the presence of the Employer. All calibrations shall be made available prior to the test and calibration certificates in original submitted to Employer at least 15 days before conductance of the test for Employer's approval.

The instruments shall be sealed after calibration by calibrating lab. The percentage calibration error/deviation should not be more than accuracy class of the instrument. Calibration low beta ratio throat tap nozzle assembly including flow straightener, upstream and downstream machined straight lengths, for main condensate flow measurements shall be as per ASME PTC-6. Secondary flow devices shall be calibrated flow nozzle / orifice plate as per ASMEPTC 19.5.

- 13.3 Corrections to the test results for steam turbine shall be applied as per the correction curves listed in technical specification. When the system is properly isolated for a performance test, the unaccounted for leakages should not be more than 0.1% of the design throttle flow at that load. To achieve the above value of unaccounted for leakages, the Bidder shall prepare the unit during pretest available shutdown. However, during the test, if it is found that the unaccounted 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).

- 13.4 The performance guarantee test will be carried out after successful completion of initial operation. Ageing allowance will be given during evaluation of PG test results and hence guaranteed heat rates shall be increased by the amount calculated as per the formula given in Cl.No.3.07, Sub-Section-3 of ASME PTC-6 Report 1985 (Reaffirmed 1991). Period of ageing shall be considered from the date of successful completion of initial operation to the date of conductance of PG test,

In calculating the above factor any period(s) during which the turbine has not been in operation at a stretch for more than a week shall not be considered.

- 13.5 The tests shall be arranged in a manner that the EMPLOYER's operation is not disrupted. Duplicate test runs shall be performed at 840 MW and 800 MW loads. The results of corrected heat rate shall agree within 0.25%. If they differ by more than 0.25%, third test shall be run at



the same point. The corrected result of any one of the three test runs, which deviates from the corrected averaged result of all the runs by more than 0.25%, shall be eliminated; otherwise the results of all the three tests runs shall be accepted.

- 13.6 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 800MW corresponding to the heat balance diagram specified in the tender specification.
 - ii. Guarantee Output test of 105% rated load corresponding to the heat balance diagram specified in the tender specification.
 - iii. Maximum continuous output corresponding to both strings of HP heaters out of operation, under rated steam conditions at design condenser pressure with 1% makeup.

14.0 Performance test for the condensers

- 14.1 Performance test for design condenser pressure shall be conducted in accordance with latest edition of ASME PTC- 12.2.
- 14.2 Condenser pressure will be measured at 300 mm above the top row of tubes under VWO conditions, 1% make-up and design C.W. flow & design temperature. The condenser pressure shall be measured with a vacuum grid utilizing ASME basket tips. The grid is fitted at 300 mm above top row of condenser tubes.
- 14.3 Tube plug margin of 5%, as per design condition, shall be considered for condenser performance calculation at design condition.
- 14.4 If tube side fouling resistance for actual test condition is not measured as per methodology given in PTC 12.2, the tube cleanliness factor corresponding to the same shall be appropriately assessed considering the aspect of actual tube cleaning prior to conducting the test.

15.0 Test Reports

The Contractor shall prepare test reports for Efficiency Test, Capacity Test and the Emissions test, in which the methods followed, instrument readings, graphs, observations, final results obtained, etc., shall be recorded.



TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED
1X800MW COAL BASED SUPERCRITICAL NORTH CHENNAI THERMAL POWER PROJECT
STAGE III IN THE PREMISES OF EXISTING NCTPS TAMILNADU, INDIA

EPC BID SPECIFICATION

FOR

**DESIGN, ENGINEERING, MANUFACTURE, ASSEMBLY, TESTING AT WORKS, SUPPLY, ERECTION,
TESTING AND COMMISSIONING OF STEAM GENERATOR, STEAM TURBINE GENERATOR AND
OTHER AUXILIARY EQUIPMENTS INCLUDING CIVIL WORKS**

BID SPECIFICATION NO. SE/E/T& H (P)/OT No.02/2015- 16

INTERNATIONAL COMPETITIVE BIDDING



VOLUME-II SECTION 2

PART 2.5 - QUALITY ASSURANCE PLAN

OWNER



M/s Tamil Nadu Generation & Distribution
Corporation Limited,
Chief Engineer / Projects,
5th Floor, Western Wing, NPKRR Maaligai
144, Anna Salai, Chennai 600 002
Telefax: 044-28520878
E-mail: cepr@tnebnnet.org

CONSULTANT



Lahmeyer International India Pvt. Ltd
INTEC HOUSE, 37, Institutional Area,
Sector 44 Gurgaon, 122002,
National Capital Region, INDIA
Phone: 0124 – 4698500,
Fax: 0124 – 4698586,
E-mail: NCTPP3@lahmeyer.in

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2	VOLUME II	SECTION 1 – DESIGN BASIS CHAPTER 1 – INTENT OF SPECIFICATION CHAPTER 2 – PROJECT INFORMATION CHAPTER 3 – SCOPE OF SUPPLY & SERVICES CHAPTER 4 – TERMINAL POINTS CHAPTER 5 – PERFORMANCE GUARANTEES & LD FOR SHORTFALL CHAPTER 6 – GENERAL TECHNICAL REQUIREMENT CHAPTER 7 – PROJECT MANAGEMENT CHAPTER 8 – PAINTING CHAPTER 9 – DRAWING/ DOCUMENTS TO BE SUBMITTED SECTION 2 – TECHNICAL SPECIFICATION PART 2.1 – MECHANICAL WORKS PART 2.2 – ELECTRICAL WORKS PART 2.3 – CONTROL & INSTRUMENTATION WORKS PART 2.4 – CIVIL WORKS PART 2.5 – QUALITY ASSURANCE & INSPECTIONS SECTION 3 – TECHNICAL DATA SHEET PART 3.1 – MECHANICAL WORKS PART 3.2 – ELECTRICAL WORKS PART 3.3 – CONTROL & INSTRUMENTATION WORKS SECTION 4 – TENDER DRAWING PART 4.1 – MECHANICAL DRAWING PART 4.2 – ELECTRICAL DRAWING PART 4.3 – CONTROL & INSTRUMENTATION SECTION 5 – MANDATORY SPARES PART 5.1 – MECHANICAL PART 5.2 – ELECTRICAL PART 5.3 – CONTROL & INSTRUMENTATION

Section 2

Technical Specification

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Quality Assurance Plan
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2.5.1 QUALITY ASSURANCE PLAN-MECHANICAL WORKS

2.5.1.1 GENERAL REQUIREMENTS

a. 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

b. 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 Employer. The same shall be discussed and finalized with the Employer and six numbers of such finalized copies shall be submitted.

2.5.1.2 SHOP TESTS FOR STEAM GENERATOR

I. PRESSURE PARTS

- (i) The material which can be identified against mill sheet or manufacturer test certificate only shall be used in the manufacture of pressure parts. Material shall meet all the mandatory requirements (and supplementary checks if asked for) of specified specification.
- (ii) All Plates above 40mm & all bar stock / forgings above 40mm dia shall be ultrasonically tested. For pressure parts, plates of thickness equal to or above 25 mm shall be ultrasonically tested.

A. Separator

- (a) Each plate shall be subjected to a 100% normal ultrasonic at the mill to meet the minimum requirements of EN 10160 1999 / equivalent ASTM standards. Elevated temperature tensile tests shall also be carried out on plate material for each heat.
- (b) After cutting to size and removal of cut outs, the plates shall be subjected to magnetic particle test along the edges of the plate and on areas adjacent to the cutouts.
- (c) All forged connections shall be examined by 100% UT before machining.
- (d) Fully machined connecting pieces of internal diameter 100mm and above, shall be subjected to magnetic particle examination.
- (e) Mechanical tests shall be carried out on specimens prepared from the production control test plates of the longitudinal welds.



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- (f) Mechanical tests shall be conducted on the specimens from manhole cutouts of dished ends.
- (g) All butt welds shall be subjected to 100% radiographic examination before stress relief.
- (h) On completion of welding, the entire Separator shall be subjected to stress relieving in the furnace.
- (i) All butt welds shall be subjected to 100% ultrasonic and magnetic particle examination after stress relief.
- (j) All full penetration welds shall be subjected to ultrasonic examination after stress relief.
- (k) After stress relieving (SR) all welds, internal and external shall be examined by MPI methods depending on size and accessibility and all butt welds shall be subjected to 100% radiography.
- (l) All connecting tubes & pipes shall be subjected to UT prior to fabrication as per BS 3602 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3mm min. and 1.5mm max.)
- (m) **Hydraulic Test and Pneumatic Test:** Complete Separator shall be subjected to hydraulic pressure test and all compensating pads to be pneumatically tested.

B. Headers

- (a) Raw material for headers shall be subjected to UT prior to fabrication as per BS 3602 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3mm min. and 1.5mm max.) shall be adhered to.
- (b) All butt welds shall be subjected to RT examination. Also MPI after SR.
- (c) All full penetration nozzle and attachment welds shall be subjected to UT prior to stress relieving.
- (d) All nozzles, branches, stubs and load bearing attachment shall be examined by MPI techniques after the toes of the weld have been ground smooth and stress relieved.
- (e) Non-load bearing welds shall be examined by MPI techniques after the toes of the welds have been ground smooth and stress relieved.
- (f) Completed closed end headers shall be subjected to hydraulic pressure tests and all compensating pads to be pneumatically tested.
- (g) All weld joints in alloy steel headers of P 91, X20 and X22 & other material of P5B group and above shall be checked for Hardness. 3% hardness check shall be carried out on welds of other alloy steel Headers.

C. Tubes & Tube Elements

- (a) Raw material pipes/ tubes for water wall, superheater, reheater, Economiser, riser, supply and connecting tubes including nozzle/stubs, connections, headers Pipe work etc. shall be subjected to 100% UT prior to fabrication as per EN 10246:7 1996 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3 mm min. and 1.5mm max.) shall be adhered to.
- (b) All bent tubes/stubs shall be checked for ovality and thinning by ultrasonic method on first off and random checks on subsequent pieces.
- (c) All tubes/stubs/panels/coils shall be checked for clearance by steel ball test and for cleanliness by sponge passage.



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- (d) Finished butt welds shall be subjected to RT or UT. Wherever the code/standard/process specifies random sampling, the same shall be minimum 20%.
- (e) Minimum 10 % of the fillet joints shall be subjected to MPI/LPI. However Fillet welds of material grades P 5B and above or any other equivalent new material grade subject to the acceptance by Client/ Consultant shall be subjected to 100% MPI/ LPI.
- (f) Tubes and fabricated panels/coils shall be subjected to hydraulic pressure test excluding loose tubes but including burner panels, reheaters, super heaters & economizers.
- (g) 10% hardness survey on butt welds of P5B material group and above.
- (h) In case of RT of tube welds with DWDI (elliptical view) number of exposure shall be as per relevant code/ plant standard and will not be less than two exposures for each weld.

D. Boiler Piping

- (a) All raw materials used shall have co-related mill test certificate meeting material specification.
- (b) All pipe lengths shall be subjected to 100 % ultrasonic examination as per EN 10246:7 1996 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3mm min. and 1.5mm max.) shall be adhered to.
- (c) All bent pipes shall be checked for ovality and thinning by UT on first off lot & on random samples for subsequent pieces. Outer surface of bends shall be subjected to MPI/LPI.
- (d) The edge preparation for shop and site welds in stainless steel /alloy steel shall be subjected to a dye penetrant check. Non-destructive examination of welds shall be carried out after post weld heat treatment, if any.
- (e) All butt welds in alloy steel piping of P91, X20 and X 22 shall be checked for RT/ UT and MPI after SR. UT shall be of Digital Recordable Type.
- (f) All weld joints in alloy steel piping of P 91, X20 and X22 & other material of P5B group and above shall be checked for Hardness. For PWHT Induction Heating shall be deployed. However PWHT can be done in furnace also. 3% hardness check shall be carried out on welds of other alloy steel piping.
- (g) All load bearing attachment welds shall be subjected to MPI after SR.
- (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. Further statutory requirement, wherever applicable shall also be complied with.
 - 1 Temperature > 400 Deg, C and/or pressure exceeding 71 bar.
 - i. 100% RT/UT on butt welds and full penetration branch welds.
 - ii. 100% MPI.
 - 2 Temperature > 175 Deg, C upto 400 Deg. 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.
 - ii. 10% RT/UT on butt welds and full penetration branch for pipe dia upto 100NB.
 - iii. 100% MPE.



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- 3 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.
- i. Wherever SR/PWHT is envisaged for alloy steel, above NDTs shall be after SR/PWHT.

E. Fittings

- (a) Raw material of all forged fitting shall be ultrasonically tested. All mother pipes used for formed fitting shall be ultrasonically tested as per BS 3602 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3mm min. and 1.5mm max.) shall be adhered to.
- (b) Fittings shall be subjected to suitable NDT as per applicable standards. However following minimum. NDE requirement shall also be applicable / met.
- i. 100% RT/UT shall be carried out both on alloy steel fittings and on carbon steel fittings.
- For use above 71 bar design condition.
- For use above 400°C design condition.
- ii. For fittings X20, P-91 and material group 5B & above
- 100% MPI &
- 10% hardness check &
- For fittings of 200 NB & above 100% UT/RT
- iii. 100% UT/RT for fittings of 200 NB & above for boiler feed discharge, recirculation and spray piping of boiler feed system.
- iv. 100% UT/RT for fittings of all other piping of size OD 508mm & above.

F. VALVES

- (a) Pressure retaining parts of valves shall be subjected to (min.) NDT as per Table A.
- (b) Hardened/stellitted valve disc and seat are to be subjected to LPI and hardness check.
- (c) Color matching of valve disc/plug and seat shall be carried out to ensure min. 80% contact and no through passage.
- (d) Hydraulic pressure test and seat leak test shall be carried out as per ANSI 16.34/ IBR.
- (e) Air seat leak test shall be carried out as per applicable Standards/Codes.
- (f) 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.
- (g) Springs for safety valves shall be tested with suitable NDT and for spring rate.
- (h) Safety and safety relief valves shall be tested for performance.
- (i) All forgings rounds above diameter 40 mm shall be ultrasonically tested

Table - A

NDT REQUIREMENTS FOR PRESSURE RETAINING COMPONENTS OF VALVES

Valve size NB in mm	ANSI Class up to 300	ANSI Class above 300 up to 600	ANSI Class above 600 below 900	ANSI Class 900 & above & below 4500



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Less than 50	Visual	Visual	Visual	MPI
50 & above But below 100	Visual	Visual	MPI	MPI & RT (on 10% of valves on 100% area)
100 & above but less than 300	Visual	MPI	MPI & RT (on 10% of valves on change of section & weld ends)	MPI & RT (on 100% area)
300 and above	MPI	MPI	MPI & RT (on change of sections & weld ends)	MPI, RT on 100% area)

Note:

For body and bonnet forgings UT with MPI may be adopted in place of RT.
For austenitic steel MPI may be replaced by LPI.

G. Non Pressure Bearing Attachments

Load bearing welds shall be subjected to examination by ultrasonic testing (UT) and magnetic particle inspection (MPI) techniques after stress relief (SR). No load bearing welds shall be subjected to MPI after stress relief. The toes of the welds adjoining the /separator shall be ground smooth prior to stress relieving before carrying out this examination.

H. Fuel oil heater

Hydraulic pressure test shall be carried out on the heating coils. All pipes, valves steam traps and mountings shall be subjected to hydraulic test as called for under IBR, BS or other approved codes.

I. Soot Blowers

- (a) Butt weld between nozzle and lance tube shall be subjected to 20% radiography tests.
- (b) Hydraulic test on valve body
- (c) Soot blower shall be subjected to operational checks as below:
 - 1. Smooth operation
 - 2. Long Tube travel, closing and opening time.
 - 3. Current drawn.

J. Steam Generator Boiler Start up Drain Re-circulation Pump

- (a) Raw material for casing, shaft and impeller shall be tested for high temperature physical properties, apart from mandatory & supplementary check of material specification.
- (b) All forging and castings shall be subjected to 100% UT/RT and MPI/DP check.
- (c) Static and dynamic balancing of the rotary parts shall be carried out.
- (d) Hydraulic pressure test shall be conducted on pumps casing at min. 1.5 times the Design Pressure.
- (e) Interchangeability shall be maintained and checked.
- (f) Each pump shall be subjected to a performance test at the manufacturer's works under as near actual site conditions as possible.
- (g) Following test shall be carried out on assembled units : -

Type Test:

- i. NPSH test



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- ii. Temperature rise test.
- iii. Under voltage test.
- iv. Quality assurance proof test.
- v. Tests to establish unit functioning of pump at temp and pressure.
- vi. Hot standstill and start up tests.

Routine Test:

- i. Hydrostatic test of complete unit.
- ii. Overspeed test.
- iii. Tests to determine unit characteristics
- iv. Pump performance.
- v. Unit run at rated voltage
- vi. Starting current at rated voltage.
- vii. Cold start up test.
- viii. Endurance test of motor windings, joints and terminal seals
- ix. Noise level.
- x. Inspection of dismantled unit.
- xi. High voltage test.
- xii. For heat exchanger for these pumps, butt welds on pressure parts shall be tested with RT/UT and all other welds shall be tested with MPI/LPI. Hydraulic test shall be carried out both on tube side as well as shell side at min. 1.5 times the design pressure.

K. Hydraulic Test

- (a) All components which are to be subjected to fluid pressure shall be tested to minimum of 150% of the design pressure. In determining the value of the maximum attainable pressure for any component the contractor shall take in to account all relevant factors (e.g. safety valve blow off pressure, fluid surges, etc.) which may cause an elevation in the pressure. The contractor shall furnish details of the basis of the calculation of maximum attainable pressure tests. The duration of the pressure tests shall be sufficient, as approved by the Engineer, to show any leakage paths and to permit a through examination of the component whilst under pressure.
- (b) The temperature of the fluid used for the pressure test shall be such as to avoid any possibility of brittle fracture at a low temperature and the same to be modified and submitted to the Engineer for approval, before commencing the test.
- (c) The fluid used shall be of a sufficient purity and where relevant, inhibits to avoid excessive corrosion and /or damage to temporary parts either during the test or prior to drying and cleaning.

L. Pneumatic Test of Compensating Pads:

All compensating pads shall be provided with two-threaded weep holes to test welds at 0.5Kg/sq.cm (g) with soap solution and "no leakage" shall be ensured.

2.5.1.3 ROTATING AND OTHER EQUIPMENTS/ITEMS FOR STEAM GENERATOR

- (a) The material which can be identified against mill sheet or manufacturer test certificate only shall be used in the manufacture of pressure parts. Material shall meet all the mandatory requirements (and supplementary checks if asked for) of specified specification.



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- (b) For sleeve bearing, UT shall be carried out on the babbitting of bearing. Dye penetrant check shall be done on edges.
- (c) Blue matching is to be performed between components.
- A. Air Preheater**
 - (a) Forged shafts coming under air preheater like stub shaft, main rotor forging, housing hub shall be subjected to 100% UT at mill and magnetic particle inspection after machining.
 - (b) For non-modular design trial assembly is to be carried out at shop prior to dispatch to site.
 - (c) Critical welds of rotor post shall be subjected to radiographic examination.
 - (d) Trial run of Air preheater Rotor drive assembly (Gear Box + pinion + Electric motor + air motor) needs to be carried out at shop
- B. Fans: Induced Draft, Forced Draft and Primary Air fans and GR fans**
 - (a) Rotor components i.e. shaft and hub shall be subjected to ultrasonic test at mill and magnetic particle examination after rough machining.
 - (b) 10% of Butt and fillet welds both in rotor and static components of the fan shall be subjected to MPI /DPT after stress relieving.
 - (c) Fan impeller shall be balanced dynamically to quality grade 2.5 of ISO 1940.
 - (d) **Test for Natural Frequency of Fans**
Full range performance test shall be carried out on one fan of each type and size as per BS 848, Part-1.
- C. Fans: Seal air Fan, Scanner air fans**
 - (a) Rotor components i.e. shaft and hub shall be subjected to ultrasonic test at mill and magnetic particle examination after rough machining.
 - (b) 10% of Butt and fillet welds both in rotor and static components of the fan shall be subjected to MPI / DPT after stress relieving.
 - (c) Fan impeller shall be balanced dynamically to quality grade 2.5 of ISO 1940.
- D. Coal Mills, PF Piping and Burners**
 - i. Raw material for shaft, coupling, gears and pinions, top and bottom races and other rotating components shall be subjected to UT. MPI/LPI shall be carried out to check surface soundness.
 - ii. Wear-resistant parts shall be UT/ RT tested to check soundness after suitable heat treatment. Check for chemical composition, hardness and microstructure shall be carried out. For ceramic materials check for various properties including hardness, density, wear rate and composition shall be carried out.
 - iii. Butt welds in the tube/ separator /body casing of the mill shall be tested by RT and MPI. All other welds in main tube/separator shall be tested by MPI/LPI for acceptance. The tube shall be statically balanced.
 - iv. All gearboxes shall be run tested for adequate duration to check rise in oil temperature, noise level and vibration. Check for leak tightness of gear case also shall be performed.
 - v. Fabricated pipe welds should be examined by MPI.



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- vi. Ceramic/basalt lined piping/bends shall be checked for proper layout.
- vii. Weldments on burner components shall be checked with suitable NDT. The burner assemblies shall be tested for operation at shop.
- viii. Trial assembly (stacking) of at least one Mill complete with all major components needs to be carried out at shop.

E. Coal Feeders

- (a) Any welds in the casing/ pulley fabrication shall be checked with MPI.
- (b) Type tests including degree of protection and routine tests shall be done as per relevant Indian Standards or equivalent International Standards.
- (c) All major items like plates for casings, head pulley, tail pulley, Pulley shaft and major castings shall be procured with respective material test certificates.
- (d) Explosion proof test at 50 psi as per NFPA code shall be done as type test. Leak tightness test shall be done on individual feeder casing. Endurance test for load cell shall be carried out.
- (e) Test for weighing accuracy, calibration and repeatability shall be carried out at various speeds by a coal flow on one feeder.
- (f) Calibration check shall be carried out on all feeder cabinet/assemblies prior to dispatch

F. EOT Cranes

- 1 Hooks
 - i. All Tests including Proof Load Test as per relevant IS shall be carried out.
 - ii. MPI/DPT shall be carried out after proof load test.
- 2 Steel Casting
 - i. DPT on machined surface shall be carried out.
- 3 Girders, End Carriage, Crab, Gear Box, and Rope
 - i. The plates of thickness 25mm and above shall be ultrasonically tested.
 - ii. 3.02 NDT requirements on weldments shall be as follows:

a.	Butt Welds in Tension	100% RT and 100% DPT
b.	Butt Welds in Compression	10% RT and 100% DPT
c.	Butt Welds in Rope	100% RT and 100% DPT
d.	Fillet Welds	Random 10% DPT

- 4 FORGINGS (wheel, gears, pinions, axle, hooks & hook trunion).
 - i. All forgings greater than or equal to 50 mm diameter or thickness shall be subjected to Ultrasonic test.
 - ii. PT/MPI shall be done after hard facing and machining.
- 5 Wire rope shall be tested as per relevant standard.
- 6 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, temperature rise, noise and vibration.



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- 7 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.
- 8 All electric hoists shall be tested as per IS-3938 and chain pulley blocks shall be tested as per IS-3832.

G. Lube Oil systems/ Hydraulic Power Pack

Lube Oil system/ hydraulic power packs shall be tested for performance.

Fans & pumps which are not mentioned in other clauses above shall be dynamically balanced and functionally tested at Manufacturer's works. Complete performance tests shall be carried out on first pump/fan of each type and capacity to verify its output against total head, power input, efficiency, vibration and noise level. Head/volume, efficiency and power input curves corrected for site conditions shall be furnished.

H. Dampers

- (a) All the dampers shall be subjected to operational test/checks.
- (b) Leak tightness of test of Dampers / Gates.
- (c) All dampers shall be checked for sealing dimensions to establish guaranteed tightness.

I. Boiler Structure, Ducts, Hoppers etc.

Steel Structure of Boiler, Mill Bunker building including Coal bunkers, Coal transfer points. Coal conveyor galleries and supporting trestles, Ducts, Hoppers, etc

- (a) Only material which has been identified against mill sheet or test certificates shall be used for construction. All plates above 40mm thickness shall be 100% ultrasonically tested.
- (b) Visual inspection of all welds shall be performed in accordance with AWS D.1.1.
- (c) NDT requirements of structural steel welds (other than Coal Bunkers) shall be as under:-
 - i. 100% RT/UT on butt-welds of plate thickness > 32 mm.
 - ii. For plates of thickness > 25mm & < 32mm - 10% RT and 100% MPI
 - iii. For plates of thickness < 25mm - 10% MPI/LPI.
 - iv. All fillet welds of built up plate girders shall be inspected 100% by MPI.
- (d) (Edge for field weld shall be examined by MPI for plate thickness > 32mm. Edge for field weld for ceiling girders shall be examined by UT for 100mm from the edge).
- (e) Ceiling girders/columns, ducts hoppers & tunnels shall be trial assembled and match marked prior to dispatch/erection. At least two consecutive girders along with cross member shall be assembled at a time.
- (f) Production test coupons for Butt and fillet welds of Main columns, ceiling grinders shall be carried out.
- (g) Coal Bunkers / Bins
 - i. 10% DPT after back gouging.
 - ii. 5 % spot radiography test on butt welds. Where access not available, UT shall be carried with prior approval of Client/Consultant.
 - iii. Full penetration welds (other than butt welds) shall be subjected to 10% Ultrasonic testing.

J. Hangers & Supports:



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

K. Metallic Expansion Joint (if applicable)

- (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 penetrant 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.
- (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 Client/Consultant 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 Employer.

L. Thermal Insulation, Lagging & Cladding:

(a) Lightly resin bonded mineral wool:

LRB mattresses/sections of Rockwool/ Glass wool shall confirm to & tested as per relevant clauses of Indian Standards. Type tests except Thermal Conductivity shall be regularly carried out once in three months, Thermal Conductivity Type Test shall be carried out minimum once in twelve months by the manufacturer. Requirements of various components like Binding wires, Lacing wires, Wire mesh, etc. shall be as per specification.

(b) Castable Refractory:

Fire Bricks / Castable Refractory confirming to & tested as per relevant clauses of Indian Standards and shall meet the requirements of specification. Castable Refractory shall have proper identification, supplier name, customer name, Batch No., Date, material name & Net weight in Kgs. with proper instructions for handling.

(c) Lagging & Cladding:

All insulation shall be protected by means of an outer covering of Aluminium sheeting confirming to ASTM B-209-1060 temper H14 from reputed manufacturer meeting the requirements of specification



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2.5.1.4 FIELD /ERECTION CHECKS FOR STEAM GENERATOR & AUXILIARIES.

Raw Material, In process and Non Destructive Testing indicated during manufacture shall be applicable for site fabrication/erection of the respective item.

- (a) All rotary equipment's shall be checked for its direction of rotation and free movement after placing it on the foundation.
- (b) All Valves shall be checked for its direction of flow.
- (c) Insulation shall be carried out only after satisfactory inspection of leak test.
- (d) Erection checks, tolerance limits and Quantum of NDE are indicated in respective Drawing, Field Quality plan and Field Welding Schedule.

A. Hydraulic Tests of Pressure Parts

On completion of erection of Steam Generator, Piping and Auxiliaries, the unit with its fittings and mountings in position shall be subjected to hydraulic pressure test in accordance with requirements of Indian Boiler Regulations.

Water used for hydraulic test shall be made alkaline by addition of suitable chemicals. After the test, the steam generator shall be drained and suitably preserved.

2.5.1.5 POWER CYCLE PIPING

H.P.PIPING FOR STEAM GENERATOR AND AUX.

1. Piping:

- a. All raw materials used shall have co-related mill test certificate meeting material specification. All test, as given in respective material code (other than supplementary requirements), shall be carried out as minimum. This includes the tests wherein it is specified in the ASTM code that the tests is to be carried out when specified by the purchaser or any such indication, in the code.
- b. All pipe lengths shall be 100 % ultrasonic tested. However for critical piping applications (Main Steam, CRH, HRH, Feed water, spray to superheater and Reheater, HP/LP Bypass, Upstream of Aux PRDS and any other system in which alloy steel is used) shall be subjected to 100% ultrasonic examination as per EN 10246:7 1996 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3 mm min. and 1.5mm max.) shall be adhered to.
- c. The edge preparation for shop and site welds in stainless steel /alloy steel shall be subjected to a dye penetrate check.
- d. Pipe bend shall be checked for ovality and thinning by ultrasonic or other acceptable methods on first off lot & on random samples for subsequent pieces for high pressure applications. Outer surface of bends shall be subjected to magnetic particle examination/LPI.
- e. Non-destructive examination of welds shall be carried out after post weld heat treatment, if any.
- f. 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.



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- g. For welds in P91, X20 & X22 and material P5B group & above Materials requiring heat treatment, induction type of heating shall be deployed for post weld heat treatment, or heat treatment can be carried out in furnace.
- 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. Further statutory requirement, wherever applicable shall also be complied with
 1. Temperature > 400 Deg. 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 Deg. C up to 400 Deg. 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.
 - ii. 10% RT/UT on butt welds and full penetration branch for pipe dia up to 100NB.
 - iii. 100% MPE.
 3. 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.
 - i. Wherever SR/PWHT is envisaged for alloy steel, above NDTs shall be after SR/PWHT.
- j. 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).

2. Fittings:

- a. Raw material of all forged/formed fitting shall be ultrasonically tested. All mother pipes used for fitting shall be ultrasonically tested or hydraulic tested. Forged fitting shall be ultrasonically tested and formed fittings shall be MPI tested.
- b. Fittings shall be subjected to suitable NDT as per applicable standards. However, following minimum NDE requirements shall be applicable / met.
 - i. 100% RT/UT shall be carried out both on alloy steel fittings and on carbon steel fittings.
 - For use above 71 bar design condition.
 - For use above 400°C design condition.
 - ii. For fittings X20, P-91 and material group 5B & above
 - 100% MPI &
 - 10% hardness check.
 - Also 100% UT/RT, For fittings of 200 NB & above
 - iii. 100% UT/RT for fittings of 200 NB & above for boiler feed discharge, recirculation and spray piping of boiler feed system.
 - iv. 100% UT/RT for fittings of all other piping of size OD 508mm & above.

3. Hangers & Supports:



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

4. Thermal Insulation & Lagging, Cladding:

a. Insulation:

Insulation shall confirm to and tested as per relevant clauses of Indian Standards and shall meet the requirements of specification. Type tests except Thermal Conductivity shall be regularly carried out once in three months, Thermal Conductivity Type Test shall be carried out minimum once in twelve months by the manufacturer. Requirements of various components like Binding wires, Lacing wires, Wire mesh, etc. shall be as per specification.

5. Lagging & Cladding:

Aluminium sheeting confirming to ASTM B-203-1060 temper H14 from reputed manufacturer meeting the requirements of specification.

6. Valves:

- a. Pressure retaining parts of valves shall be subjected to (min.) NDT as per Table 1.
- b. Hardened/stellitted valve disc and seat are to be subjected to LPI and hardness check.
- c. Color matching of valve disc/plug and seat shall be carried out to ensure min. 80% contact and no through passage.
- d. Hydraulic pressure test and seat leak test shall be carried out as per ANSI 16.34/IBR.
- e. Air seat leak test shall be carried out as per applicable Standards/Codes.
- f. Functional testing shall be carried out on each valve to check the following as per the approved valve data sheet
 - i. Smooth operation
 - ii. Valve travel, closing and opening time.
 - iii. (Current drawn by actuators.
- g. Springs for safety valves shall be tested with suitable NDT and for spring rate.
- h. Safety and safety relief valves shall be tested for performance.
- i. All forgings rounds above diameter 40 mm shall be ultrasonically tested

Valve size NB in mm	ANSI Class up to 300	ANSI Class above 300 up to 600	ANSI Class above 600 below 900	ANSI Class 900 & above & below 4500
Less than 50	Visual	Visual	Visual	MPI
50 & above But below 100	Visual	Visual	MPI	MPI & RT (on 10% of valves on 100% area)



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100 & above but less than 300	Visual	MPI	MPI & RT (on 10% of valves on change of section & weld ends)	MPI & RT (on 100% area)
300 and above	MPI	MPI	MPI & RT (on change of sections& weld ends)	MPI, RT on100% area)

NOTE: For body and bonnet forgings UT with MPI may be adopted in place of RT for austenitic steel MPI may be replaced by LPI.

7. Metallic expansion Joint (if applicable)

- Hydraulic pressure test shall be carried out on each pipe and expansion bellow.
- Longitudinal butt weld on bellow shall be subjected to suitable NDT examination before forming, and after forming MPE / DP test shall be carried out.
- All welds shall be subjected to 100% magnetic particle/dye pentrant check and butt welds shall be subjected to 100% radiographic testing.
- All the bellows subjected to vacuum service shall be subjected to vacuum test.
- 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.
- 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).
Expansion Joints Manufacturers Association (EJMA) test reports may be furnished by manufacturer for consideration and approval of Employer.

8. CHEMICAL DOSING SYSTEM

- Pumps of chemical dosing system shall be performance tested as per relevant international codes.
- Dosing skid shall be subjected to leakage test and functional test.
- Oxygen cylinders shall be as per relevant standard meeting statutory requirements.



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Low Pressure Piping

	Tests/Check Items / Components	Material Test	DPT/ M PL	Ultrasonic Test	WPS/ WQS/ PQR	Balancing	Hydraulic / Water Fill Test	Pneumatic Test	Assembly Fit up	Dimensions	Functional / Operational Test	Performance test	Other tests	All Tests As per relevant Std	Adhesion / Spark Tests	Remarks
1.	Pipes & Fitting And Metered Bends	Y ^a	Y ^b		Y		Y			Y			Y ¹⁵			
2.	Diaphragm Valves	Y ^a					Y ⁵			Y				Y ⁶		
3.	Butterfly Valves(Low Pressure)															
a)	Casted Butterfly Valves						Y		Y	Y	Y		Y ⁷			
i.	Body (Cast)	Y ^a	Y ^b													
ii.	Disc (Cast)	Y ^a	Y ^b													
iii.	Shaft	Y ^a	Y	Y ^c												
b)	Fabricated Butterfly Valves															Refer Note 14
4.	Gate/Globe/Swing Check Valves	Y ^a	Y ^b	Y ^c			Y ⁵	Y	Y	Y	Y		Y ⁸			



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5.	Dual Plate Check Valves	Y ^a	Y ^b	Y ^c			Y	Y	Y	Y	Y		Y ⁴			
6.	Rolled & Welded Pipes	Y ^a	Y ³		Y		Y ¹			Y						
7.	Coating & Wrapping Of Pipes	Y ²											Y ²			
8.	Tanks & Vessels	Y ^a	Y ^b		Y		Y						Y ¹¹			
9.	Strainers	Y ^a	Y ^b				Y									
10.	Rubber Expansion Joints	Y ^a					Y ¹²		Y				Y ¹³			
	Tests/Check Items / Components															
11.	Rubber Lining of Pipes	Y ^a	X		X		Y			Y				Y ⁹	Y	
12.	Hangers & Supports	Y ^a								Y						
13.	Fasteners	Y ^a		X				X								
14.	Site Welding		Y ¹⁰		Y		Y									

Notes:

1. Weld Joints not Subjected to hydraulic test shall be subjected to 100% RT.
2. Spark Test, Adhesion Test and Material Test for primer and enameled & Coal Tar Tapes as per AWWA0-C-203-91
3. DPT on route run and after back gouging and on finish welds.
4. Dry Cycle Test (Dual Plate Check Valve) 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.



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6. Test on rubber parts per batch of rubber mix such as hardness, adhesion, spark test, bleed test and flex test on 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 Employer's 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. Hardness, Bleeding Test and Ozone resistance test shall be done on rubber material.
10. Dry film thickness check, humidity check, pipe temperature check, adhesion check and Holiday Detection test shall be done.
11. 10% of welds shall be subjected to DPT.(100% DPT for compressed air line and boiler & deaerator fill line.)
12. Pressure drop across the strainer for each type and size as a special test shall be carried out. In case of already carried out, the test report shall be submitted for review and acceptance by Client/Consultant.
13. During hydraulic and vacuum test 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%.
14. 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.
15. In addition of all tests as indicated for cast Butter Fly valve being applicable for fabricated butterfly valves, following test shall be done for fabricated butter fly valves:"
 - i. UT as per ASTM A-435 on plate material for body and disc shall be carried out for plate thickness 20mm and above.
 - ii. 100% RT and DPT as per ASTM, section-VIII, Division-I, on butt Joints of body and disc. 10% DPT on other welds shall be done.
 - iii. Post weld heat treatment as per ASME, Section-VIII, Division-I on butt Joints of body and disc if thickness is more than 30mm
 - iv. Welders and WPS shall be qualified as per ASME`-section IX.
 - a) One per heat/heat treatment batch/lot.
 - b) On machined surfaces only for castings and on finished butt welds.
 - c) For shaft/spindles > or =50mm



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16. If applicable: Segmented flange exceeding 30 mm thickness shall be stress relieved and not more than 4 segments is allowed. For stainless segmented flanges and stainless steel fabricated fitting, 100% radiography of all weld seams including mother pipe weld seam shall be employed.
17. If applicable: For pressure vessel welds RT shall be done as per design code requirements



2.5.1.6 STEAM TURBINE AND ASSOCIATED EQUIPMENT

A. High Pressure & Intermediate Enclosure

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).

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 employer's 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 employer's approval.
- d. Unspecified alloying elements shall be controlled as per the applicable standard.

Each casting shall be subjected to magnetic particle examination on the entire inner and outer surfaces after heat treatment.

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 on established practice of manufacturer. Bidder to furnish their practice in this regard for Employer's approval.

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 areas shall be submitted along with certificates. Hardness survey shall be carried out on the repaired area.

Where stub pipes and transition pieces are welded to the main body of an enclosure the following shall be carried out:

- i. Radiographic examination and Magnetic particle or dye penetrant examination of weld preparation.
- ii. Magnetic particle examination of finished welds after stress relief.
- iii. Radiographic or ultrasonic examination of finished welds.



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- 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.
- v. Hardness survey on the weld joint, HAZ and parent material.
Wall thickness measurement by ultrasonic for critical and highly stressed zones of the casting shall be carried out.
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.

B. Low Pressure Enclosure (Fabricated)

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

a.	Butt welds	10% RT or UT and 10% MPE/DP test
b.	Fillet welds	10% MPE/DPT
c.	Nozzle welds	10% MPE/DPT
d.	Lifting lug & other load bearing fillet welds	100% MPE/DPT
e.	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 Employer's approval.
- e. Feeler gauge tightness check from inside and outside to ensure required joint tightness shall be carried out.

C. Rotors

Forgings

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

- 1. 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:



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Steels chosen for design metal temperatures less than 400°C are exempt from creep /stress rupture testing.

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 employer's approval.

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 employer's approval.

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 forging. Supplier should furnish the proposal, along with scanning plan and probe angles to be used, for Employer's 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.

Complete Rotors

- 1 Axial & radial run-outs and surface finish checks shall be carried out before and after blading and after overspeed tests. Run out examination will be carried out at blade shrouds also.
- 2 Check for clearance between rotor groove and blade at the root.



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- 3 Rotors shall be dynamically balanced at rated speed.
- 4 An overspeed test shall be carried out during which the rotor shall withstand an overspeed of 120% for five continuous minutes. If bidder's practice is different from as stated above, then same shall be furnished to Employer's approval. During this test vibration measurement and analysis shall be carried out.
- 5 After blading and again after overspeed 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 tangentials, wheel axials and group axials.
- 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 overspeed.
- 7 Lock blade lift after the overspeed shall be checked and record for same shall be maintained.

D. 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 overspeed 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 :-
100% radiography and 100% MPI on blades.



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100% hardness testing.

Mechanical testing and metallurgical testing.

Weld repair shall not be permitted unless prior approval of Employer is obtained.

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

E. Diaphragms

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.

Cast/Forged/Machined Diaphragms

- 1 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 employer's 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.

Colour matching of all the diaphragms by putting two halves together, and feeler gauge tightness check shall be carried out. .

F. 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



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- required to be carried out for maximum test duration of 1000 hrs/mutually agreed parameters for employer's 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 employer's approval.
 - iv. Unspecified alloying elements shall be controlled as per the applicable standard.
 - b. Dye penetrant checks shall be carried out on stellited / nitrided 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.

G. Cast and Forged Steel Components

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

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.

Each pressure containing enclosure shall be subjected to a hydraulic pressure test at 1.5 times the design pressure.



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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

H. 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.

I. 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. Nitrided and stellited components will be subjected to DPT and hardness check.

J. Inspection of Completed Turbine

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 Employer's 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 overspeed governor etc. This is indicative check only. However, the details shall be finalised during QP finalisation stage.

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



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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. (To this end the vendor shall give details of their normal works practice. In order to prove the compliance with design of the steam turbine control and emergency control equipment, functional tests shall be carried out in the manufacturer's works).

These tests shall be:

- a. Part of a no-load run under steam and / or
- b. By approved rig tests.

2.5.1.7 AUXILIARIES OF STEAM TURBINE

A. Bearing Pedestals and Bearings

Cast Pedestals & Housing

Leakage tests shall be conducted on pedestals.

Fabricated Pedestals & Housing

- 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.

Bearings shell

- 1 The shell and castings\forgings shall be subjected to suitable nondestructive 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.

B. 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.

2.5.1.8 LUBRICATING OIL, JACKING OIL AND CONTROL OIL SYSTEMS

1. Pumps

- a. Main oil pump shaft shall be subjected to ultrasonic examination. Butt welds shall be subjected to RT/UT.



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- b. 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.
- c. 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.
- d. 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 Employer for approval.

2. Oil purifiers.

- i. All pressure parts will be subjected to hydraulic pressure test.
- ii. 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.
- iii. All rotating parts like bowl assembly etc, shall be subjected to static and dynamic balancing test.
- iv. 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. Refer relevant clauses of the specification for other items such as piping, heat exchangers, valves, filters, blowers / exhausters etc. in this system.

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

1. SHELL, HOTWELL, WATER BOXES, DOORS AND TUBESHEETS

- 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 atleast 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 Employer's approval. Trial insertion of a few tubes through main tube plates and support plates shall be carried out to ensure



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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.

- 2. Condenser Tubes shall be tested as per the requirements of relevant codes and standards.

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.

4. SPRING ASSEMBLY

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

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

i. 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.

The complete package shall be subjected to hydraulic pressure and leakage test and shop tested to check interlocks and functional requirements. The one



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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.

**2.5.1.11 FEED WATER HEATER, DRAIN COOLERS, GLAND STEAM CONDENSER, HEAT EXCHANGERS
& PRESSURE VESSELS / STORAGE TANKS**

- a. All raw materials used shall have co-related mill test certificate meeting mandatory and supplementary checks of material specification.
- b. Material for Tube plates shall be ultrasonically tested. Finished plates shall be subjected to suitable NDT. For clad plates, bonding shall be checked by UT. Vendor shall furnish their practice regarding manufacturing & NDT for supply of clad plates for Employer's review. Drilled Tube plates shall be checked for ovality of holes, ligaments, surface finish etc.
- c. 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.
- d. Butt Welded / Full penetration joints shall be checked by suitable RT / UT. Fillet welds shall be checked by MPI / DPT.
- e. Tubes shall be tested as per the relevant codes / specification / standards.
- f. 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.
- g. 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 hydrotest, 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.

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

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.



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- 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 $> 400^{\circ}\text{C}$ and / or pressure exceeding 71 bar.
100% RT/UT on butt welds and full penetration branch welds.
100% MPE.
 2. Temperature $> 1750^{\circ}\text{C}$ up to 4000°C and / or pressure exceeding 17 bar and up to 71 bar.
100% RT / UT on butt welds and full penetration branch welds for pipe dia more than 100 NB.
10% RT / UT on butt welds and full penetration branch welds for pipe dia up to 100 NB.
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.
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.
- j. 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.



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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 penetrant 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.
- 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 employer 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 Employer.

3. Rubber Expansion Joint

- a. Rubber compound test slab after vulcanising 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 fibre 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 alongwith control rod assembly shall be subjected to deflection test under design pressure. The details of test procedure shall be subjected to approval by employer.
- 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.



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- 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%.
- i. 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 employer in earlier projects for the same type / size /design, test certificate for the same may be furnished for approval of Employer.

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.

5. Hangers and Supports

- 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.
- e. Complete hanger will be subjected to performance test and load test.

2.5.1.13 VALVES

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.



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**TABLE-1
NDT REQUIREMENTS FOR PRESSURE RETAINING COMPONENTS OF VALVES**

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

Note:

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

1. Extraction Line Valves

- a. Surface crack examination and hardness check shall be carried out on all hard faced/stellited 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 Employer for approval.



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2. 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 vulcanising 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 employer.
- 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.
 - i. Smooth uninterrupted movement of valve.
 - ii. Closing and opening time.
 - iii. Current drawn by actuator.
 - iv. 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.

2.5.1.14 MISC. ITEMS / EQUIPMENTS

A. FILTERS / STRAINERS

Filters / strainers shall be tested as per the requirements of relevant codes / standards.

Filters / strainer shall be performance tested for pressure drop, flow, particle size. If performance test is earlier established, then records shall be reviewed.

B. BLOWERS/ EXHAUSTERS

Rotors shall be dynamically balanced. Leakage tests (if applicable) shall be carried out.



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Performance tests including noise and vibration tests shall be carried out as per relevant standards / codes.

C. LP CHEMICAL DOSING SYSTEM

Pumps of chemical doing system shall be performance tested as per relevant international codes.

In case of diaphragm type of pumps, the life cycle test shall be done on pumps. If this test is already conducted for same model in earlier projects of TANGEDCO, then TCs for same shall be reviewed.

Dosing skid shall be subjected to leakage test and functional test.

2.5.1.15 ELECTRICAL AND CONTROL & INSTRUMENTATION:

Refer Electrical and Control & Instrumentation Sections.

2.5.1.16 SITE TEST:

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

A. 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.

B. 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 employer.
- 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 upto the tip of the last stages of blades of LP cylinder.



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- g. Condenser water boxes shall be tested hydraulically at a minimum test pressure of 1.5 times the design pressure.

C. 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 programme of turbine for Employer's approval.

**2.5.1.17 CONDENSER ON LOAD TUBE CLEANING SYSTEM/DEBRIS FILTER FOR MAIN TURBINE
CONDENSER AND DRIVE TURBINE CONDENSER (IF OFFERED)**

General Requirements

A. Ball Recirculation Pump

- a. All rotating parts shall be dynamically balanced.
- b. 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.
- c. Complete pump assembly shall be subjected to shop performance test at supplier's works.

B. Ball Sorter / Fabricated Body (housing)

- a. 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.
- b. Body shall be subjected to hydraulic pressure test at 1.5 times the design pressure.
- c. Performance test shall be carried out on ball sorter assembly.

C. Strainer

- a. Strainer mesh shall be checked for chemical composition and mesh size.
- b. Strainer body shall be subjected to hydraulic pressure test at 1.5 times the design pressure.
- c. Strainer assembly shall be checked for its function.

- D.** 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, proper functioning of DELTA-P system.

E. Piping and Fittings

Piping and fabricated fittings shall be subjected to following NDT.



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- 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. Wrought/ forged fittings shall be tested as per relevant code/ specification/ standard.

F. Coating / lining

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.
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:
 - a. Adhesion test
 - b. Check for resistance to bleeding
 - c. Measurement of thickness
 - d. Shore hardness test
 - e. Visual examination and spark test at 5 kv/mm of thickness.

G. VALVES

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



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2.5.1.18 CONDENSATE EXTRACTION PUMPS AND DRIP PUMPS (IF OFFERED)

INPROCESS TEST												FINAL TESTS					
ITEM DESCRIPTION	Chemical Analysis	Mechanical Prop	Heat Treatment	Run out	U.T.	R.T	D.P.T.	M.P.I.	Balancing	Hyd. Test	Inclusion Rating	Pressure Drop Test	Performance test	NPSH Test	Vibration	Noise	Strip Down Test
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Pump Casing	Y	Y ¹	-	-	-	-	Y	-	-	Y	-						
Suction Bell	Y	Y ¹	-	-	-	-	Y	-	-		-						
Shaft	Y	Y ¹	Y	Y	Y	-	Y	Y	-		Y						
Impeller	Y	Y ¹	Y	-	-	-	Y	-	Y		-						
Rotor	-	-	-	Y	-	-	-	-	Y								
Fabricated Items	Y	Y ¹	-	-	-	Y ²	Y	-	-	Y ³							
CEP													Y ⁴	Y ⁵	Y ⁶	Y ⁷	Y ⁸
Strainer																	
a) Body	Y	Y	-	-	-	-	Y*	-	-	Y	-						
b) Assembly											Y**						

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



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2. 10% Random on Butt Welds
3. Pressure Containing Parts.
4. 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.
5. 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.
6. Vibration on all Condensate Extraction Pumps shall be measured in transverse, Horizontal and Vertical Direction at all measuring points.
7. 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.
8. 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 conducted only in case abnormal performance such as Excessive Vibration, High noise, high bearing temperature etc. is observed during performance test.

Note:

- i. Quantum of In-Process Checks/ Tests is 100% until & unless specified otherwise.
- ii. Shop tests shall be conducted with softest Quality Water.
- iii. Bidder shall furnish details of proposed test procedures including test lay out, type and level of accuracy of instruments, sample calculation etc.
- iv. Tests shall be done in accordance with latest edition of Hydraulic Institute standard.
- v. 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



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**** 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 all



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2.5.1.19 POWER CYCLE HEATERS & DEAERATOR

A. Deaerator

Sl. No.	TESTS/CHECKS COMPONENTS/ ACTIVITY	Chemical Analysis	Mech. Properties	Impact	Hardness	Flattening	Flaring	UT	RT	MPI	DPT	Eddy Current	Helium Leak Test	SR	HT	Hydraulic	Pneumatic	Dimension	WPS/PQR/WQR/A pp. Performance test	Mock up Test
1.	Shall & 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		



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B. Heaters

Sl. No.	TESTS/CHECKS COMPONENTS/ ACTIVITY	Chemical Analysis	Mech. Properties	Impact	Hardness	Flattening	Flaring	UT	RT	MPI	DPT	Eddy Current	Helium Leak Test	SR	HT	Hydraulic	Pneumatic	Dimension	WPS/PQR/WQR/App. Performance test	Mock up Test
1.	TUBE SHEET																			
a)	Forging	Y	Y					Y		Y					Y			Y ⁱ		
b)	Plates	Y	Y	Y				Y			Y							Y ⁱ		
c)	Cladding							Y			Y			Y		Y		Y ⁱ		
2.	Shell Plates	Y	Y	Y				Y												
3.	Feed Nozzle Manhole forging	Y	Y			Y ^k		Y ⁱ				Y ^k						Y		
4.	Welding/ Fabrication																			



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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			
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																		
8.	Complete Heater																		

C. REMARKS FOR DEAEARATORS 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) (i) For plates.



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- (ii) For welding
- (iii) For wall thickness
- e) Including wall thickness
- f) (i) 100% RT/UT shall be carried out on bodies, bonnets, nozzle and stem of valves of HP heater.
(ii) 100% DPT/MPI on machined surface of valve body, bonnet, stem, disc & springs.
- g) Outer surface (Dished end Knuckle Portion)
- h) Including – Seat leakage
– Relieving
- i) Capacity – popping test at set and blow down pressure
- j) Include ovality of holes, surface finish and size of holes.
- k) For cladding bond and cladding thickness during bound check and after drilling
- l) For feed nozzle (pipes)
- m) For forgings
- n) After bending also
- o) Dimension to include wall thinning
- p) Both tube and shell side. After hydro test drying and nitrogen filling to be done.
- q) As per the code.
- r) 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.

Notes:

- 1) Quantum of checks shall be 100% unless otherwise specified.
- 2) Chem. /Mech. shall be one / per heat or HT batch.



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POWER PROJECT STAGE III**



EPC TENDER SPECIFICATION FOR BTG PACKAGE

2.5.1.20 BOILER FEED PUMPS & DRIVE TURBINE

BFP + BOOSTER PUMP + TURBINE																
INPROCESS TESTS																
Sl.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	Dimension	Remark
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	
A.	BFP+BOOSTER PUMP															¹ Chemical/Mechanical Shall be one per heat / HT batch. # On BFP Impeller as per ASTM E 446 level 2 *** In case of Fabricated Construction. ² One per type and size. + Type of NDE & quantum of check shall be as per relevant code & pressure class.
i.	Barrel Casing	Y	Y ¹	Y	-	Y	-	-	Y	-	-	Y	-	-	-	
ii.	Discharge Branch	Y	Y ¹	Y	-	Y	-	-	Y	-	-	Y	-	-	-	
iii.	Casing Cover	Y	Y ¹	Y	-	Y	-	-	Y	-	-	Y	-	-	-	
iv.	Suction Branch	Y	Y ¹	Y	-	-	-	Y	-	-	-	Y	-	-	-	
v.	Diffuser	Y	Y ¹	Y	-	-	-	Y	-	-	-	-	-	-	-	
vi.	Ring Section	Y	Y ¹	Y	-	Y	-	Y	-	-	-	-	-	-	-	
vii.	Impeller	Y	Y ¹	Y	-	-	Y#	Y	-	Y	-	-	-	-	-	
viii.	Shaft	Y	Y ¹	Y	-	Y	-	Y	Y	-	-	-	Y	-	-	
ix.	Rotor	-	-	-	Y	-	-	-	-	Y	-	-	-	-	-	



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EPC TENDER SPECIFICATION FOR BTG PACKAGE

B.	STRAINER																++ Include body & seat leakage test and functional test
i.	Body	Y	Y	-	-	-	-	Y***	-	-	-	Y	-	-	-		
ii.	Assembly	-	-	-	-	-	-	-	-	-	-	-	-	Y ²	-		
C	GEAR BOX AND HYDRAULIC COUPLING																Note: Quantum of Checks/ Tests is 100% until & unless specified otherwise.
i.	Gear	Y	Y ¹	Y	-	Y	-	Y	Y	-	-	-	-	-	-	-	
ii.	Pinions	Y	Y ¹	Y	-	Y	-	Y	Y	-	-	-	-	-	-	-	
iii.	Shaft	Y	Y ¹	Y	-	Y	-	Y	Y	-	-	-	-	-	-	-	
iv.	Casing	Y	Y ¹	-	-		-	-	-	-	-	Y	-	-	-	-	
v.	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	Tests as per relevant portion of specification															



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POWER PROJECT STAGE III**



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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	Y ²	Y ^{3 (a)}	Y ^{3 (b)}	Y ^{3 (c)}	Y ^{3 (c)}	Y ⁴	Y ^{3 (d)}	Y ⁵	Y ⁷	Y	Y ⁶	
Booster Pump	Y ¹	Y ²	Y ^{3 (a)}	Y ^{3 (b)}	-	-	Y ⁴	-	-	Y ⁷	-	Y ⁶	
Gear Box	Y ⁸	-			-	-	-	-	-	-	-	Y ⁸	-
HYD Coupling	-	-	-	-	-	-	-	-	-	-	-	Y ⁹	Y ⁶
Drive Turbine	Tests as per relevant portion of specification												
Elect Items	Tests as per relevant portion of specification												



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POWER PROJECT STAGE III**



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- A. (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. (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.
- C. 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.
- D. ③ (a) Vibration on all Boiler Feed Pumps and Booster Pumps shall be measured in transverse, Horizontal and Vertical Direction at all measuring points.
- E. (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.
- F. (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.
- G. ④ 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.
- H. 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
- I. 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.
- J. 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



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EPC TENDER SPECIFICATION FOR BTG PACKAGE

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

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

Note:

- 1) Shop tests shall be conducted with softest 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.

2.5.1.21 LOW PRESSURE PIPING



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EPC TENDER SPECIFICATION FOR BTG PACKAGE

Sl.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/operation al Test	Performance Test	Other tests	All Tests as per Relevant Std	Adhesion / Spark	Remarks
1)	Pipes & Fittings and Metered Bends	Y ^a	Y ^b		Y		Y									
2)	Diaphragm Valves	Y ^a					Y ⁵			Y				Y ⁶		
3)	Butterfly Valves (Low Pressure)															
a)	Casted Butterfly Valves															
i.	Body (Cast)	Y ^a	Y ^b				Y		Y	Y	Y		Y ⁷			
ii.	Disc (Cast)	Y ^a	Y ^B													
iii.	Shaft	Y ^a	Y	Y ^c												
b)	Fabricated Butterfly Valves															Ref. Note 14



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EPC TENDER SPECIFICATION FOR BTG PACKAGE

4)	Gate / Globe / Swing Check Valves	Y ^a	Y ^b	Y ^c			Y ⁵	Y	Y				Y ⁸			
5)	Dual Plate Check Valves	Y ^a	Y ^b	Y ^c			Y	Y	Y				Y ⁴			
6)	Rolled & Welded Pipes	Y ^a	Y ³		Y		Y ¹			Y						
7)	Coating & Wrapping of Pipes	Y ²										Y ²				
8)	Tanks & Vessels	Y ^a	Y ^b		Y		Y									
9)	Strainers	Y ^a	Y ^b				Y						Y ¹¹			
10)	Rubber Expansion Joints	Y ^a					Y				Y ¹³					
11)	Rubber Lining of Pipes	Y ^a	Y ^b		Y			Y				Y ⁹	Y			
12)	Hangers & Supports	Y ^a				Y										
13)	Fastners	Y ^a		Y ^b		Y										
14)	Site Welding		Y ¹		Y											



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EPC TENDER SPECIFICATION FOR BTG PACKAGE

Notes:

- 1) Weld Joints not subjected to hydraulic 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 Employer's 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 plate's material for body and disc. 100% RT as per ASTM, Section-VIII, and Division-I, on butt joints 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 m

Quality Assurance Plan
Part 2.5.2 Electrical Works



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EPC TENDER SPECIFICATION FOR BTG PACKAGE

2.5.2 QUALITY ASSURANCE PLAN FOR ELECTRICAL ITEMS

2.5.2.1 GENERATOR & AUXILIARIES

PROCESS CHECK FOR STATIC PARTS GENERATOR / EXCITOR

TESTS ITEM/ COMPONENTS /PROCESS	Visual & dimension	Chem.Prop.(raw material)	Heat treatment	Mech. Prop.(raw material)	Impact.(raw material)	Hydraulic test	Pneumatic test	RT/UT (10% for butt weld) for hydrogen cooled machine	MPI/DPT(All welds)	Relative permeability	Ferrite content	DIN 43760, IS 848,7358	DIN 48124
Sheet and Fabrication -END shield	Y	Y	Y	Y	Y	Y	Y	Y	Y				
-Stator casing	Y	Y	Y	Y	Y	Y	Y	Y	Y				
-Bushing boxes	Y	Y	Y	Y	Y	Y	Y	Y	Y				
-Terminal plates	Y	Y	Y	Y	Y	Y	Y		Y				
-Manhole and covers	Y	Y	Y	Y	Y	Y	Y		Y				
-Trunnions	Y	Y	Y	Y	Y			Y	Y				
-Corebar	Y	Y		Y									
-Press ring	Y	Y		Y					Y				
-Core bolt (insulated)	Y	Y		Y				Y	Y				
-Gaskets	Y			Y									
-Bearing and Hydrogen Seals	Y	Y		Y				Y2					
-Terminal Bushing													Y
-RTD/ Thermocouple												Y	
Additional checks for -Non magnetic Components										Y			
-Non magnetic Components welding											Y		



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EPC TENDER SPECIFICATION FOR BTG PACKAGE

Y-Test applicable, Y-For Hydrogen cooled machine, Y2-UT on babbitt for bearing,

PROCESS CHECK FOR CORE GENERATOR/EXCITOR

TESTS ITEM/ COMPONENTS / PROCESS	Specific loss before and after ageing	Magnetisation	Anotrophy of losses	Stacking factor	Burr level	Check for varnish, insulation (chem, elect., viscosity, curetime, solid content, dielectric properties	Dimension & surface (uniformity of varnish coat	Spot weld check
Core lamination	Y	Y	Y	Y		Y	Y	
After punching Insulated core Laminations				Y	Y	Y	Y	
Ventilation Stamping								Y
Core assembly							Y	
	Process check including Heating & pressure application	Insulation test of core tension bolt & core bar	Functional check of ventilation ducts	Hot spot by infra red camera & ELCID	Location of temp. detectors	Iron loss at rated flux density		
CORE assembly (additional Checks for Generator)	Y	Y	Y	Y	Y	Y		

Y - Test Applicable



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EPC TENDER SPECIFICATION FOR BTG PACKAGE

PROCESS CHECK CONDUCTOR (GENERATOR / EXCITOR)

STATOR CONDUCTOR AND WINDING

ITEM/ COMPONENTS /PROCESS	Mech. prop (sample)	Chem. prop (sample)	Resistivity/Resistance	Metallography prop.	Eddy current & pr. test	Insulation adhesion	Flexibility of bending	Dielectric test	Dimension/visual	Electric test	Physical prop.	Brazing procedure	X-Ray of Water box	Process check	Flow test	Helium leak test & PR. test	Check on RTD + location
Winding copper and Connecting bus bars	Y	Y	Y	Y	Y												
Insulated conductor						Y	Y	Y	Y								
Insulation material	Y	Y							Y	Y	Y						
Manufacturing Winding bar & phase bar								Y	Y	Y		Y	Y	Y	Y	Y	
Winding laying								Y	Y	Y				Y			Y
Water Supply Hoses	Y	Y						Y	Y							Y	
Winding support ring		Y							Y		Y						
Connection between bars												Y					
wound stator																Y	

Y – TEST APPLICABLE



**1X800 MW COAL BASED NORTH CHENNAI THERMAL
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EPC TENDER SPECIFICATION FOR BTG PACKAGE

PROCESS CHECK CONDUCTOR (GENERATOR / EXCITOR)

STATOR CONDUCTOR AND WINDING (CNTD.)

TESTS ITEM/ COMPONENTS / PROCESS	Tan delta and delta, tan delta upto 1.2 un	Corona protection resistance	Reactance of stator winding	Magnetic Test of metallic parts	Magnetic test and Vibration fatigue	Dielectric test at elevated and room temp.	Inter strand Insulation test	Thermal shock and boroscopic Examination of brazed water box	Slot wedge tightness & radial movement	Type test on two bars for Heating cycle test, Thermal stability test, Voltage endurance test	Support arrangement
Winding copper and connecting bus bars											
Insulated conductor						Y					
Insulation material											
Manufacturing Winding bar & phase bar	Y	Y					Y	Y		Y	
Winding laying	Y										Y
Water Supply Hoses				Y	Y						Y
Connection between bars							Y				
wound stator	Y		Y						Y		

Y - Test Applicable



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EPC TENDER SPECIFICATION FOR BTG PACKAGE

PROCESS CHECK FOR ROTOR AND ASSEMBLY

TESTS ITEM/ COMPONENTS /PROCESS	Rep. sample tensile stress	Rep. sample 0.2 limit	Rep. sample elongation	Hardness on Sample	Impact & stress rupture prop. check on sample	Rep. sample Chem. prop.	NDTT, FATT	Process check including heattreatment (as applicable)	Ultrasonic test/RT (at suppliers works and after preliminary machining)	Sulphur Prints Check	Flux carrying capacity / Magnetic prop.	Boroscopic Examination
Rotor forging & slip ring shaft	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Rotor end retaining ring & cover, locking ring & slip ring forgings, diode wheel	Y	Y	Y		Y	Y		Y	Y			
Rotor winding copper rotor wedges, damper Wedges, CC- bolts & D-leads	Y		Y			Y		Y	Y			
Rotor slot boxes / insulating material						Y						
Coil manufacture												
Rotor winding								Y				
Winding connection studs & assembly												
Complete rotor								Y				
Test on completed rotor at various speed upto rated speed												
Test on completed rotor before & after overspeed												
Fan hubs/blades						Y		Y	Y			
GENERATOR assembly												
Rectifier wheel	Y		Y					Y	Y			
Permanent magnet					Y						Y	



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EPC TENDER SPECIFICATION FOR BTG PACKAGE

EXCITOR assembly												

Y- Test Applicable

PROCESS CHECK FOR ROTOR AND ASSEMBLY

GENERATOR/EXCITOR (Cntd.)

TESTS ITEM/COMPONENTS /PROCESS	MPI/DP/NDT test	Visual/Dimension/Cleanliness	Adhesion, thickness of Coat on silver plating	Electrical conductivity and Oxygen content	Mech. test on sample	Electrical test	Resistance measurement	Purge test on vents	Helium leak test for Hydrogen cooled M/C	Inter turn test	Dielectric test	Gas tightness
Rotor forging & slip ring shaft	Y	Y										
Rotor end retaining ring &cover, locking ring & Slip ring forgings,diode wheel	Y		Y									
Rotor winding copper, rotor wedges, amper Wedges, CC-bolts & D- leads	Y		Y	Y	Y	Y						
Rotor slot boxes / Insulating material					Y	Y						
Coil manufacture		Y				Y	Y					
Rotor winding	Y	Y				Y		Y	Y	Y	Y	
Winding connection studs & assembly	Y				Y						Y	Y
Complete rotor							Y				Y	
Test on completed rotor at various speed upto rated speed							Y			Y	Y	
Test on completed rotor before & after overspeed		Y								Y	Y	
Fan hubs/blades	Y	Y										
Generator assembly		Y										
Rectifier wheel		Y										



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EPC TENDER SPECIFICATION FOR BTG PACKAGE

Permanent magnet		Y			Y							
Excitor assembly		Y										

Y-Test Applicable

PROCESS CHECK FOR ROTOR AND ASSEMBLY

GENERATOR/EXCITOR (Cntd.)

ITEM/ COMPONENTS /PROCESS	Insulation Resistance	PI at 5 kV	Radial run out/alignment	Impedence measurement/ RSO (repetitive surge oscillograph)	Dynamic balancing ISO 5393, 5406, 2372, 1940 including Air run test	Over speed test (120%) for 2 minute	Functional test	Axial run out, seal ring holder	Metallography examination	Torque on joint bolts	Fitting and locking of Balancing weights	Brazer and brazing procedure
Rotor forging & slip ring shaft									Y			
Rotor end retaining ring & cover, locking ring & Slip ring forgings, diode wheel												
Rotor winding copper, rotor wedges, damper Wedges, CC- bolts & D-leads										Y		
Rotor slot boxes/ insulating material												
Coil manufacture												Y
Rotor winding												Y
Winding connection studs & assembly	Y											
Complete rotor	Y	Y	Y	Y	Y	Y				Y		
Test on completed rotor at various speed upto rated speed				Y								
Test on completed rotor before & after overspeed	Y	Y	Y	Y								
Fan hubs/blades											Y	
GENERATOR assembly	Y		Y				Y		Y	Y	Y	Y



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EPC TENDER SPECIFICATION FOR BTG PACKAGE

Rectifier wheel			Y					Y		Y	Y	
Permanent magnet												
EXCITOR assembly			Y				Y			Y	Y	

Y-Test applicable

ADDITIONAL CHECK FOR EXCITOR

TESTS ITEM/ COMPONENTS / PROCESS	As per IEC-146	As per IEC-76	Pole parallelism & polarity	Mech. chem. & Magnetic prop.	Functional check	Insulation resistance	IEEE/ANSI-C37.18	IS-8084	As per specification	Dimensional and visual
Fuse diode & filter Circuit	Y									Y
Aux. Transformer (if applicable)		Y								
PMG & Exciter stator			Y	Y		Y				
Banding wire				Y						
Excitor field Breaker field discharge resistor					Y					
Bearing, exciter armature field, axis coil RTD						Y				
Excitation Transformer		Y								
Thyristors		Y								
Field breaker							Y			
Bus duct AC/DC								Y		
Voltage Regulator									Y	



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EPC TENDER SPECIFICATION FOR BTG PACKAGE

FINAL ACCEPTANCE TEST GENERATOR / EXCITOR

TESTS ITEM/ COMPONENTS /PROCESS	Gas tightness for Hydrogen cooled M/C	Resistance measurement	Rotor impedance at various speeds	Heat run test	Function check	Voltage regulation	OCC	SCC	Record Aux. parameters	Steady state reactances	Efficiency By separation of losses
Works running on generator	Y	Y	Y	Y			Y	Y	Y	Y	Y
Without EXC, OC & SC with rated voltage & current for Generator				Y							
On total wdg / phases at interval 0.2 Un for Generator											
Condition after dismantling											
Works test on brush less excitor		Y		Y			Y				
PMG works test		Y		Y		Y					
Full load for PMG & convertor assembly				Y							
Convertor assembly				Y							
Static excitation system				Y	Y						

Y - Test Applicable



**1X800 MW COAL BASED NORTH CHENNAI THERMAL
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EPC TENDER SPECIFICATION FOR BTG PACKAGE

FINAL ACCEPTANCE TEST GENERATOR / EXCITOR (Contd.)

TESTS ITEM/ COMPONENTS /PROCESS	Insulation resistance 5 kV	Polarisation index 5 kV	Phase seq. voltage balance	Shaft voltage & current	H.V. test (except electronic	RTD, BTD Check	Capacitance measurement	Tan delta, delta tandelta	Rotor journal	Bearing oil catcher
Works running on generator	Y	Y	Y	Y	Y	Y	Y	Y		
Without EXC, OC & SC with rated voltage & current for Generator										
On total wdg / phases at interval 0.2 Un for Generator							Y	Y		
Condition after dismantling									Y	Y
Works test on brush less excitor	Y				Y					
PMG works test	Y		Y		Y					
Full load for PMG & convertor assembly										
Convertor assembly	Y				Y					
Static excitation system	Y				Y					

Y - Test Applicable



EPC TENDER SPECIFICATION FOR BTG PACKAGE

FINAL ACCEPTANCE TEST GENERATOR / EXCITOR (Contd.)

TESTS ITEM/ COMPONENTS /PROCESS	Seal rings, liners	Winding Overhang	Vibration measurement	Reduced voltage running and No load	Load characteristics	Characteristics of search coil, quad, axis	Ripple content	Visual & dimension	Partial discharge, DLA
Works running on generator			Y					Y	Y
Without EXC, OC & SC with rated voltage & current for Generator									
On total wdg / phases at interval 0.2 Un for Generator									
Condition after dismantling	Y	Y							
Works test on brush less excitor			Y	Y	Y	Y		Y	
PMG works test				Y	Y				
Full load for PMG & convertor assembly									
Convertor assembly									
Static excitation system							Y		

Y - Test Applicable

Notes:

- This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
- All generators shall be assembled at works and shall be tested to verify/ensure design and workman ship in accordance with IEC-34, VDE 0530, IEEE 115, IEEE 43. The manufacturer shall submit detailed test procedure which clearly specify test set up, instruments to be used, acceptance norms (wherever applicable) recording of different parameter, interval of recording, precautions etc.
- Cooler, control panel and other auxiliaries (as applicable) to be suitably tested as per tests covered in the specification.
- Test requirements of primary water system, seal oil system and Hydrogen cooling system shall be as per tests specified for similar items under respective tables covered in this section.



EPC TENDER SPECIFICATION FOR BTG PACKAGE

2.5.2.2 GENERATOR BUSDUCTS AND NEUTRAL GROUNDING EQUIPMENTS

GENERATOR BUS DUCT											
Attributes / Characteristics Items/ Components Sub Systems	Visual & Dimensional Checks	Electrical / Mechanical / Chemical Properties	WPS & PQR	NDT / DP / MPI / UT	Painting Shade & Adhesion Test	Galvanising Test as per IS: 2629 / 2633 / / 6745	Electrical clearance & Creepage	Functional/Operational check	Make / Type / Rating / Model / TC / General Physical Inspection	Trial Assembly at works.	Routine Test as per relevant standard & Specification
Enclosure / Cubicle	Y	Y		Y	Y						
Busbar Flexible Connector & Disconnecter Link	Y	Y									
Galvanised Steel Structure & Plate	Y					Y					
Seal of Bushing & Post & Post Insulator IS:5621 & 2544	Y	Y					Y		Y		Y
Welding	Y		Y	Y							
Gasket, Silicagel Breather, CT, VT, Surge Capacitor & Arrestor, NGT, NGR, Elastomer Spring Head								Y	Y		Y
Bus Bar Pressurisation System	Y							Y			
Complete Bus Duct IS:8084	Y				Y					Y	Y
Notes : 1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents during QP finalisation for all the items. 2) All major Bought Out Items will be subject to Customer approval.											



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NEUTRAL GROUNDING RESISTOR											
Attributes / Characteristics Items/Components Sub Systems	Visual & Dimensional check	Mechanical properties	Electrical strength	Chemical Composition	Make / Type / Rating / Model / TC / General Physical Inspection.	Insulation Resistance Measurement before and after	HV Test	HV Test	Degree of Protection Test	Routine Test as per relevant standard	Galvanising Test Routine Test
Resistor	Y	Y	Y	Y		Y					
Cubicle	Y		Y						Y		
Galvanised Steel Structures (IS:2633/2629/6745) (IS:2062)	Y										Y
Bushing / Post & Support Insulator (IS:2544 / 5621)	Y	Y	Y		Y					Y	
Complete NGR (IEEE-32)	Y					Y	Y	Y	Y		Y
Notes : 1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents during QP Finalisation for all the items. 2) All major Bought Out Items will be subject to Customer approval.											



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2.5.2.3 GENERATOR CIRCUIT BREAKER

Characteristics / Type of Check	Operations / Activity																			
	Material quality	Appearance inspect																		
			Power frequency withstand voltage test on major insulation components																	
			Power frequency withstand voltage test on control and secondary wiring																	
			Mechanical operation test incl. timing testing																	
			Leakage test																	
			Electric resistance of current path test																	
			Mechanical operation test																	
			Timing test for disconnecting switch																	
			Test of control signals																	
			Test of alarm																	
			Test of interlocking																	
			Nameplate check																	
			Gas receiver tests																	
			Resistor, heater, coil check tests																	
			Control and secondary wiring check tests																	
			Clearance and mechanical adjustment check tests																	
			Testing for storage energy of GCB																	
			Documents review before dispatching																	
			Packing list and container check																	
			Packaging Inspection																	Y



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Control signals, alarm and interlocking	Y					Y	Y			Y										Y
GCB	Y																			Y
GCB																				Y
GCB	Y																			Y
GCB	Y										Y		Y							
GCB	Y	Y							Y											Y
GCB												Y								Y
GCB	Y												Y							

Notes :

1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents during QP Finalisation for all items

2) All major Bought Out Items will be subject to Customer approval.

Y – Test Applicable



EPC TENDER SPECIFICATION FOR BTG PACKAGE

2.5.2.4 GENERATOR TRANSFORMERS

Attributes / Characteristics Items/Components Sub Systems	Visual & Dimensional Checks	Mechanical properties	Electrical strength	Thermal properties	Chemical Composition	Compatibility with oil	Core Loss*, Hot Spot	NDT / DPT / MPI / UT	Ageing Test.	Voltage Ratio, Vector Group & Polarity, Magnetic Balance Test	Make / Type / Rating / Model / TC / General Physical Inspection.	10 kV Isolation test on core	WPS & PQR	Routine Test as per relevant standard	Vacuum & Pressure Test
Tank, H.V. & L.V. Cable Box / Flange throat	Y	Y						Y							Y
Conservator / Radiator / Cooler / Pipes	Y	Y						Y							
Copper Conductor (IS:191)	Y	Y	Y		Y										
Insulating Material	Y	Y	Y	Y	Y	Y									
CRGO Lamination & Built Core	Y	Y	Y		Y	Y	Y								
Bushing / Insulator (IS:2544 / 5621)	Y	Y												Y	
Gasket	Y				Y	Y			Y					Y	
Air Cell	Y													Y	
Transformer Oil (IS:335)														Y	
On Load / Off-Circuit Tap Changer (IEC :214)	Y													Y	
Core Coil Assembly & Pre- tanking	Y									Y		Y			



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Marshalling Box	Y	Y						Y						Y				
WTI, OTI, MOG, Bucchohz Relay, PRD, Thermister, Breather, Terminal Connector, Bushing CT, Fan & Pumps with Drives, Impact Recorder, Globe & Gate Valve, PD Detector, FRA and DGA Equipment											Y			Y				
Welding (ASME Sect-IX)	Y												Y					
* - Core Loss on first Job Y – Test Applicable																		
Attributes / Items/Components Sub Systems	Oil Leakage Test		Jacking test followed by DP Test om load bearing		DGA of Oil for main tank and OLTC Chamber		Measurement of capacitance and tan delta		Partial Discharge measurement (long duration)as per IEC-76 clause No. 12.4		Temperature Rise Test		Routine Test		Nitrogen Dew Point Measurement before fianl packing on transformer at receipt at site.		Paint Shade Thickness and Adhesion & finish.	
Complete Transformer (IS:2026 / IEC:76)	Y		Y		Y		Y		Y		Y		Y		Y1		Y	
Notes : 1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents during QP Finalisation for all items. 2) All major Bought Out Items will be subject to Customer approval. Y1 – Applicable only for N2 filled transformer Y – Test Applicable																		



EPC TENDER SPECIFICATION FOR BTG PACKAGE

2.5.2.5 UNIT & STATION TRANSFORMERS

Attributes / Characteristics Items/Components Sub Systems	Visual & Dimensional Checks	Mechanical properties	Electrical strength	Thermal properties	Chemical Composition	Compatibility with oil	Core Loss (on first job only), Hot Spot	NDT / DPT / MPI / UT	Ageing Test.	Voltage Ratio, Vector Group & Polarity, Magnetic Balance Test	Make / Type / Rating / Model / TC /	10 kV Isolation test on core	WPS & PQR	Routine Test as per relevant standard	Vacuum & Pressure Test
Tank, H.V. & L.V. Cable Box / Flange throat	Y	Y						Y							Y
Conservator / Radiator / Cooler / Pipes	Y	Y						Y							
Copper Conductor (IS:191)	Y	Y	Y		Y										
Insulating Material	Y	Y	Y	Y	Y	Y									
CRGO Lamination & Built Core	Y	Y	Y		Y	Y	Y								
Bushing / Insulator (IS:2544 / 5621)	Y	Y												Y	
Gasket	Y				Y	Y			Y					Y	
Air Cell	Y													Y	
Transformer Oil (IS:335)														Y	
On Load / Off-Circuit Tap Changer (IEC :214)	Y													Y	
Core Coil Assembly & Pre- tanking	Y									Y		Y			
Marshalling Box	Y	Y						Y						Y	



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WTI, OTI, MOG, PRD, Thermister, Breather, Terminal Connector, Bushing CT, Fan & Pumps with Drives, Impact Recorder, Bucholz Relay, Globe & Gate Valve, PD Detector, FRA and DGA Equipment											Y			Y	
Welding (ASME Sect-IX)	Y												Y		

Attributes / Characteristics Items/Components Sub Systems	Oil Leakage Test	Jacking test followed by DP Test on load bearing Member	DGA of Oil for main tank and OLTC Chamber	Measurement of capacitance and tan delta	Partial Discharge measurement (long duration) as per IEC-76	Routine Test	Paint Shade, Thickness and finish	Nitrogen Dew Point Measurement before final packing on transformer at receipt at site.
Complete Transformer (IS: 2026 / IEC:76)	Y	Y	Y	Y	Y	Y	Y	Y
Notes : 1) This is an indicative list of checks / tests. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents during QP finalisation for all items. 2) All major Bought Out Items will be subject to Customer approval. Y – Test Applicable.								



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2.5.2.6 AUXILIARY TRANSFORMERS

Attributes / Characteristics Items/Components Sub Systems	Visual & Dimensional Checks	Mechanical properties	Electrical strength	Thermal properties	Chemical Composition	Compatibility with oil	Core Loss*, Hot Spot	NDT / DPT / MPI / UT	Ageing Test.	Voltage Ratio, Vector Group & Polarity, Magnetic Balance Test	Make / Type / Rating / Model / TC / General Physical Inspection.	WPS & PQR	Routine Test as per relevant test	Vacuum & Pressure Test	Routine Test
Tank, H.V. & L.V. Cable Box / Flange throat	Y	Y						Y						Y	
Conservator / Radiator / Cooler / Pipes	Y	Y						Y							
Copper Conductor (IS:191)	Y	Y	Y		Y										
Insulating Material	Y	Y	Y	Y	Y	Y									
CRGO Lamination & Built Core	Y	Y	Y		Y	Y	Y								
Bushing / Insulator (IS:2544 / 5621)	Y	Y									Y		Y		
Gasket	Y				Y	Y			Y				Y		
Transformer Oil (IS:335)													Y		
Off-Circuit Tap Changer	Y										Y				
Core Coil Assembly & Pre-tanking	Y									Y					
Marshalling Box	Y	Y						Y					Y		



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Attributes / Characteristics Items/Components Sub Systems	Visual & Dimensional Checks	Mechanical properties	Electrical strength	Thermal properties	Chemical Composition	Compatibility with oil	Core Loss*, Hot Spot	NDT / DPT / MPI / UT	Ageing Test.	Voltage Ratio, Vector Group & Polarity, Magnetic Balance Test	Make / Type / Rating / Model / TC / General Physical Inspection.	WPS & PQR	Routine Test as per relevant test	Vacuum & Pressure Test	Routine Test
WTI, OTI, MOG, PRD, Breather, Terminal Connector, Bucchohz Relay, Globe & Gate Valve,	Y										Y				
Welding (ASME Sect-IX)	Y											Y			
Complete Transformer (IS:2026)	Y														Y
Y - Test applicable * - Core Loss on first Job Note: 1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan Indicating the practice and procedure along with relevant supporting documents. 2) All major Bought Out Items will be subject to Customer approval.															



EPC TENDER SPECIFICATION FOR BTG PACKAGE

2.5.2.7 HT SWITCHGEAR

ATTRIBUTES/ CHARACTERISTICS ITEMS, COMPONENTS, SUB-SYSTEM ASSEMBLY	Make, Type, Model, Rating & TC	Electrical Properties	Mechanical properties	Chemical Properties	Dimensions & Finish	Functional & Operational Features as per relevant standard & Spec.	Item to conform to relevant Standards	Pretreatment as per IS 6005	Paint shade, thickness, adhesion & finish	Functional Checks	HV & IR Test	Degree of Protection Routine test as per relevant standard.	CB Routine Operation testing as per IEC	All Routine Tests as per IS
Aluminium Bus bar material (IS : 5082)	Y	Y	Y	Y	Y		Y							
Copper Bus bar material (IS : 613)	Y	Y	Y	Y	Y		Y							
Bus bar Support Insulator (IS : 9431)	Y	Y	Y		Y		Y				Y			
HT Circuit Breaker (IEC : 56)	Y				Y	Y	Y			Y				
HT Contactors (IS : 9046)	Y				Y	Y	Y			Y				
Protection & Auxiliary Relays (IS : 3231 / 8686)	Y				Y	Y	Y			Y				
HT CT's & PT's (IS : 2705 / 3156)	Y				Y		Y							
HT Fuses (IS : 9385)	Y				Y	Y	Y							
Surge Arrester (IEC : 99-4)	Y				Y		Y							
LT Contactors (IS : 13947)	Y				Y	Y	Y			Y				



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Control & Selector Switches (IS : 6875)	Y				Y	Y	Y			Y			
Indicating Meters (IS : 1248)	Y				Y	Y	Y			Y			
Indicating Lamps (IS : 13947)	Y				Y	Y	Y			Y			
Push Buttons (IS : 4794)	Y				Y	Y	Y			Y			
Control Transformer (IS : 12021)	Y				Y	Y	Y						
LT Fuses (IS : 13703)	Y				Y	Y	Y						
Energy Meters (IS : 722)	Y				Y	Y	Y						

ATTRIBUTES/ CHARACTERISTICS ITEMS, COMPONENTS, SUB-SYSTEM ASSEMBLY	Make, Type, Model, Rating & TC	Electrical Properties	Mechanical properties	Chemical Properties	Dimensions & Finish	Functional & Operational Features as per relevant standards & Spec.	Item to conform to relevant Standards	Pre-treatment as per IS 6005	Paint shade, thickness, adhesion & finish	Functional Checks	HV & IR Test	Degree of Protection Routine test as per relevant standards & spec.	CB Routine Operation testing as per IEC	All Routine Tests as per IS
Transducers (IEC : 60688)	Y				Y	Y	Y							
Diodes	Y	Y				Y	Y			Y				
Terminal Blocks	Y	Y				Y	Y							
Synthetic Rubber Gasket (IS : 11149 / 3400)	Y	Y			Y		Y							
Breaker Handling Trolley	Y				Y	Y			Y	Y				



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HT Switchgear Panel (IS : 3427)	Y				Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Notes: 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2. Make of all major Bought out Items will be subject to Customer approval.														

2.5.2.8 HT BUSDUCT

Attributes / Characteristics Items/Components Sub Systems	Visual & Dimensional Checks	Electrical / Mechanical / Chemical Properties	WPS & PQR	NDT / DP / MPI / UT	Paint Shade & Adhesion Test	Galvanising Test as per IS: 2629 / 2633 / / 6745	Electrical clearance & Creepage	Functional/Operational check	Make / Type Rating / Model / TC / General Physical Inspection	Routine Test as per relevant standard	Routine Test on Complete Bus Duct
Enclosure / Cubicle	Y	Y		Y	Y						
Busbar Flexible Connector & Disconnecter Link	Y	Y									
Steel Structure & Plate IS:2062		Y				Y					
Bushing, Post & Support Insulator IS:9431 & 2544	Y						Y			Y	
Welding	Y		Y								
Gasket, Silicagel Breather								Y	Y	Y	
Complete Bus Duct IS:8084	Y				Y					Y	Y



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Note :

- 1) This is an indicative List of test/checks. The manufacturer is to furnish a detailed Quality Plan indicating his practice and procedure along with relevant supporting documents during QP finalisation for all items.
- 2) All major Bought Out Items will be subject to Customer approval.

2.5.2.9 LT INDOOR TRANSFORMERS

Attributes / Characteristics Items/Components Sub Systems	Visual & Dimensional check	Mechanical properties	Electrical strength	Thermal Properties	Chemical Properties	Core Loss*, Hot Spot	NDT / DP / MPI	Voltage Ratio, Vector Group & Polarity	Make / Type / Rating / Model /TC / General Physical Inspection	WPS & PQR	Routine Test as per relevant standard	Measurement of capacitance & tan delta between winding	Routine Test
Enclosure door, H.V. & L.V. Cable Box / Flange Throat	Y	Y							Y				
Copper Conductor	Y	Y	Y		Y								
Insulating Material	Y			Y	Y								
CRGO Lamination & Built Core	Y					Y							
Bushing /Insulator (IS:2544 / 5621)	Y								Y		Y		
Gasket	Y								Y		Y		
Off-Circuit Tap Changer	Y								Y				
Core Coil Assembly	Y							Y					
Marshalling Box	Y												
WTI, Thermister, Terminal Connector	Y								Y				



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Welding										Y			
Complete Transformer (IS:11171)	Y											Y	Y
Core Loss for first Job Notes: 1) This is an indicative List of test/checks. The manufacturer is to furnish a detailed Quality Plan indicating his practice and procedure along with relevant supporting documents during QP finalisation for all item. 2) All major Bought Out Items will be subject to Customer approval.													

2.5.2.10 LT SWITCHGEAR & BUSDUCT

LT SWITCHGEAR (MCC, PCC, ACDB, DCDB, FUSE BOARDS, LOCAL PUSH BUTTON STATION, LOCAL MOTOR STARTERS)															
ATTRIBUTES/ CHARACTERISTICS	ITEMS/ COMPONENTS/ SUB SYSTEM ASSEMBLY	Make, Model, Type, Rating & TC	Dimensions & Finish	Electrical properties	Mechanical Properties	Chemical properties	Functional & Operational Features as per relevant standard & Spec.	Item to conform to relevant Standards	Pre-treatment as per IS 6005	Paint Shade, Adhesion, Thickness & Finish	Functional Checks	Milli-volt drop Test	IR – HV – IR Test	Degree of Protection Routine test as per relevant standard.	All Routine tests as per spec. & IS
	Sheet Steel (IS : 513)	Y	Y		Y	Y		Y							
	Aluminium Bus bar Material (IS : 5082)	Y	Y	Y	Y	Y		Y							
	Copper Bus bar Material (IS : 613)	Y	Y	Y	Y	Y		Y							
	Support Insulator (IS : 9431,IS : 10912, IEC : 660)	Y	Y	Y	Y			Y							



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LT SWITCHGEAR (MCC, PCC, ACDB, DCDB, FUSE BOARDS, LOCAL PUSH BUTTON STATION, LOCAL MOTOR STARTERS)														
ATTRIBUTES/ CHARACTERISTICS ITEMS/ COMPONENTS/ SUB SYSTEM ASSEMBLY	Make, Model, Type, Rating & TC	Dimensions & Finish	Electrical properties	Mechanical Properties	Chemical properties	Functional & Operational Features as per relevant standard & Spec.	Item to conform to relevant Standards	Pre-treatment as per IS 6005	Paint Shade, Adhesion, Thickness & Finish	Functional Checks	Milli-volt drop Test	IR – HV – IR Test	Degree of Protection Routine test as per relevant standard.	All Routine tests as per spec. & IS
Air Circuit Breaker (IS: 13947)	Y	Y				Y	Y			Y	Y			Y
Energy Meters (IS : 722)	Y	Y				Y	Y			Y				Y
Power & Aux. Contactors (IS : 13947)	Y	Y				Y	Y			Y				Y
Protection & Aux. Relays (IS : 3231)	Y	Y				Y	Y			Y				Y
Control & Selector Switches (IS : 6875)	Y	Y				Y	Y			Y				Y
CT’s & PT’s (IS 2705 / 3156)	Y	Y					Y							
MCCB (IS : 13947)	Y	Y					Y							
Indicating Meters (IS : 1248)	Y	Y				Y	Y			Y				Y
Indicating Lamps (IS : 13947)	Y	Y				Y	Y			Y				Y
Air Break Switches (IS : 13947)	Y	Y				Y	Y			Y				
Control Terminal Blocks	Y	Y				Y	Y							
Fuse (IS 13703)	Y	Y				Y	Y			Y				
Control Transformer (IS : 12021)	Y	Y				Y	Y			Y				Y



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LT SWITCHGEAR (MCC, PCC, ACDB, DCDB, FUSE BOARDS, LOCAL PUSH BUTTON STATION, LOCAL MOTOR STARTERS)													
ATTRIBUTES/ CHARACTERISTICS ITEMS/ COMPONENTS/ SUB SYSTEM ASSEMBLY	Make, Model, Type, Rating & TC	Dimensions & Finish	Electrical properties	Mechanical Properties	Chemical properties	Functional & Operational Features as per relevant standard & Spec.	Item to conform to relevant Standards	Pre-treatment as per IS 6005	Paint Shade, Adhesion, Thickness & Finish	Functional Checks	Milli-volt drop Test	IR – HV – IR Test	Degree of Protection Routine test as per relevant standard. All Routine tests as per spec. & IS
Push Buttons (IS : 4794)	Y	Y				Y	Y			Y			Y
Transducer (IEC : 60688)	Y	Y				Y	Y			Y			Y
MCB (IS : 8828)	Y	Y				Y	Y			Y			Y
Breaker Handling Trolley	Y	Y				Y			Y	Y			Y
Synthetic Rubber Gasket (IS : 11149)	Y	Y		Y	Y		Y						
LT SWITCHGEAR (IS : 8623)	Y	Y				Y	Y	Y	Y		Y	Y	Y
Notes: This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 3. Makes of all major Bought Out Items will be subject to Customer approval. Y – Test Applicable.													



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LT BUSDUCT															
ATTRIBUTES , CHARACTERISTICS															
ITEM, COMPONENTS, SUB SYSTEM ASSEMBLY	Dimension & Surface Finish	Make, Type, Rating & TC	Electrical Properties	Mechanical Properties	Chemical Properties	Item to conform to relevant IS	WPS Approval, Welder Qualification	Weld Quality Check (DP test & x-ray Test)	Paint Shade, Thickness, Adhesion & Finish	Tightness by Torque measurement	Electrical Clearances	Galvanizing Test as per IS 2629/ 2633/	IR – HV – IR Test	Phase Sequence Check	Degree of Protection routine test as per relevant standard.
Aluminum Sheets / Plates / Strips / Flexibles / tubes (IS : 5082 / 737)	Y	Y		Y	Y	Y	Y	Y							
CRCA Flats / ISMC (IS 2062)	Y	Y		Y	Y	Y									
Neoprene / Synthetic Rubber Gaskets (IS 11149 / 3400)	Y	Y		Y	Y										
Rubber Bellows (IS : 3400)	Y	Y		Y	Y										
Support Insulator (BS : 2782, IEC : 660, IS : 10912)	Y	Y	Y	Y											
Galvanized Structure & GI Earthing Flat (IS : 2629 / 2633 / 4749)	Y	Y				Y						Y			
Space Heater & Thermostat		Y	Y										Y		
LT Busduct (IS : 8623 PART 2)	Y	Y				Y	Y	Y	Y	Y	Y		Y	Y	Y
Notes: 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2. Makes of all major Bought Out Items will be subject to Customer approval.															



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2.5.2.11 MOTORS

INDUCTION MOTOR & SYNCHRONOUS MACHINE

TESTS/CHECKS ITEMS/COMPONENTS	Visual	Dimensional	Make/Type/Rating/TC/General Physical Inspection	Mech/Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing(WPS/PQR)	Heat Treatment
Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y					Y
Shaft	Y	Y	Y	Y	Y	Y			Y
Magnetic Material	Y	Y	Y	Y	Y		Y		
Rotor Copper/Aluminium	Y	Y	Y	Y		Y	Y		Y
Stator copper	Y	Y	Y	Y			Y		Y
SC Ring	Y	Y	Y	Y	Y	Y	Y	Y	Y
Insulating Material	Y		Y	Y			Y		
Tubes for Cooler	Y	Y	Y	Y	Y				Y
Sleeve Bearing	Y	Y	Y	Y	Y				Y
Stator/Rotor, Exciter Coils	Y	Y	Y				Y	Y	
Castings, stator frame, terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y	



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Fabrication & machining of stator, rotor, terminal box	Y	Y			Y				Y
Wound stator	Y	Y					Y	Y	
Wound Exciter	Y	Y					Y	Y	
Rotor complete	Y	Y					Y		
Exciter, Stator, Rotor, Terminal Box assembly	Y	Y					Y		
Accessories, RTD, BTD, CT, Brushes, Diodes, Space heater, antifriction bearing, cable glands, lugs, gaskets etc.	Y	Y	Y						
Motor (IS 325 / 4722 / 9283)	Y	Y	Y						



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TESTS/CHECKS ITEMS/COMPONENTS	Magnetic Characteristics	Hydraulic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	All tests as per IS-325/IS-4722/IS 9283	Vibration	Over speed	Tan delta, shaft voltage & polarisation index test
Plates for stator frame, end shield, spider etc.									
Shaft									
Magnetic Material	Y		Y						
Rotor Copper/Aluminium									
Stator copper			Y						
SC Ring									
Insulating Material			Y						
Tubes for Cooler		Y							
Sleeve Bearing		Y							
Stator/Rotor, Exciter Coils									
Castings, stator frame, terminal box and bearing housing etc.									
Fabrication & machining of stator, rotor, terminal box									
Wound stator									
Wound Exciter									
Rotor complete				Y	Y				
Exciter, Stator, Rotor, Terminal Box assembly									



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Accessories, RTD, BTD, CT, Brushes, Diodes, Space heater, antifriction bearing, cable glands, lugs, gaskets etc.									
Motor (IS 325 / 4722)						Y	Y	Y	Y1
Note : - This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating the practices & Procedure followed alongwith relevant supporting documents during QP finalisation. However QP approval is not envisaged for LT motors upto 50 KW. - Makes of all major bought out items shall be subject to Customers approval. Y1 = for HT Motor / Machines only. Y – Test Applicable									



EPC TENDER SPECIFICATION FOR BTG PACKAGE

2.5.2.12 VARIABLE FREQUENCY DRIVE

Parameter Description	Component Description	Physical Inspection, Identification Labels & Physical Damages	Physical Inspection, Dimensions, Painting, Cutouts, Lifting Hooks	Locking Arrangements, Components, Drawing Pocket, Boring Accessories	Mounting Accessories, Plinth & AV pads, Cable	Hinges, Louvers & Filters	Physical Inspection	Type No., Rating, Dimensions & Accessories	No Phase, Ratio, Tappings & Rating	Type No., Rating, Dimensions & Accessories	Rating & Wattage	Rating & Wattage	Operation Of The Equipment	Mechanical Completion, Components Mounting	Terminal Block Mounting, Fixing Of Cable	Hardwares Checking, Labeling Of The Equipments,	Point to point Wiring Check	Wire Sizes Used, Wire Colours Used, Ferruling,	Termination Check, Continuity, Check	Power Up Tests & Power, Distribution Test,	VFD Parameterisation
VFD		Y																			
Panel			Y	Y	Y	Y															
Cables, wires							Y														
MCBs								Y													
Control Transformer									Y												
Contactor										Y											
Space Heater											Y										
Thermostat												Y	Y								
Assembled System														Y	Y	Y	Y	Y	Y	Y	



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Notes :

- 1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents during QP Finalisation for all items.
 - 2) All major Bought Out Items will be subject to Customer approval.
- Y – Test Applicable

2.5.2.13 HT CABLES

Attributes / Characteristics Item / Components / Sub System Assembly	Make, Type, Rating & T.C	Dimension/surface finish	Mechanical properties	Chemical Composition	Curing Properties	Electrical properties	Hot Set Test/ Eccentricity & Ovality	Lay length & Sequence	Armour coverage, cross over, looseness, gap between two wire	Sequential marking/surface finish/ cable length	T.S & elongation before & after ageing on sheath & insulation	Thermal stability on sheath	Anti Termite Test	Constructional requirements feature as per relevant standard & specification	Routine & Acceptance Test as per	FRLS Test
Aluminium (IS-8130)	Y	Y	Y	Y		Y										
Semiconducting Compound	Y		Y		Y	Y										
XLPE Compound (IS-7098 Part-II)	Y		Y		Y	Y					Y					
FRLS PVC Compound (IS-5831, ASTM-D2843, ASTM-2863, IEC-754 Part-1)	Y		Y								Y	Y	Y			Y
Triple Extrusion & curing /Manufacturing of Core							Y	Y								
Copper Tape	Y	Y	Y			Y										
Polyster tape	Y	Y														



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Armour wire/strip	Y	Y	Y													
PVC compound(IS-5831)	Y		Y			Y										
Copper tapping																
Inner sheath																
Armouring									Y							
Outer Sheathing										Y	Y	Y	Y	Y		Y
Power Cable (Finished) (IS : 7098 Part II, IEEE : 383, IEC : 332, IS-5831, ASTM-D2843, ASTM-2863, IEC-754 Part-1)	Y							Y	Y	Y	Y	Y	Y	Y	Y	Y
Wooden drum(IS-10418)													Y			

tes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
Make of all major Bought Out Items will be subject to Customer approval.



EPC TENDER SPECIFICATION FOR BTG PACKAGE

2.5.2.14 LT POWER CABLES

Attributes / Characteristics	Item / Components / Sub System Assembly	Make, Rating, Type & TC	Dimension/surface finish	Mechanical Properties	Chemical Composition	Electrical Properties	Spark Test	Hot set test (XLPE)	Lay length / Sequence	Armour coverage, Cross over, looseness, Gap between two armour wire/strip	Sequential marking/surface finish /cable length	Tensile strength, elongation before & after ageing of insulation & sheath	Thermal Stability of insulation and sheath *	Anti ternite treatment test	Constructional / requirement as per relevant standards & Spec.	Routine and acceptance test as per Relevant Standard and specification	FRLS Test
	Aluminium (IS-8130)	Y	Y	Y	Y	Y											
	PVC Compound (IS-5831)	Y		Y		Y						Y					
	XLPE Compound (IS-7098 Part-I)	Y		Y		Y		Y				Y					
	FRLS PVC Compound (IS- 5831)/ASTM-D-2843/ASTM- D-2863 IEC-754 Part-I	Y		Y								Y					Y
	Armour wire/ Formed wire (IS-3975)	Y	Y	Y													
	Insulated Core		Y				Y	Y	Y				Y				
	Laid up core		Y														
	PVC Inner sheath		Y														
	Armouring		Y							Y							
	Outer sheath		Y								Y	Y	Y	Y			Y



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Finish cable (IS-1554 & 7098 Part-1)/ASTM-D-2843/ASTM-D-2863 IEC-754 Part-I Swedish Chimney SEN SS 4241475 for (F3 category)/ Flamability test IEEE-383	Y	Y								Y	Y	Y	Y	Y	Y		Y	Y
Wooden drum (IS-10418)		Y											Y					
- Not applicable for XLPE insulation Notes: - This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan Indicating the practice and procedure along with relevant supporting documents. - Make of all major Bought Out Items will be subject to Customer approval.																		



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2.5.2.15 LT CONTROL CABLES

Attributes / Characteristics Item / Components / Sub System Assembly	Make, Type, Rating, T.C	Dimension/surface finish	Mechanical Properties	Chemical Composition	Electrical Properties	Spark Test	Lay length/Sequence	Armour coverage, cross over, looseness, gap between two armour wires	Sequential marking/surface finish/cable length	Tensile strength, elongation before & after ageing of insulation & sheath	Thermal stability of insulation and sheath	Anti-termite treatment test	Constructional feature as per relevant standards & Spec.	Routine & Acceptance test as per relevant standard & specification	FRLS Test
Copper Conductor (IS-8130)	Y	Y	Y	Y	Y										
PVC Compound (IS-5831)	Y		Y		Y					Y					
FRLS PVC Compound IS-5831 ASTM-D-2843 ASTM-D-2863 IEC-754 Part-1	Y		Y							Y					Y
Armour wire/ Formed wire (IS-3975)	Y	Y	Y												
Insulated Core		Y				Y	Y								
Laid up core		Y													
PVC Inner sheath		Y													
Armouring		Y						Y							
Outer sheath		Y							Y	Y	Y	Y			Y
Finish cable (IS-1554) ASTM-D-2843 ASTM- D-2863 IEC-754 Part-1 Swedish Chimney: SEN SS 424-1475(F3 category)	Y	Y						Y	Y	Y	Y	Y	Y	Y	Y
Wooden drum(IS:10418)												Y			



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- Notes:** 1.This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting Documents
2. Make of all major Bought Out Items will be subject to Customer approval.

Y – Test Applicable.

2.5.2.16 DC SYSTEM

BATTERY

LEAD ACID BATTERY											
ATTRIBUTES / CHARACTERISTICS											
ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY	Dimensions & Finish	Conformance to relevant part drg. & Manufacturer's standards	Chemical composition	Lead Coating Thickness (min. 25 microns, IS: 6848 App.F) & Adhesion Check	Conformance to Spec. for Teak Wood	Paint Process checks, Paint Shade, Thickness, Adhesion & Finish	Constructional requirements as per relevant standard & spec.	Insulation Resistance	Marking (Routine & Acceptance Test)	Checking of Polarity & absence of short circuit (Routine & Acceptance Test)	Test for Capacities for 10 hrs. discharge rate along with the test for voltage during discharge (Acceptance Test)
Container & Lids (IS : 1146)	Y	Y									
Vent Plugs	Y	Y									
Sealing Compound (IS : 3116)		Y	Y								
Positive & Negative Plates		Y	Y								
Separators (IS : 6071)	Y	Y									
Electrolyte (Water / Sulphuric Acid) (IS : 1069 / 266)		Y	Y								
Inter-cell Connectors & Fasteners	Y	Y		Y							
Battery Stand	Y	Y			Y	Y					
Cell Insulators	Y	Y						Y			
Stack Assembly	Y	Y									



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Lead Acid Battery (IS : 1652)	Y						Y		Y	Y	Y
Note: This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. Y - Test applicable											



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Ni- Cd BATTERY															
ATTRIBUTES / CHARACTERISTICS	ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY	Dimensions & Finish	Impact Strength	Conformance to relevant part drg. & Manufacturer's standards	Resistance to Alkali	Chemical composition	Nickel Plating thickness	Paint Shade, Thickness, Adhesion & Finish	Air Pressure Test after heat sealing	Marking & Mass (Routine & Acceptance Test)	Air Pressure Test (Acceptance Test)	Retention of Charge Test (Acceptance Test)	AH Test (Acceptance Test)	Insulation Resistance (Acceptance Test)	Polarity & absence of short circuit (Routine & Acceptance Test)
	Container & Lids	Y	Y	Y	Y										
	Vent Plugs	Y		Y	Y										
	Perforated Steel Strips	Y		Y	Y		Y								
	Active Material for Positive & Negative Plates			Y		Y									
	Separators	Y		Y	Y										
	Electrolyte			Y		Y									
	Inter-cell Connectors & Fasteners	Y		Y	Y		Y								
	Battery Stand	Y			Y			Y							
	Cell Insulators	Y		Y	Y										
	Stack Assembly	Y		Y					Y	Y			Y		Y
	Ni-Cd Battery (IS : 10918 / IEC : 623)	Y								Y	Y	Y	Y	Y	Y
Note:															
4. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.															
5. Makes of all major Bought out Items will be subject to Customer approval.															
Y - Test applicable															



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BATTERY CHARGER														
Attributes / Characteristics	Items / Components / Sub- assembly	Make, Model, Type, Rating & Finish	Chemical & Mechanical Tests	Sheet Steel Pre-treatment & Painting process checks	Conform to relevant Standards	Dimensional check and Paint shade, thickness, adhesion & Finish checks	Complete physical examination for constructional features of Battery Charger as per relevant standard & spec.	Temperature Rise Test	Dynamic Response Test	Ripple Content Test, Load Limiter & Annunciator & AVR Operation Test	Operational & Functional Checks	HV & IR Test	Burn-In Test at 50°C for 48 hrs	Degree of Protection Test as per relevant standard.
Rectifier Transformer (IS : 2026)	Y				Y			Y				Y		
Electronic Components including Potentiometer (Vernier Type)	Y				Y									
PCB & Electronic Cards	Y				Y									
19” standard racks for electronic cards	Y						Y							
Control & Selector Switches (IS : 6875)	Y				Y						Y			
Indicating Meters (IS : 1248)	Y				Y						Y			
Indicating Lamps (IS: 13947)	Y				Y						Y			
Air Break Switches / Fuses (IS : 13947 / 13703)	Y				Y						Y			
Control Terminal Blocks (IS : 13947)	Y				Y									
Control Transformer (IS : 12021)	Y				Y						Y			
Push Buttons (IS : 4794)	Y				Y						Y			
MCB (IS : 8828)	Y				Y						Y			



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PVC insulated Copper control wires (IS : 694)	Y			Y									
Sheet Steel (IS : 513)	Y	Y	Y	Y									
Synthetic Rubber Gaskets	Y	Y		Y									
Annunciator	Y									Y		Y	
Battery Charger	Y				Y	Y	Y	Y	Y		Y	Y	Y

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Makes of all major Bought Out Items will be subject to Customer approval.

Y - Test applicable



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2.5.2.17 DIESEL GENERATORS

DIESEL ENGINE											
TESTS/CHECKS	Material Test	DP/MPI	UT(On forging and piston Bonding)	Balancing	Hydraulic/water fill test	Assy./fit up	Dimension	Functional/Operation test	Performance test as per BS-5514/or equivalent IS/ISO- Standard including Governing Test for 3 hrs at full load and one hr at 10% overload	Fuel consumption, rated power measurement, rated speed	All other tests(if applicable) as per Spec./ relevant Std
ITEMS/COMPONENTS											
Crank shaft	Y	Y	Y	Y							
Cylinder blocks/heads	Y				Y						
Liner/ Radiator	Y				Y						
Rotating/moving parts other than crank shaft	Y	Y									
Piston	Y	Y	Y								
Diesel Engine						Y	Y	Y	Y	Y	Y
Note: This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan Indicating the practice and procedure along with relevant supporting documents. Y – Test Applicable											



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ALTERNATOR																		
TESTS/CHECKS	Visual	Dimensional	Make/Type/Rating/TC/General Physical Inspection	Mech./Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing(WPS/PQR)	Heat Treatment	Magnetic Characteristics	Hydraulic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	All tests as per IS-4722	Vibration	Over speed	Tan delta, shaft voltage & polarisation index test
Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y					Y									
Shaft	Y	Y	Y	Y	Y	Y			Y									
Magnetic Material	Y	Y	Y	Y	Y		Y			Y		Y						
Rotor Copper/Aluminium	Y	Y	Y	Y		Y	Y		Y									
Stator copper	Y	Y	Y	Y			Y		Y			Y						
SC Ring	Y	Y	Y	Y	Y	Y	Y	Y	Y									
Insulating Material	Y		Y	Y			Y					Y						
Tubes for Cooler	Y	Y	Y	Y	Y				Y		Y							
Sleeve Bearing	Y	Y	Y	Y	Y				Y		Y							
Stator/Rotor, Exciter Coils	Y	Y	Y				Y	Y										
Castings, stator frame, terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y										
Fabrication & machining of stator, rotor, terminal box	Y	Y			Y				Y									



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ALTERNATOR																
TESTS/CHECKS	Visual	Dimensional	Make/Type/Rating/TC/General Physical Inspection	Mech/Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing(WPS/PQR)	Heat Treatment	Magnetic Characteristics	Hydraulic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	All tests as per IS-4722	Tan delta, shaft voltage & polarisation index test
ITEMS/COMPONENTS																
Wound stator	Y	Y					Y	Y								
Wound Exciter	Y	Y					Y	Y								
Rotor complete	Y	Y					Y						Y	Y		
Exciter, Stator, Rotor, Terminal Box assembly	Y	Y					Y									
Accessories, RTD, BTD,CT,AVR. Brushes, Diodes,Space heater, antifriction bearing, cable glands, lugs, gaskets etc.	Y	Y	Y													
Alternator (IS 4722)	Y	Y	Y												Y	Y
Note: 1.This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents during QP finalisation. 2. Make of all major bought out items will be subject to Customer approval. Y1= for HT Machines only. Y – Test Applicable																



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FINAL ASSEMBLY										
TESTS/CHECKS ITEMS/COMPONENTS	Material Test	Dimension	WPS/PQR/Welding	NDT/DP/MPI/UT	Check completeness	Hydraulic/Leak/Pressure test	Functional Tests	All routine test as per Spec/ IS	No load test for one hour of the DG set assembly	Clearances & Alignment
Base frame	Y	Y	Y	Y	Y					
Fuel Tank	Y	Y	Y	Y	Y	Y				
Battery (IS – 1691)								Y		
Battery Charger								Y		
Control Panel								Y		
Assembled DG Set		Y			Y		Y		Y	Y
NOTES: 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2. Make of all major Bought Out Items will be subject to Customer approval.										



EPC TENDER SPECIFICATION FOR BTG PACKAGE

2.5.2.18 CABLING, EARTHING & LIGHTNING PROTECTION

ATTRIBUTES / CHARACTERISTICS ITEMS/COMPONENTS / SUB SYSTEMS	Make, Type, Rating/ TC	Dimension	Pre-treatment of sheet	Paint shade, paint thickness, adhesion	IP protection	Bought out items/Bill of material	HV & IR	Galvanise Test (If Applicable)	Functional Test as per spec.	Proof Load	Deflection test	Constructional feature as per relevant standard & Specification.	Routine & acceptance test as per Relevant standard and specification	Item confirm to relevant standard
Switch box/junction box/ Receptacles (IS-513, IS:5, IS:2629, 2633, 6745)	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y	Y	
Cable glands(BS-6121)	Y	Y												Y
Cable lug(IS-8309)	Y	Y												Y
Lighting wire(IS-694)	Y	Y										Y		Y
Flexible conduits	Y	Y										Y		Y
Conduits(Galvanise & Epoxy) IS-9537 & IS- 2629,2633,6745	Y	Y	Y					Y					Y	
RCC Hume Pipe (IS-458)	Y	Y												Y
Cable termination & straight through joint (VDE- 0278)	Y	Y			Y	Y						Y	Y	
Cable Trays, Flexible supports system & accessories IS-513, 2629,2633,6745	Y	Y	Y			Y		Y		Y	Y	Y	Y	
Trefoil clamp	Y	Y												Y
GI flats for earthing & lightning protection (IS 2062, 2629, 6745,2633)	Y	Y	Y					Y						Y
GI wire (IS-280)	Y	Y	Y					Y						Y
Wall Mounted – Lighting Panel (IS-513, IS-5, IS-2629, IS-2633, IS-6745)	Y	Y		Y	Y			Y				Y	Y	
Fire Sealing System (BS-476)	Y	Y			Y							Y		Y



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Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Make of all major Bought Out Items will be subject to Customer approval.

Y – Test Applicable

2.5.2.19 ILLUMINATION

Attributes/Characteristics Item/Components / Sub System/Assembly	Make, Type, Rating/ TC	Dimension	Pre-Treatment of sheet	Paint Shade Thickness Adhesion & Finish	Galvanise Test	IP Test	Bought Out Items/ Bill of Material	HV & IR	Functional Check as per spec.	Constructional Feature as per relevant standard & spec.	Routine & Acceptance Test as per relevant std and spec	Item to conform to relevant standard
Luminaries (IS-10322 Part-5 Sec.1)	Y					Y		Y			Y	
Electronic Ballast	Y											Y
Lighting Wire (IS-694)	Y											Y
Fans (IS-374)	Y											Y
Pole (IS-2713)	Y			Y						Y	Y	
Lamps (IS-9800, IS-9974)	Y											
Lighting Mast (IS-2629, 2633, 4759, 2062, 6745)	Y	Y			Y					Y	Y	
Wall Mounted Lighting Panel (IS- 513, IS-5)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Switch Box/ Junction Box/Receptacles/ Local Push Button Station, Lighting Panel (IS-513, 2629, 2633, 4759, 6745)	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	
Cable Gland (BS-6121)	Y	Y										Y
Cable Lug (IS-8309)	Y	Y										Y
Flexible Conduit	Y											Y
Lighting Transformer (IS-1117)	Y									Y	Y	
Flood Light Mast										Y	Y	



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Attributes/Characteristics												
Item/Components / Sub System/Assembly	Make, Type , Rating/ TC	Dimension	Pre-Treatment of sheet	Paint Shade Thickness Adhesion & Finish	Galvanise Test	IP Test	Bought Out Items/ Bill of Material	HV & IR	Functional Check as per spec.	Constructional Feature as per relevant standard & spec.	Routine & Acceptance Test as per relevant std and spec	Item to conform to relevant standard
Epoxy & Galvanised Conduit (IS- 9537, 2629, 2633, 4759, 6745)	Y	Y									Y	

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Make of all major Bought Out Items will be subject to Customer approval.

Y – Test Applicable

Quality Assurance Plan

Part 2.5.3 Control & Instrumentation Works



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VOLUME II-SECTION 2
PART 2.5- QUALITY ASSURANCE PLAN
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QUALITY ASSURANCE AND TESTING AND GUARANTEES

2.5 Quality Assurance Plan

2.5.3 General Requirement

All equipment furnished under this specification shall be subject to test by authorized quality assurance personnel of the Bidder, representatives of the Owner during manufacture, erection and on completion. Bidder's quality assurance personnel for these shop and site tests shall be identified in advance and shall be acceptable to the Owner. The approval of the Owner or passing of such inspection of tests will not, however, prejudice the right of the owner to reject the equipment if it does not comply with the specifications when erected or fails to give complete satisfaction in service.

The Bidder shall furnish details of shop and site tests proposed to be conducted by him at various stages to meet the specification requirements for each type of instrument/system along with his proposal. Bidder shall also furnish details of his proposed shop and site quality assurance organization for this contract. Bidder shall prepare a detailed shop and site 'Quality Assurance Programme' to meet the requirements of these specifications for Owner's approval. This document shall also contain the formats for reports and maintenance of test records specification of test equipment to be used for site tests.

All equipment and systems furnished under this specification shall be subjected to shop & site tests in accordance with the Quality Assurance Program approved by the Owner and shall be adequate to ensure full compliance with these specification, all applicable codes & standards and detailed engineering drawings and documents approved by the Owner.

The Bidder shall provide all required test equipment and simulation devices for performing all shop and site tests. All tests equipment shall be of reputed make, required accuracy class and shall be recently calibrated. The record of calibration of test equipment shall be made available to the Owner on demand.

The cost of all tests as per the requirements of this specification and approved quality assurance programme shall be included in Bidder's lump sum price for this package and no extra price shall be payable by the Owner for conducting any test as per the intent and requirements of this specification.

All approval/Inspection are to be carried out by the Owner only.

2.5.3.1 Testing Method

i) Shop Test

Shop tests shall include all tests to be carried out at Bidder's works at of this sub-bidder and at works where raw materials used for manufacture of equipment is produced.



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Individual components, instruments and devices furnished in accordance with specification sheets, and I&C device list enclosed with these specifications shall be shop tested by manufacturer prior to shipment. The manufacturer shall conduct these tests for certifying compliance with published specifications for the equipment and provide test results to the Owner in writing. These tests and test certificates shall be in accordance with the agreed 'QA' programme for major systems/equipments. However, manufacturer's standard methods shall be followed if details of tests for any equipment are not covered under this agreed 'QA Programme'. Whenever tested quality material is specified and wherever called upon by Indian Boilers Regulations or by the design code, the test pieces are to be prepared and tested to Owner's satisfaction.

In the event of Owner being furnished with certified particulars of tests, which have been carried out by the suppliers of material, the Owner may, at his discretion, dispense with these tests.

ii) **Material Tests**

Whenever tested quality material specified and whenever called upon by Indian Boilers Regulations or by design code, the test pieces, are to be prepared and tested to Owner's satisfaction.

In the event of Owner being furnished with certified particulars of tests, which have been carried out by the suppliers of material, the Owner may, at his discretion, dispense with these tests.

iii) **Test at Manufacturer's Works**

Works tests are to include electrical, mechanical performance and hydraulic tests in accordance with relevant IS, IBR or any other approved standard or any other tests called for by the Owner under these specifications to ensure that the equipment being supplied fulfils the requirements of these specifications. For equipments not covered by any IS or other approved standards, the tests to be carried out shall be in accordance with Bidders' quality assurance programme approved by the Owner.

Control systems, monitoring systems, control panels instrument enclosures, and power supply systems shall be shop tested according to unique requirements specified in the applicable section of these specifications for each item and quality assurance program approved by the owner.

All shop tests shall be performed prior to shipment and the Owner shall be given the opportunity to witness these tests. The Bidder shall notify the Owner regarding readiness for shop test at least 10 days before the scheduled date if the tests to be conducted within Indian and at least 60 days before the schedule date if the test is to be conducted abroad.

iv) **Factory Tests**



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Automatic Control and Monitoring system (DDCMIS, DCS & any other microprocessor based control system) including alarm annunciation system furnished as per this specification shall be subject to shop and site tests as per the requirements of this specification, applicable codes and Owner approved Quantity Assurance Program so as to demonstrate to the Owner that the equipment furnished by the Bidder meets the intent and requirement of this specification. These tests shall include but shall not be limited to the tests indicated in the subsequent clauses.

v) Surge Protection Test for Solid State Equipment

All solid state equipment shall be able to withstand the noise and surge inherent in a Power House, and shall strictly comply with SWC tests ANSI C 37.90A, 1974 for IEEE-472 (1974). Complete details of the features incorporated in electronic system to meet this requirement, the relevant test carried out, and the test certificates shall be submitted along with the proposal.

vi) Burn-in and Elevated Temperature Test

All solid state electronic equipment shall be tested as a complete system/equipment with all devices connected for a minimum of 168 hours continuously under energized conditions prior to shipment from manufacturer's works, as per the following cycle :-

1. During the first 48 hours of testing the ambient temperature shall be maintained at 50 deg.C and relative humidity at 95%. The equipment shall be interconnected with all devices, which will cause it to repeatedly perform all operations; it is supposed to perform in actual service, with load on various components being equal to those, which will be experienced in actual service.
2. The 48 hours tests period shall be continuous but shall be divided into four 12 hours segments. The input voltage during each 12-hour segment shall be nominal voltage for 11 hours, followed by 110% of normal voltage for 30 minutes followed by 90 percent of nominal voltage for 30 minutes. The 48 hours elevated temp test shall be followed by 120 hours of burn in test as specified in the above paragraphs except that the temperature is reduced to ambient temperature prevalent at that time. Alternatively copy of type test certificate for burn-in test shall be submitted.

The Bidder shall furnish full details regarding shop tests and site tests, as per good engineering practices. The Owner shall approve all such tests and the supplier shall conduct all such tests without calling for additional price. The tests shall cover factory tests, burn-in and elevated temperature tests, simulation and functional tests, insulation tests as applicable, the rating of the contact devices and components, surge withstand capability test, conformity of interconnection cables, testing and checking of other conditions deemed to be necessary with the system/equipment items.

All instruments and control equipment supplied against this contract shall be factory calibrated at least at five (5) points throughout the range and checked for their



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functional/performance requirements. The instruments shall also be calibrated at site prior to commissioning.

All panels, instruments enclosures, junction boxes, etc. shall be type tested for degree of protection and applicable in accordance with IS: 2147. 8.02.04

Type, routine and acceptance testing of all equipments, supplied under this contract, shall be in accordance with relevant NEEA/IS/IEC/ANSI/BS/ISA standards, in addition to the requirements of Owner approved Quality Plans. Six (6) copies of test reports shall be submitted to the Owner for approval prior to dispatch of respective equipment

The representative of Owner shall be given opportunity to witness the factory tests which shall be mutually finalized during the progress of the contract.

All control systems to be furnished for this project, shall be factory tested for circuit continuity and direction of response. The Components to be tested shall include all controllers, HAND/AUTO station, other system modules, alarm contactors and multi-conductor interconnecting cables. The tests shall be performed with all of the system components supplied by the Bidder connected to form a complete system with the sole exception of transmitters. The tests shall include a means of confirming the mathematical design response of the control system by simulating changes in system input. The tests shall be a qualitative functional test of each component of control system, which simulates dynamic inputs and monitors system outputs.

Certain control loops shall be factory tested using closed loop mathematical simulation techniques. Control loops to be tested by closed loop methods are broadly as under. However, owner has discretion to test and all control loops during simulation testing.

1. Firing rate control (fuel and air flow control)
2. Furnace draft control
3. Boiler separator level control

2.5.3.2 Response time for Turbine Control System.

The input simulation equipment shall be designed to produce effects from control system outputs based on mathematical model of the predicted performance and process dynamics of the main unit equipment. The control constants of various control loop components shall be adjusted to produce a stable and optimum control adjusted to produce a stable and optimum control when connected to the simulation equipment.

Simulation data including factory adjustment of control system constants, and simulation equations shall be tabulated and shall be made available by the Bidder for owner's use during field check out and the Startup of the control system.

Availability of a simulated type test for automatic control loops specified with a detailed description of testing methods utilized, shall be indicated.



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The availability of facilities for carrying out the model test for the control systems shall be indicated by the bidder. Also details of test procedures and copies of test results conducted for a similar fossil fuel fired unit shall be furnished. The data required from Boiler and Turbo generator supplies shall also be furnished by the Bidder.

Brief description of all tests proposed to be conducted on each control system components during various stages of manufacture, installation and commissioning shall be furnished. Copies of test data accumulated during the tests shall be submitted to the mutually agreed formats. The owner shall witness the factory tests which shall be performed at a time mutually agreeable to the Bidder and the owner.

2.5.3.3 Factory Acceptance Tests for DDCMIS, DCS & Simulator

Type of Document	S.No	Name of the document	Test required or not
General	1	Factory acceptance test (fat): ref note-1	Yes
Test requirements	1	Test shall be performed with the completely assembled system and also with complete package	Yes
	2	I&C software and performing all functions expected out while in actual service and with system configuration as finalised	Yes
	3	Process input/output conditions and other load on the system to be stimulated either by hardware /software	Yes
	4	All system software and application software to be loaded and operational on the system prior to fat	Yes
	5	Fat to be conducted at elevated temperature of 45 deg. C for minimum 48 hours	Yes
	6	Fat under four cycles of voltage fluctuations via normal at 110% of rated voltage	Yes
	7	Performance test	Yes
Test drawing and documents	1	Total system configuration drawings	Yes
	2	Fat procedure consisting of	Yes
	i.	Test equipment	Yes
	ii.	Test environment	Yes
	iii.	Test configuration	Yes
	iv.	Test procedure	Yes
	v.	Test schedule	Yes
	vi.	Test venue	Yes
	vii.	Test reports – specimen copies	Yes
Preliminary checks	3	Function design specification for each equipment / system	Yes
	1	General appearance check and bill of material check	Yes
	2	Construction check as per overall general arrangement drawings	Yes
	3	Dimensional check	Yes
	4	Labelling, terminal arrangement and equipment identification check	Yes
	5	Power supply, voltage level check and power led's on check	Yes



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Type of Document	S.No	Name of the document	Test required or not
Redundancy check	6	Cooling fan operation check	Yes
	7	Grounding network check	Yes
	1	Power supply under voltage and over voltage check (+/- 10%)	Yes
	2	Processor and main data bus network redundancy check, if applicable	Yes
	3	Communication coupler if applicable redundancy check	Yes
	4	Communication module of the controller to network redundancy check, if applicable	Yes
	5	Power supply redundancy check	Yes
	6	Hardware on line maintainability check	Yes
Controllers engineering	1	Closed loop control simulation check	Yes
	2	Open loop control simulation check	Yes
	3	Control loop response check	Yes
	4	Bumpless auto manual transfer check	Yes
	5	Operating station – graphic overview check	Yes
	6	Operating station- trend check	Yes
	7	Operating station- real time trend check	Yes
	8	Operating station- mimics check	Yes
	9	Operating station- check for operating control directly from mimics	Yes
	10	Operating station- function keys check	Yes
	11	Operating station- touch screen function check	Yes
	12	Operating station- analog control display check	Yes
	13	Operating station- sequence control display check	Yes
	14	Operating station- operator guidance message check	Yes
	15	Operating station- alarm management function check	Yes
	16	Operating station logging function check	Yes
	17	Operating station / response / updating check	Yes
	18	Keyboard lock function check	Yes
	19	Operating station interchangeability and assignability check	Yes
	20	Printer assignability and back-up function check	Yes
	21	Floppy disk / std. / optical disk unit storage and retrieval check	Yes
	22	Operating station assignability check for hard copier function	Yes
	23	Plant performance calculation check	Yes
	24	Communication interface to other's system simulation check	Yes
	25	Data bus distance building check (refer note- 3)	Yes
	26	Graphic display building function check	Yes
Maintenance	1	Closed loop control system modification check	Yes
	2	Open loop control system modification check	Yes
	3	Alarm display prioritisation check	Yes
	4	System security check	Yes
	5	System alarm check	Yes
	6	System diagnostic function check	Yes
	7	Point detail configuration check	Yes
	8	Control loop tuning check	Yes
	9	System self documentation check	Yes
Notes	1.	The intent of the fat is to demonstrate and ensure that the I&C system meets all the functional requirements as intended in the specification / contract. A completed integrated test of the system shall be carried out at vendor's works in the presence	



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Type of Document	S.No	Name of the document	Test required or not
		of owner, on completion of integration / manufacturing of the system. The shipment of I&C equipment to site will be effected only after the fat has been accepted by the owner.	
	2	Fat procedure shall be prepared by vendor and to be submitted for owners / approval well in advance prior to the commencement of fat	
	3.	Fat shall be conducted with the distance between the processor and other supporting peripherals as per the final layout in the control room.	
	4.	All the relevant approved documents required for fat shall be submitted by the bidder in advance prior to commencement of fat.	

2.5.3.4 Factory Acceptance Test for Simulator

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

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

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

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

1. Pre power on checks
2. Power on check
3. Hardware tests
4. Functional tests
5. Parametric tests
6. Specific tests on Electronic hardware

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

- a. Verification of individual modules in line with approved documents.
- b. Verification of adherence to parameters for various plant configurations at different initial conditions.
- c. **Functional test for C&I Model**



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

d. Functional tests for HMIPIS

1. Verification of all types of displays, logs including their formats, bar graphs, X-Y plots etc. Verification of all function keys on keyboards and availability of all operator functions.
2. Verification of event generation and handling capabilities of HMIPIS processors by simulating various types of events / data and observing associated event sequence display and alarm signalling boxes.
3. Calculations:

All calculations shall be tested to demonstrate that these are in accordance with the specification and I/O schedule. The Bidder shall prepare all tests cases for calculations (3 for each calculation at low, mid and upper ranges of inputs) and submit them for the owner's approval. Test cases shall include performance calculations, flow and level calculations, pressure and temperature compensations, etc.

4. Checking historical storage and retrieval functions including long-term storage.
5. Checking healthiness of processor, main memory. Testing of initialization and loading of configuration data, etc.
6. Verification of all programmers' stations functions for HMIPIS and Control System, as well as for documentation facility as specified.
7. Various display response time / System accuracy etc.
8. Display update time on OWS

e. Functional test for networking & communication devices

1. Verification of various features as per approved documents.
2. Verification of throughput after creating high communication traffic.

f. Instructor's workstation Functions

Verification of all features of instructor functions like malfunction, initial conditions, snap shots, trainee exercises etc. in line with specification & approved documentation.

g. Programming and Documentation functions



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1. Verification of all programming function like, modification of application software, database, administrators function etc. in line with specification and approved documents.
2. Verification of all documentation functions in line with specification and approved documents.

2.5.3.5 FAT Procedure

The Bidder shall submit a detailed FAT procedure for owner's approval during detailed engineering stage based on the above guidelines. The FAT procedure to be submitted by the Bidder shall be detailed and exhaustive enough such that owner is satisfied that all the Simulator System specification requirements and features are being tested and the system meets these requirements.

i) Tests to be performed during FAT of Peripherals & other control system

1. Colour Graphic Video Display Unit (OWS)

- a. Functional tests (As per FAT procedure. Note-1)
- b. Test for capabilities of OWS including error detection for the complete system (Both hardware & software) simulating worst conditions
- c. Noise test
- d. Surge withstanding capacity as per IEEE or equivalent
- e. Quality assurance as governed by BS 5750 or equivalent
- f. Design, construction, components, finishes and testing of electronic equipment as per EES-1980 (General specification of electronic equipment) or equivalent Note-1: Test to be witnessed by Owner.

2. Keyboard

- a. Test for satisfactory operation of keyboard controls, push buttons and all associated functions (As per FAT procedure. Note-1)
- b. Quality assurance as governed by BS 5750 or equivalent for functional test for the complete system simulating worst conditions
- c. Design, construction, components, finishes and testing of electronic equipment as per EES-1980 (General specification of electronic equipment) or equivalent Note-1: Test to be witnessed by Owner.

3. Printers

- a. Noise level test for the printer
- b. Test of interlock performance and error detection feature.
- c. Quality assurance as governed by BS 5750 or equivalent
- d. Design, construction, components, finishes and testing of electronic equipment as per EES-1980 (General specification of electronic equipment) or equivalent

4. Floppy / Tape Drive Unit / Bulk Memory Unit / DVD, CD drive Unit / DAT Drive



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- a. Noise test
- b. Surge withstanding capacity as per IEEE or equivalent
- c. Quality assurance as governed by BS 5750 or equivalent
- d. Design, construction, components, finishes and testing of electronic equipment as per EES-1980 (General specification of electronic equipment) or equivalent
- e. Test of Control unit and drive for all features, date checking features.

5. Vibration Monitoring & Analysis System

- a. Simulated functional test (Note-1)
- b. Tests for server, LED monitor, Printer, Keyboard (Note-1: Test to be witnessed by Owner)

6. PADO (Performance & Optimization System)

- a. Simulated functional test (Note-1)
- b. Tests for server, LED monitor, Printer, Keyboard (Note-1: Test to be witnessed by Owner.)

7. ERP System

- a. Simulated functional test (Note-1)
- b. Tests for server, LED monitor, Printer, Keyboard (Note-1: Test to be witnessed by Owner.)

8. MIS System

- a. Simulated functional test (Note-1)
- b. Tests for server, LED monitor, Printer, Keyboard (Note-1: Test to be witnessed by Owner.)

9. HMS System

- a. Simulated functional test (Note-1)
- b. Tests for server, LED monitor, Printer, Keyboard (Note-1: Test to be witnessed by Owner.)

Notes:

- 1. The intent of the FAT is to demonstrate and ensure that the I&C system meets all the functional requirements as intended in the specification / contract. A completed integrated test of the system shall be carried out at vendor's works in the presence of Owner or Owner's representative, on equipment to site will be effected only after the FAT has been accepted by Owner.
- 2. FAT procedure shall be prepared by vendor and to be submitted for Owners approval well in advance prior to the commencement of FAT.



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2.5.3.6 Calibration of Instruments

The Bidder shall carry out the calibration of instruments as indicated below by submitting the test procedure and quality assurance plan for the Owner's approval. Bidder shall also prepare detailed checklist/calibration sheets for each of the systems/equipment clearly indicating the step-by-step procedures to be carried out for calibration pre commissioning, loop checking, powering and commissioning.

The calibration of all instruments shall be checked and calibration records prepared for the Owner's use. If the instruments require recalibration, Bidder shall recalibrate the instruments and revise the calibration records and submit to the Owner.

2.5.3.7 Tests to be performed for Field Instruments

S.No	Tests to be performed
1.	Pressure Gauges
	Calibration Hydro test (1.5 times max. pr.)
2.	Pressure switches
	Calibration test / Hydro test / Contact rating test / Accuracy test / Repeatability
3.	Differential Pressure Gauges
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
4.	Differential Pressure Switches
	Calibration test / Hydro test / Contact rating test / Leak test / Accuracy test / Repeatability test.
5.	Thermometers
	Calibration / Material test / Accuracy test / Bore concentricity : $\pm 5\%$ of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
6.	Temperature switch
	Calibration / Material test / Accuracy test / Bore concentricity: 1.5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.) / Contact rating test.
7.	Resistance temperature detector assembly.
	Calibration / Material test / Bore concentricity test / Insulation test ($\leq 500 \text{ M}\Omega$ at 500V DC) As per ISA, Hydro test for TW. Bore concentricity: $\pm 5\%$ of wall thickness, Accuracy test.
8.	Thermocouple assembly
	Calibration / Material test, Insulation test ($\geq 500 \Omega$ at 500 V, DC) as per ISA, Hydro static test (1.5 times max. pr.), Bore concentricity: $\pm 5\%$ of wall thickness.
9.	Thermo wells
	Material test / Bore concentricity: $\pm 5\%$ of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
10.	Level Gauges



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S.No	Tests to be performed
	Hydrostatic test / Material test / Seat leakage test / Ball check test.
11.	Level switches (Magnetic)
	Material test / Contact rating test / Hydro test / Calibration test.
12.	Flow Switch
	Material test / Hydro static test (1.5 times max. pr.) / function test.
13.	Flow glasses
	Material test / Hydrostatic test (1.5 times max. pr.) / function test.
14.	Variable area flow meters
	Calibration test / Material test / Hydrostatic test (1.5 times max. pr.)
15.	Flow element
	100% Radiography test / Hydro test / Calibration test, IBR Certificate.
	Calibration test for flow element shall be witnessed by Owner.
16.	Control valves / Pneumatic block valve / Pressure regulating valve – Refer chapter 10.
17.	Position transmitters
	Calibration / hysteresis and Accuracy test
18.	Electro Pneumatic Convertors
	Calibration test / Accuracy test
19.	Solenoid valves
	Hydro test / Seat leakage test / CV test / Coil insulation test
20.	Air filter regulators
	Calibration test / Accuracy test
21.	Junction Boxes
	Test for degree of protection / Material test
22.	Tests for terminal blocks
	Test for moulding for flame resistant, Non-hygroscopic and Decarbonised / Insulation test between terminals / Insulation between terminal block and frame.
23.	Thermocouple extension cable
	Thermo-e.m.f characteristic / Continuity test / Measurement on capacitance, inductance and loop resistance / Insulation resistance / High voltage test as per latest IS / Tensile and elongation test / Oxygen index test / Any other test applicable.
24.	Mass flow meter
	Performance test / Calibration test / Hydrostatic test.
25.	Boiler Level Gauge
	Hydrostatic test / Material test / Seat leakage test / IBR Certificate
26.	pH / Conductivity measurement / Silica / Dissolved oxygen analysers:
	Calibration test, Accuracy test
27.	Sample cooler :



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S.No	Tests to be performed
	Hydro test, IBR Certificate
28.	Sampling racks :
	Hydro test, IBR Certificate for tubes and fittings.
29.	SO₂ / NO_x analyser / SPM analyser:
	Calibration test, accuracy test
30.	Interposing relay
	Functional test, temperature rise test, H.V test, Insulation test
31.	Transmitter Racks :
	Hydro test, air leak test for piping / tubing and fittings. IBR certification as required for tubing / piping and fittings.
32.	Pressure Transmitter
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
33.	Differential pressure transmitter
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
34.	Temperature Transmitter
	Calibration test / Accuracy test / Ambient temperature error test
35	Pneumatic Block Valves
	a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 Deg.C) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 Deg.C) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test
36.	Pressure Regulating Valve
	a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 Deg.C) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 Deg.C) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test
37.	Local Panels :
	Visual inspection, wiring & continuity check, H.V. and I.R. tests on panels, checking of bill of materials, functional tests.
38	Wiring Termination & Accessories



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S.No	Tests to be performed
	Routine test: Conductor resistance test / High voltage test / Impulse dielectric test / insulation test / Humidity test / Temperature rise test on power circuits / short time current test on power circuits.
	Type test: Annealing test / Test for insulation and sheath / Flame retardency test - a) Oxygen index, b) Flammability / Test for acid gas generation / test for water absorption / wet dielectric test
39	Marshalling / System cabinets
	Verification of degree of protection / Electrical tests as detailed under wiring Termination & accessories / Type test and routine test as per relevant Indian standards.
	Notes:
	1. Test Certificates in addition to inspection at manufacturers works shall be furnished for all the instruments for Owner's review. 2. Above Test to be witnessed shall be finalized by Owner. 3. In addition to above test, test as per approved QAP shall also be witnessed by owner

i) Testing Types

The BIDDER shall furnish the Type test reports of all type tests as per relevant standards and codes. As well as other specifics test indicated in the specification. A list of such test are given for various equipment in table titled, Type Test Requirement for C&I System and under the item special requirement for solid state requirements/systems. For the balance equipments/instruments type test may be conducted as per manufacturer standards or if required by relevant standards.

- 1) Out of these test listed, the bidder / sub vendor / manufacturer is required to conduct certain type test specifically for this contract (and witnessed by employer or his authorized representative). Even if the same have been conducted earlier as clearly indicated subsequently such tests.
- 2) For the rest, submission of type test, results, and certificates shall be acceptable provided following points
 - a) The same have been carried out by the bidder/ sub vendor on exactly the same model/rating of equipment. (For control valves this shall be same size, type & design).
 - b) There has been no change in the components from the offered equipments and tested equipments.
 - c) The test has been carried out as per the latest standards along with amendments as on the date of bid opening.
- 3) In case the approved equipment is different from the one on which the type test had been conducted earlier or any of the above grounds, then the tests have to be repeated and the cost of such tests shall be borne by the bidder/sub-vendor within the quoted price and no extra cost will be payable by the owner on this account.



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As mentioned against certain items, the test certificates for some of the items shall be reviewed and approved by the main bidder or his authorized representative and balanced have to be approved by the employer. The schedule of conduction of type test/submission of reports shall be submitted and finalized during preaward discussion.

For the type test to be conducted, bidder shall submit detailed test procedure for approval by owner. This shall clearly specify test setup, instruments to be used, procedure, and acceptance norms (wherever applicable). , recording of different parameters, intervals of recording precaution to be taken etc. for the test to be carried out.

ii) Special Requirements for Solid State Equipments /Systems

The minimum type test report, over and above the requirements of above clause which are to be submitted for each of the major C&I systems like DDCMIS, DCS etc. shall be as indicated below:

Surge Withstand Capability (SWC) for solid state equipments/equipments

1. All solid state systems/equipments shall be able to withstand the electrical noise and the surges as encountered in actual service conditions and inherent in the power plant. All the solid states systems /equipments shall be provided with all required protection that needs the surge withstand capability as defined in ANSI 37.90.1/IEEE 472. Hence, all front end cards which receive external signals like analog input and output modules, Binary input and output modules etc. including power supply, data highway, data links shall be provided with protection that meets the surge withstand capability as defined in ANSI 37.90.1/IEEE 472. Complete details of the features incorporated in the electronic system to meet this requirement the relevant test carried out, the test certificates, etc. shall be submitted along with the proposal. As an alternative to the above, suitable class of EN 61000-4-12 which is equivalent to ANSI 37.90.1/IEEE 472 may also be adapted for SWC test.
2. The dry heat test as per IEC-68-2-2 or equivalent
3. Damp heat test as per IEC 68-2-3 or equivalent
4. Vibration test as per IEC 68-2-6 or equivalent
5. Electrostatic Discharge test as per EN 61000-4-2 or equivalent
6. Radio frequency immunity test as per EN 61000-4-6 or equivalent
7. Electromagnetic Field Immunity test as per EN 61000-4-3 or equivalent

Test listed at Item no 5, 6, 7 above are applicable for electronic cards only as defined under item no. 1 Above

iii) Type Test Requirements for C&I Systems

S.No	Item	Test Requirement	Standard	Test to be specifically conducted	Owners approval required on test certificate



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S.No	Item	Test Requirement	Standard	Test to be specifically conducted	Owners approval required on test certificate
1	Electrical metering instruments	As per standards	IS 1248	No	Yes
2	Thermocouple	Degree of Protection Test	IS - 13947	No	No.
3	Junction Box	Degree of Protection Test	IS - 13947	Yes	Yes
4	RTD	As per standards	IEC-60751	No	No
5	Electronic Transmitter	As per standards	BS 6447 / IEC 60770	No	Yes
6	E / P convertor	As per standards	Manufacturing standard	No	Yes
7	Instrumentation cable (Twisted and shielded) (Refer Vol. II, Chapter 8)				
8	Battery	As per standard	IS 10918	Yes	YES
9.	Voltage stabiliser	Over load test	Approved procedure	No	YES
		Temp. rise test without redundant fans	Approved procedure	No	YES
		Input voltage variation test	Approved procedure	No	YES
10	DDCMIS				
	CLCS system	Model Test	Approved procedure	No	No
	BMS & MFT	Safety requirement	VDE0116, SEC 8.7	No	YES
11	Conductivity type level switch	Degree of protection test	IS 13947	No	No
12	Local gauges	Degree of protection test	IS 13947	No	No
13	Process actuated switches	Degree of protection test	IS 13947	No	No
14	Control valves	CV test	ISA 75.02	No	YES
15	LIE / LIR	Degree of	IS 13947	YES	YES
16	Flue gas O2 analyser, other Flue	Degree of protection test	IS 13947	No	YES
17	Flow nozzles & Orifice plates	calibration	ASMEPTC BS 1042	YES	YES

Note:



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Type test are to be conducted only for the items, which are being supplied as part of this package.

For batteries with electric power supply system of main plant C&I, the bidder shall submit for owner's approval the reports of all the type tests as per IS-10918 carried out within last 5 years from the date of bid opening and the test should have been either conducted at an independent laboratory or should have been witnessed by an owner/client. The complete type test report shall be for any rating of battery in a particular group, based on plate dimensions being manufactured by supplier.

For batteries with electric power system of auxiliary plants, type test reports for batteries shall be as per standard –practice of manufacturer.

iv) Testing at Site [Prior to commercial operation]

a) All equipment shall be checked thoroughly in respect of the following:

1. Visual and mechanical testing
2. Complete system configuration loading functions; system diagnostics; system proper operation specified power supply specifications.
3. Checking of loop configuration & OS displays; correct functioning of all keyboards; correct change-over of redundant devices; proper functioning of printer, sample printing of all types of log reports, shutdown reports and MIS reports; shutdown system.
4. Loading of user's programme and checking out of results.
5. Repeating any or all such tests (as necessary) as performed at works.

b) Modulating Control Loop Test

Loop test performed after calibration of all instruments and leak test of signal lines to check the functional performance of all elements of loop. Control loop testing shall be generally by simulation of process conditions and shall fix points namely 0%, 25%, 50%, 75% and 100% of full scale inputs. The field/receiver pressure switches shall be simulated for abnormality by disconnecting the wires of terminals and checking the function of all associated systems. Performance of individual loops may be accepted for an overall accuracy of +0.5%. After the loop test is complete, the bidder shall connect back any terminations and connections removed for loop check.

c) Protection, Interlocking Sequence Control Loop Checking

1. Loop check shall be carried out for checking the interconnection, configuration and overall system functioning. It includes termination of field cables in control room, checking of interconnection between equipment, ferruling, tagging of interconnecting cables & ferruling of field cables in control room and performing overall loop performance check from field instruments/equipment to DDCMIS and back; and all associated loop interconnections.



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2. Loop checking ensures proper configuration, functioning and interconnection.
3. All readings shall be recorded on an approved format covering the following:
 - i) All loop components shall be checked for proper functioning.
 - ii) For field switches and other initiating devices, abnormalities shall be simulated by disconnecting the wires at the field instruments end.
 - iii) Alarm cards shall be checked for different settings on both increasing and decreasing signals. Shutdown schemes shall be checked for proper functioning, configuration and actuation.
 - iv) Signal from shutdown scheme to shutdown values shall be checked at the respective values. The stroke checking as well as time of operation checking of shutdown values with its logging also forms a part of loop checking.

d) Commissioning Tests

The Bidder shall perform commissioning tests for all their offered instrumentation and control devices, loops, sub-systems and systems. Commissioning tests for instrumentation and controls shall include but not be limited to

- i) Test on devices and loops
- ii) Functional tests on subsystems and systems
- iii) Performance tests on systems to demonstrate that it meets all guarantees as proposed by the bidder
- iv) Fine tuning of control systems

e) Authorization to Ship Test

Authorization to ship test procedures shall be prepared by the Bidder and shall be submitted to the Owner for approval of at least 7 days prior to commencement of these tests. The Authorisation to ship test shall test all functions of the system. These tests shall include all of the features of the operational tests. Every input point will be tested. The following tests shall also be included: -

1. Simulation of Inputs

To verify conversion accuracies, scans rates, operator's panel functions, and correctness of calculations.

2. Operational Test

To verify that the system performs all required functions and meets the specification requirement.

3. Diagnostic Test



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To test working and bulk memory locations, instruction complements, functioning of outputs and peripheral devices, functioning of system check modules, etc.

4. Power Consumption Test

To verify KW consumption.

5. Power Failure Test

To observe the consequences of a total power failure.

6. Accuracy and Repeatability Test

Accuracy and repeatability for analog inputs shall be demonstrated by statistical analysis using the point values read every scan cycle for a consecutive 8 hour period for a total of 10 per cent of all analog inputs. The specified noise rejection capabilities shall be demonstrated using the same test and analysis, by the application of at least 135 V RMS common mode and 25 RMS differential mode to the inputs. The noise rejection test shall be a second 8-hour test. Inputs to be used will be randomly selected by the Owner prior to the test. The test shall be carried out during the Authorisation-to-Ship Tests

7. Functions

All computer functions shall be tested to demonstrate they are in accordance with the specification.

8. Format

All computer print outs & OWS display formats shall be checked to demonstrate that they are in accordance to the specification.

9. Calculations

All computer calculations shall be tested to demonstrate they are in accordance with the specification and computer I/O schedule. The Bidder shall prepare all test cases for calculations (three for each calculation at low, mid and upper ranges of inputs) and submit them for the Owner's review in accordance with contract schedule. Test cases shall include performance calculations, flow and level calculations.

10. Demonstration of the manual and auto switchover from master to standby controller.

11. Demonstration of automatic switchover from the main to redundant data highway.



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12. System and sub-system response time tests.
13. The Bidder shall provide a complete factory test of the system hardware and software. All diagnostic and software debug tests shall be performed at the factory in presence of the Owner. Test shall be performed with the computer system assembled and all parts interconnected together with simulated analog and digital inputs.
14. Solid-state logic system shall be tested as complete assemblies. Testing of individual components or modules will not be acceptable.

The authorization-to-ship tests shall include all reasonable exercises, which the combination of equipment and software can be expected to perform. The test shall include, but not be limited to the following:-

1. Thorough exercising of each device.
2. Demonstration of required spare system capacity point by point exercising of each input and output.
3. Demonstration of all man/machine functions.
4. Demonstration of the proper functioning of all software.

One month to the start of the factory test, the Bidder shall submit his testing procedures for approval. The Owner will witness factory tests. The Bidder shall notify the Owner at least 2 weeks prior to factory testing. Following the test if, in the opinion of the Owner, the system has not been adequately manufactured, programmed, tested, or debugged, the test shall be re-run. The system shall not be shipped without the approval of the Owner. The results of all the factory tests shall be documented and submitted to the Owner.

Upon successful completion of the authorisation-to-ship tests the Owner/ Engineer will provide the Bidder with a written authorisation for shipment of the system equipment to the site.

f) On site tests

All the site activities including unloading, storage cum insurance of equipment and materials on arrival to site, installation, commissioning and carrying out all the tests at site shall be performed by the Bidder at no cost to the Owner in presence of Owner and with the permission of owner as and when required.

The Bidder shall furnish the necessary manpower and the services of technical representative(s), who shall provide technical guidance and advice for the installation of the equipment and placing the system in operation. The services of the technical representative(s) shall be available for the period from arrival of the equipment on site until the equipment is finally accepted by the owner. The on-site tests shall include the following tests in the sequence given:-



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g) Inspection of Equipment on Arrival

The Bidder's field representative(s) shall inspect all supplied equipment upon arrival on-site. All observed damage to equipment shall be reported to the Owner.

h) Preliminary onsite checks and tests

After field installation and before equipment energisation and connection of field inputs, the Bidder shall carefully inspect all equipment and shall check all Bidder supplied wiring and cable to assure correctness of corrections and proper equipment installation. After these checks, the Bidder's representative shall power the system and perform a standard diagnostic test to assure that the system is working. The field inputs and outputs will then be connected by Bidder.

i) Startup / Initial Operation

On completion of erection of the equipment and before start-up, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the owner and the Bidder for correctness and completeness of installation and acceptability for start-up, leading to initial precommissioning tests at site. The list of pre-commissioning tests to be performed shall be as mutually agreed and included in the Bidder's quality assurance program.

The Bidder's commissioning/start-up engineers, specifically identified as far as possible, shall be responsible for carrying out all the precommissioning tests. On completion of inspection, checking and after precommissioning tests are satisfactorily over, the complete equipment shall be placed on initial operation during which period the complete equipment shall be operated integrally with sub-systems and supporting equipment as a complete plant.

The Bidder shall intimate his clearance for taking unit in service after completion of routine / performance tests.

j) Trial Operation

After taking the unit in service and taking full loading of the same, the plant shall then be taken on trial operation during which period all necessary adjustments shall be made while operating, over the full load range enabling the plant to be made ready for performance and guarantee tests.

The duration of Trial operation of the complete equipment shall be 7 days out of which at least 72 hours shall be continuous operation on full load or any other duration as may be agreed to between the owner and the Bidder. The Trial Operation shall be



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considered successful, provided that each item of the equipment can operate continuously at the specified operating characteristics, for the period of Trial Operation.

For the period of Trial Operation, the time of operation with any load shall be counted. Minor interruptions not exceeding 30 minutes at a time caused during the continuous operation shall not affect the total duration of Trial Operation. However, if in the opinion of the Owner, the interruption is longer, the Trial Operation shall be prolonged for the period of interruption.

A trial operation report comprising observations and recordings of various parameters to be measured in respect to the above described Trial Operation shall be prepared by the Bidder. This report, besides recording the details of the various observations during trial run, shall also include the dates of start and finish of the trial operation and shall be signed by the representatives of both the parties. The report shall record all the details of interruptions, adjustments made and any minor repairs done during the Trial Operation. Based on the observations, necessary modifications/repairs to the system shall be carried out by the Bidder to the full satisfaction of the Owner to enable the latter to accord permission to carry out performance and Guarantee tests on the plant. However, minor defects which do not endanger the safe operation of the equipment shall not be considered as reasons for withholding the aforesaid permission.

The system shall be completely tested in the field by the Bidder's service representatives in the presence of the Owner. All diagnostic and software debug tests performed at the factory shall also be performed in the field. These tests shall include a full demonstration of all operating software programs operating in the real time environment. The results of all field tests shall be documented and submitted to the owner.

k) System Documentation Check

Upon successful completion of the preliminary On-site checks and tests the owner's and the Bidder's representative shall check that all required system documentation, in its final form was delivered to the Owner. All error and insufficiencies in the system documentation (manuals, drawings, software) shall be corrected by the Bidder before the Owner accepts the system. Duly corrected system documentation shall be furnished to the Owner.

l) Performance and Guarantee Test and Acceptance of the System by Owner

After successful trial operation the final test as to the performance and guarantees shall be conducted at site, by the Owner. The Bidder's commissioning and start-up engineers shall make the unit ready for such tests, assist the owner in conducting such tests free of cost. Such tests will be commenced within a period of one month or less after the successful completion of Trial Operations. Any extension of time beyond the above-specified period shall be mutually agreed upon. Such test shall be for operation of 7 days out of which at least 72 hours shall be continuous operation on full load.



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These tests shall be binding on both the parties of the Bidder to determine compliance of the equipment and the performance guarantees.

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

The guaranteed performance figures of the equipment/systems shall be provided by the Bidder as per this specification. Should the results of these tests show any decrease from the guaranteed values, the Bidder shall modify the equipment as required to enable it to meet the guarantees. In such case, Performance and Guarantee Tests shall be repeated within one month from the date of equipment is ready for retest, and all cost for modifications including labour, materials and the cost of additional testing to prove that the equipment meets the guarantees shall be borne by the Bidder. If the Vendor is unable to meet the guarantees, even after the adjustments/calibration, the Owner retains the option to reject the Equipment, and in the case of such option of rejection being exercised, the Vendor shall replace the entire equipment with the one, which shall meet the guaranteed values.

The above guarantees will be inclusive of the final control element responses. The bidder has the responsibility to commission the control loop inclusive of the final control element, some of which are supplied by others/Owner.

These tests shall be sufficiently detailed so as to fully satisfy the Owner that the equipment/systems furnished by the Bidder meet all requirements of this specification as well as the published specifications of the respective manufacturers.

2.5.3.8 Measurement System

The Bidder shall guarantee the proper functioning of all the measurement system equipment as specified in enclosed data sheets.

The test of long-term stability of analog inputs calibration shall be demonstrated by the comparison of the results of the 8-hour stability test run at the field, using precision test voltage, with no calibration allowed during the test (no manual recalibration allowed for the time of the eight-hour field stability test. The bidder will have access to the records at all times and the test will be conducted in a manner as to satisfy the bidder that the specified operating conditions have been maintained. A complete copy of the test data will be furnished to the Bidder. In case of failure to pass the test, the bidder shall change or replace the equipment furnished so that the test can be performed successfully.

2.5.3.9 Control System

The distributed control system shall provide a unit operating turndown ratio of not less than six to one. The requirement is based upon the unit maximum load resulting in readings for steam flow, feed water flow, air flow, fuel flow and stem pressure that are at a maximum of 90 per cent of the range span. If the readings are less than 90 per cent, the turn down requirement will be adjusted for each affected system.



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The control system shall permit the performance of the following dynamic load tests while maintaining safe furnace conditions, major process parameters and without endangering other equipment. All tests will be performed with the system in automatic mode:

- a. Drop 50 per cent of maximum load capability from approximately full load at a rate of 10% per minute
- b. Drop load from full rated output to the lowest load runback limit, at a rate corresponding to the fastest runback rate.
- c. Pick up 50 per cent of the maximum load capability from approximately 50 per cent load at a rate of 10 % per minute.

During transient conditions causing deviation of process variables, the control system furnished under this specification shall not permit deviations which exceed those permitted by the manufactures of the controlled process equipment, for load demand changes as indicated above. The exact parameters to be monitored for this test are given in the table no. 4.1, chapter 4. The control loops shall perform to return the controlled variable to the set point in a stable manner without cycling in the shortest possible time and without any loop interactions or cycling of generation when generation matches unit load demand.

The bidder shall also guarantee that the control system provided by him will be responsive and stable and will maintain the deviation of controlled variables from set point within the limits, so that the equipment being controlled will operate below over the range required. The controls shall operate automatically, with no assistance from the operator. The bidder shall successfully demonstrate the performance of automatic control systems as per Table No.4.1 at Chapter 4 before acceptance and taking over of this system by the Owner.

The following parametric tests shall also be conducted under worst case loading conditions

- a. For control system CPU loading, cycle time/controller reaction time and memory spare capacity.
- b. For Controllers CPU loading, spare duty cycle spare memory capacity
- c. Spare duty cycle for system bus
- d. Various display response time
- e. System accuracy
- f. OWS update time

For the parametric test, the following requirements shall be met Processor spare duty cycle (free time) Under worst case loading of MMIPIS and system bus each MMIPIS processor shall have 40% free time when measured over any two second period and 50% free time when measured over any one minute period. Under worst case loading conditions of control system processor shall have 20% free time when measured over any one minute period.

1. System bus spare duty cycle (free time)

The Bidder shall furnish all necessary data to fully satisfy the owner that the processor spare duty cycle figures quoted by the Bidder are realistic and based on configuration and



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computation capability of the offered system and these shall be achieved in the fully implemented system as commissioned at project site.

The system bus shall have min. 50% free time during the worst case loading conditions of control system, MMIPIS and the system bus, measured over any 2 seconds interval.

2. Display response time

The system shall acknowledge all operator requests in one of the following manners within one second of pressing of the last button:

- Commencement of the request display OR
- Acknowledgement of operator request in a suitable manner.
- The display response time as defined above, under the worst case loading conditions shall not be worse than the following:

1	All control related displays	1sec.
2	Point details display (Single point)	1-2sec.
3	Bar chart display (20point, current data)	1-2sec.
4	Operator guide / plant start-up Guide message display (full Screen of alphanumeric Information and a maximum of ten numbers of dynamic Data items)	1-2sec.
5	Plant mimic display of fair Complexity with a minimum of 120 numbers of dynamic data Items e.g., values, macros, Line segment, etc.	2-3sec.
6	Group review display (current Values of twenty points)	2-3sec.
7	X-Y plot display (2 X-Y-plots And a single display requiring Both historical as well as Current data)	3-4sec.
8	X-T plot display (trend of 6 Analog points and a single Display requiring both historical As well as current data)	3-4sec.
9	Plant summary display (e.g., Bad point summary, limit check Removed point summary. Assume The whole data base search is Required and the summary display Contains ten points only).	3-4sec.

The response time for screen update after the execution of the control command from the command is issued (for example command to start a motor to the time the screen is updated) shall be two seconds (excluding the drive actuation time).

3. System accuracy requirements

The overall system accuracy from signal input terminals to output presentation on LED display and printers for the least accurate input range and maximum scan rate shall be not worse than $\pm 0.2\%$ of full scale of the process range.

4. OWS update rates

- All OWS display shall be updated at least every one second.



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2. The system shall be accepted by the owner after satisfactory completion of precommissioning test, trial operation and performance guarantee test, contingent upon satisfactory computation of 365 days availability guarantee tests.
3. All expenses connected with performance guarantee test for acceptance of the system and all operating & test personnel shall be borne by the bidder.
4. The system acceptance will consist of a written statement by the owner that all system documentation are received in the proper form and quantity, and that all on site operational and acceptance tests are successfully completed.

2.5.3.10 Availability Guarantee Test

The Bidder shall guarantee 99.7 per cent system availability for a continuous period of 365 days. An availability guarantee test shall be conducted to assure this level of availability. If the accrued downtime exceeds 0.3 per cent of 365 days, during a loss of availability, a new 365 days run shall start at the time when the system becomes available again. Loss of availability (unavailable system) shall be defined as the loss of the system's guaranteed accuracy and repeatability or of any system function; except, however, that the loss of a function for not more than five per cent of the points shall not be considered loss of availability. Loss of a function for not more than five per cent of the points shall be treated as partial unavailability and the corresponding outage time shall be weighed with respect to function and percentage of the points for which the function and percentage of the points for which the function is unavailable. Loss of each function shall have one weighing factor and unavailability of each equipment, peripheral device or process I/O card etc. shall have another weighing factor. The system shall be considered unavailable upon loss of functions or equipment such as loss of two control OWSs, all control room printers, all control room displays, control room operator keyboard, all alarming capability more than 5 percent of inputs or accuracy of more than 5 per cent of inputs, etc. The guaranteed accuracy and repeatability shall be maintained for the entire 365 days run without manual recalibration.

Downtime shall start upon loss of a system function and shall end upon restoration of all system functions. A minimum of one hour's down time shall be charged for each loss of availability in determining system availability. If availability is lost due to owners error exclusive of any possible errors through misuse of the operator's console or engineer's/programmer's console while locked but inclusive of any possible errors through misuse of operator's or engineer's / programmer's console while unlocked, downtime will not be charged to the Bidder.

2.5.3.11 Test Dates

The availability test shall commence after the performance guarantee and acceptance tests.

2.5.3.12 Test Duration and Definition



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The availability test duration shall be 365 days of accumulated test duration time. Such duration time shall be continuous from the start of test except as declined hereinafter. The availability shall be expressed by a percentage, which shall be calculated as:

100 (Test duration time – Accumulated system outage time)

2.5.3.13 Test Duration Time

The accumulated system outage time shall be a total of time in which all Bidders supplied systems and system functions are not available. A weighing factor shall be used to determine the amount of outage/time assessed due to partial failures. System outage time shall be calculated as:

(Outage time) x (Weighing Factors)

System outage time shall be accumulated over the test duration and shall be the accumulated system outage time.

i) Outage Time and Weighing Factors

Outage time will be assessed for the length of time in which all or any part of each of the following functions are not either continuously available or available when requested by operator action. The outage time shall be weighed by each function's associated weighing factor as listed in below:

ii) System Element Weighting Factor

a)	Data acquisition and Validation	-	1.00
b)	Control Function	-	1.00
c)	Historical Storage Function	-	0.30
d)	Operator guides (OWS)	-	0.50

iii) System Element Weighting Factor

a)	System summaries	-	0.30
b)	Alarming, displays and logs	-	0.90
c)	Other displays	-	0.30
d)	Logs (except SOE)	-	0.30
e)	Report	-	0.30
f)	Sequence of events log	-	0.30
g)	OWS Graphic	-	0.30
h)	Each Bulk Memory	-	0.50
i)	Each utility OWS and alarm OWS	-	0.33

iv) Display / KBD

a)	Each Control OWS	-	0.50



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b)	Each Keyboard	-	0.50
c)	Each printer	-	0.30
d)	Cartridge Tape	-	0.40
e)	Data Highway	-	0.75
f)	Each Programmer's OWS/KBD	-	0.30
g)	Engineer's Workstation	-	0.30
h)	5% I/O Points	-	1.00
i)	5% Controllers	-	1.00

Weighting factors for other system elements shall be defined and agreed upon after contract award. The loss of functions based on the weighting factors above shall be limited to 1.00 maximum.

2.5.3.14 Conditions

Upon loss of any function as listed previously the Owner shall notify the Bidder. Downtime shall start at the time of notification exclusive of actual travel time required by the Bidder but not in excess of 8 hours.

The Bidder shall include in his proposal the price and quantity of any spare parts necessary for his performance of the availability test. Any degradation of functions shall accrue outage time regardless of processor configuration. During a period of system outage, the Owner shall use operable functions of the system provided that such use does not interfere with maintenance of the inoperable functions or hardware as determined by the Bidder.

Should the Bidder determine that partial use of the system by the Owner will interfere with the Bidder's maintenance procedures, system outage time shall accumulate with a weighing factor of 1.0 since no functions are available to the Owner? This shall include off-line servicing. Outage time for each function shall stop at the time the Bidder returns each of the functions as listed in clause on "outage time and weighing factors" to full service and relinquishes full use of the system to the Owner.

Outage of system functions due to the failure of equipment not supplied by the Bidder shall not be used to calculate system availability. The time required to initialize the Bidder's system following such outages shall not be used to calculate system availability provided that initialization time does not exceed 10 minutes. Time required for initialization of the Bidder's system for any reason, in excess of 10 minutes shall accumulate as system outage time.

All costs associated with maintaining 99.7 percent availability for a continuous period of 365 days shall be borne by the Bidder. This includes hardware, software, spares and services. The 99.7 per cent availability shall exclude downtime required for scheduled maintenance and service. The Bidder's proposal shall list maintenance and service requirement for all applicable equipment. If these requirements are not listed, it shall be understood that no downtime is required.

2.5.3.15 Training

Bidder will be responsible for providing training to Owner's personnel on offered control systems at Bidder's Works/Bidder's Associate's Works. It shall include training operators in the use of system, in



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the programming and hardware maintenance of the equipment to the extent that the Owner's personnel can make corrections and changes to the systems programs and maintain the system's hardware.

2.5.3.16 Warranty

The Bidder shall provide an unlimited warranty on all equipment and software for three years after the start of the warranty period, i.e. after satisfactory completion of initial operations. This warranty shall include repair, replacement or correction of identified software or hardware discrepancies at no cost to OWNER. No repairs/replacement shall normally be carried out by the Owner when the plant is under the supervision of Bidder's supervisory engineers. If in the event of any emergency, in the judgment of the Owner, delay would cause serious loss or damage, repairs may be made by the Owner or a third party chosen by the Owner without advance notice to the Bidder and the cost of such work shall be paid by the Bidder.

The Bidder shall provide warranty spares and an exhaustive list of warranty spares including components for system hardware and instrumentation and peripherals based on (and keeping adequate margin over) normally experienced failure rate shall be submitted by the Bidder for Owner's review regarding adequacy of the same. The Bidder must furnish the list before inviting OWNER personnel for ATS test. The warranty spares as per the list mentioned above will be dispatched by the Bidder along with the main equipment consignment. The Bidder shall also provide expandable items for the warranty period. This shall include printer ribbon, ink/toner cartridge print head etc.

In case of any hardware failure which hamper normal operation, the Bidder during the warranty period must provide on-site technical expertise to repair/rectify the problem within a week and if any component is not available at site, the Bidder must arrange to supply these components at site within additional 48 hours. If a software problem is identified, this problem shall be corrected within two weeks.

After six months of DDCMIS operation the Bidder shall provide the list of parts and expendables utilized for the period. The same information will be provided at the conclusion of the warranty. In order to discharge the warranty responsibility, the bidder shall include in his proposal lump sum price for the provisions of a team of service personnel at Site who will be fully qualified to perform the required duties throughout the warranty period of one year. The Bidder shall deploy at least one engineer, two supervisors and four technicians in the team. The Owner shall approve the exact nos. & composition of team members. In case, the team is unable to rectify hardware or software problems, the Bidder shall depute and/or station additional specialist to rectify the problem to ensure 99.7% availability of system.

2.5.3.17 Remote Service Centre for DDCMIS & DCS

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



17.0 PACKING, FORWARDING AND SHIPMENT & PACKAGING

- 17.1 The Contractor will be responsible for the goods being properly packed and marked for shipment by Rail, Road Sea or Air to see that goods are delivered in an acceptable condition at project site. Goods shall be assembled to the maximum extent practicable prior to despatch. All goods shall be packed so as to withstand unusually rough handling. Packing case size and weights shall take into consideration the remoteness of the delivery point and absence of heavy handling facilities during transit and exposure to extreme temperature, salt and precipitation during transit & storage. Wherever necessary Heavy equipment should be on skids, so that the cable slings may be readily attached. Packaging of complete units is desired in those instances where item is to be warehoused upon acceptance and later re-dispatched or issued as a complete unit. Special packing instructions may be included in the specification for each item.
- 17.2 The contractor wherever applicable shall after proper painting, pack and crate all equipment in a manner suitable for export to a tropical, humid climate region in accordance with the internationally accepted export practices and in such a manner so as to protect it from damage and deterioration in transit by road, rail and/or sea and during storage at the 'site' till the time of erection. The Contractor shall be held responsible for all damages due to improper packing.
- 17.3 The Contractor shall give complete information concerning the weight, size content of each package including any other information the Owner/Purchaser may require, such as date of shipment from works and port of embarkation as well as expected date of arrival of such shipment at the designated port of arrival at site etc. The following documents shall be couriered to the Purchaser within fifteen (15) days from the date of shipment.
- i. Bill of lading (5 non-negotiable copies)
 - ii. Invoice (5 copies)
 - iii. Packing list (5 copies)
 - iv. Inspection Certificate (5 copies)
 - v. Test Certificate, wherever applicable (5 copies)
 - vi. Invoice for Ocean freight (5 copies)
 - vii. Certificate of Country of Origin (5 copies)
 - viii. Certificate of Insurance (5 copies)
 - ix. Documents regarding Lloyds clause (5 copies)
 - x. Any other document as required by Bank (5 copies).

For Indigenous Equipment:

The following documents shall be sent by courier to the Purchaser within three (3) days from the date of dispatch of each consignment:

- i. Photo copies of the clean lorry receipt (5 copies)
- ii. Contractors signed Invoice (5 copies)



- iii. Challan & Packing list (5 copies)
- iv. Inspection Certificate (5 copies)
- v. Approved Test Certificates, wherever applicable (5 copies)
- vi. Certificate of Insurance (5 copies)

17.4 The distribution of copies of the above documents shall be as follows:

- i. SE/E/T&HP/TANGEDCO, Chennai – 1 Copy
- ii. Finance & A/c Dept. TANGEDCO, Chennai - 1 copy
- iii. SE/ PROJECT/ NCTPP Stage III - 3 copies.

17.5 The Contractor shall prepare detailed packing list of all packages and containers, bundles and loose material forming each and every consignment despatched to site. The Contractor shall further be responsible for making all necessary arrangements for loading, unloading and other handling right from his works till the site and also till the equipment is erected, tested and commissioned. The Contractor shall be solely responsible for proper storage and safe custody of all equipment.

17.6 The Contractor shall send at least six (6) copies of "Model Packing Lists" of various equipment/ materials within fifteen (15) days of finalisation of the CMB/ CMS. These lists shall be used as check lists and for despatch of all the equipment and materials to be supplied under the Contract. These lists shall be periodically updated by the Contractor based on the changes on subsequent detailed engineering.

17.7 Ocean transportation shall preferably be by Indian Flagship.

17.8 New materials shall be used for Packing and all packing materials become property of the owner on receipt of material at site.

17.9 Each individual package of each shipment shall be clearly marked for identification as follows:

- a. Name address of the consignee:

The Chief Engineer / NCTPP, Stage III
TANGEDCO
Athipattu Pudhunagar,
Chennai 600 120

- b. Project name: 1 x 800 MW, NCTPP, Stage-III
- c. Contract No:
- d. Packing No:
- e. Net weight/Gross weight:
- f. Port of lading:



- g. Destination port:
- h. Ultimate destination:

17.10 All packages must be marked consecutively from number one upwards covering all shipments until completion of the contract without repeating the same number.

17.11 Each box, crates, case bundles or each piece of loose material shall be painted with a combination of one green band and one red band of at least 4cm wide each, round the body of the box, crates etc., as the case may be. The purpose of color band is for easy identification of TANGEDCO cargo, during customs clearance.

17.12 PACKAGING

All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage on deterioration during transit, handling and storage at site till the time of erection while packing all the materials, the limitations from the point of view of availability of railway wagon sizes in India should be taken account of. The details of various wagons normally available with Indian Railways for transportation of heavy equipment are enclosed in the specification. The Vendor/Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing.

18.0 SHIPPING NOTES & DOCUMENTS

18.1 The Contractor shall supply shipping documentation strictly in the English language. The Onus of transport and delivery of all goods/equipment's to be imported from source/works to project site shall rest with the contractor completely as a part of this EPC Contract.

18.2 Shipping procedure for imported equipment's: The contractor shall make his own arrangement for shipment and may appoint their forwarding agent. The Guidelines of Ministry of shipping & Surface transport/ Government of India shall be followed.

18.3 Packing list which must indicate whether shipment is partial or complete and which shall incorporate the following information on each container, etc., according to its individual shipping number:

- i. Export case markings
- ii. Case number
- iii. Gross weight and net weight in kilograms
- iv. Dimensions in centimeters
- v. Complete description of materials with identification of all parts to the respective drawings, catalogues and instruction manuals. The identification of the parts shall be contained on an identification tag fastened to the respective part.



- 18.4 The shipping documents shall include the following:
- 18.4.1 Bill of lading/airway bill, signed invoices, packing list, certificate of country of origin, Purchaser certificate accepting shipment, a certificate from the contractor that drawings/documents for the purpose of customs clearance have been enclosed with the packages for shipment etc.
- 18.4.2 The signed invoice must indicate the following:
- i. Details of goods, i.e. names, types, qualities, quantities, net weights and other particulars as available for each type including trademarks or other symbols of such goods.
 - ii. Selling price or value of goods per unit expressed in the type of currency under transaction. This price or value shall be the actual price or value of goods as stated in the price schedule.
 - iii. Other expenses:
 - i. Packing charges if any.
 - ii. Insurance premiums, if insured.
 - iii. Freight.
 - iv. Others, if any.
- 18.5 In case of shipment by airfreight, the airway bill number, name of the airline, flight number and date of arrival in Chennai (Tamil Nadu, India) shall be advised immediately to TANGEDCO as advance intimation.
- 18.6 In case of short/shipment for which the Contractor is responsible, he shall make prompt delivery of the short/shipped goods at no cost to TANGEDCO, and the Contractor shall bear all additional expenses incurred by TANGEDCO due to such short-shipment. The Contractor shall bear all additional expenses including customs duty since the consignment would have already suffered Customs duty in the first instance itself).
- 19.0 DEMURRAGE, WHARFAGE, ETC.
All demurrage, wharfage and other expenses incurred due to delayed clearance of the material or any other reason for delay in observing the formalities set out elsewhere in this document shall be to the account of the contractor.
- 20.0 INSURANCE
- 20.1 Comprehensive Marine cum Erection Insurance Policy for contract work:
- 20.2 The Goods supplied under the contract shall be properly and fully insured by the contractor

Chapter 7

Project Management



CHAPTER 7 PROJECT MANAGEMENT

1.0 METHOD OF EXECUTING THE PROJECT

The entire work of project execution shall cover complete civil works, electrical, Instrumentation & mechanical systems for BTG and associated system as specified elsewhere in the specification is the responsibility for timely execution and performance of the plant. The contractor shall design, engineer, manufacture, and supply, erection, testing & commission the main plant package for generation of 800 MW nominal rating.

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

2.0 RESPONSIBILITY

The contractor 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 contractor shall comply with the requirements of Quality Assurance Services detailed in Volume-III, Part E of the technical specification.

3.0 ORGANIZATION

3.1 Organization Chart

The Contractor shall describe how his management organization will meet the requirements of this Technical Specification. The Contractor shall furnish a detailed organization chart for the project management team, clearly identifying the key personnel in each of the areas mentioned at 1.01.0 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.



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

3.2 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 Purchaser for the execution of the Project.

Separately, designated leaders shall be identified for each of the areas mentioned under 1.01.0 who, in, will report to the Project Manager for all matters related to the contract.

3.3 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 Purchaser Engineer without having the need to refer to his headquarters each time.

3.4 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, erection, testing & commissioning of the Project.

3.5 Management of Health & Safety

The Contractor 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.

4.0 GENERAL REQUIREMENTS OF PROGRAMMES AND SCHEDULES

The programs supplied by the Contractor as part of the Contract shall fully inter-relate design, manufacture, erection and commissioning. Events shall be identified in all programs and agreed with the Purchaser / Purchasers Engineer. Events shall indicate points in the programs at which a significant stage has 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 Contractor and shall not be changed except as may be agreed by the Purchaser / Purchaser's Engineer.

The Contractor shall designate a Planning Representative who shall be readily available at all reasonable times to the Purchaser / Purchaser's Engineer and who shall be of sufficient status to have free access to



the Contractor's management staff and to the Contractor's and sub contractors work / shops, site works etc. and shall be able to represent the Contractor on all matters of planning and progress.

5.0 Form of Programs

5.1 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.

5.2 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.

5.3 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.

5.4 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.

5.5 Time Units

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

5.6 Abbreviations

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

6.0 IMPLEMENTATION SCHEDULE

The schedule for the completion of the 1x800 MW Power Project shall be as follows:

Milestone	Period in days from the Effective Date



Commissioning days for the unit

The Contractor 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 Contractor shall furnish to the Purchaser, various schedules as defined below.

6.1 Engineering Schedules

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

6.2 Manufacturing and Delivery schedule

The Contractor 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 contractor. Such schedules shall be reviewed, updated and submitted to the Purchaser/ Purchaser's engineer, once in every two months thereafter, by the contractor. Schedules shall also include the materials and equipment purchased from outside suppliers. In the dispatch program, the Contractor shall indicate a schedule of estimated program; tonnage's specifically identifying various oversize dimensioned consignments (ODC). All dispatch details and item lists shall be made available to both Purchaser & site immediately after shipping.

6.3 Erection Schedule

The Contractor shall provide the Purchaser 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 Purchaser subsequent to the signing of the Contract.

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

7.0 DETAILED RESPONSIBILITIES

The Contractor shall provide effective management of the Contract, which shall be compatible with the Purchaser's requirements as set out in this Technical specification. He shall allow access to his works and those of his sub-contractors at all reasonable times to permit the Purchaser/Purchaser's Engineers participation if the Purchaser/Purchaser'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 contractor's obligations to complete the works in accordance with the contract.



8.0 Planning & Monitoring

a. Planning

The Contractor shall prepare a Master Network schedule in the form of PERT network consisting of at least 1000 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 her 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 Contractor and project management team. The master network shall also identify a complete list of inputs to be furnished by the Purchaser, 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 contractor shall not change the Master Network without the prior approval of the Purchaser. In the event that the Purchaser approves a revision to the Master network the contractor shall submit a revised master network within two weeks thereafter. This program 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 Purchaser, or as proposed by the contractor and accepted by the Purchaser. Such an agreed revised program shall become the overall contract program for the outstanding works.

9.0 Monitoring & Progress Reporting, Management Information System

The progress reports would be issued every month, one from the head office of the contractor and another from the site office. Reports shall include such schedules, charts and drawings, as the Purchaser/Purchaser's engineer considers necessary for adequately monitoring the contract. The reports shall be made available to the Purchaser/Purchaser'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:

10.0 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 Purchaser / Purchaser'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.



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 contractor 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.

11.0 Engineering Management

The contractor, 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 program 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 Contractor shall further develop the Level-3 (L-3) network for engineering activities, which will indicate schedule for data availability, drawing availability, drawing release date and document submission dates.

Detailed (L-2) and (L-3) networks shall be finalized sequentially by the Contractor 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 contractor and the equipment sub-vendors so as to ensure the correctness and completeness of related engineering documentation before the same is submitted to the Purchaser.

12.0 Contracts Management

Based on the master network schedule the Contractor 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 contractor shall also submit site mobilization plan.

The Contractor 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 Purchaser's Engineer before further manufacture can take place. These L-3 programs for the manufacture and dispatch shall clearly identify responsibilities of the contractor, Sub-contractor and Purchaser. These networks shall be submitted within one (1) month of the date of finalization of the various sub-contracts by the Contractor.

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

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



13.0 Construction Management

Within one (1) month of the signing of the Contract, the contractor shall submit a program 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 facilitate start of erection and subsequent activities and shall form the basis for site execution and detailed monitoring the three monthly rolling program with the first month's program being tentative based on the site conditions shall be prepared based on these L-3 programs. The contractor shall also be involved along with the Purchaser to tie up detailed resource mobilization plan over the period of time of the contract matching with the performance targets.

The L-3 program shall be jointly finalized by the site in-charge of the contractor with the Purchaser's project coordinator as well as the site-planning representative. The erection program 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.

14.0 Construction Methods, Logistics and Equipment

Contractor's Proposals

The Contractor 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 contractor shall relate movement of Major Contractor's equipment to the construction program time scale. The Contractor shall furnish his delivery methods and routes to the site and identify special or abnormal loads or cargoes with dimensions.

Contractor's Equipment

The Contractor shall detail in his write-up a; Contractor'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 Contractor shall describe the usage intended for each crane.

Contractor's Proposals

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

15.0 Spares Management

The contractor shall provide a suitable spares management system.



It is the responsibility of the contractor to ensure availability of spares during the period of testing and commissioning and all spares to meet Contractor's obligations under the Defects Liability Period.

The contractor 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.

Contractor shall define in his write-up the spares management system and the storage facilities provided.

16.0 Resource Control

To enable the Purchaser to assess that the Contractor's proposals are adequate to meet the contract program requirements, the Contractor shall describe his resource management system for the contract in his write-up.

17.0 Production Control and Manufacture

a. Manufacturer's Standards

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

b. Places of Manufacture

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

c. Sub-Contractors

The Contractor shall submit in his write-up, a list of all items that he deems necessary to be sub-contracted.

The contractor's orders to the Sub-Contractors shall quote the Purchaser'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.

d. Progress Reports

During the design and manufacturing stages in the contract, contractor shall submit to the Purchaser/Purchaser'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 Purchaser/Purchaser's Engineer during the early phase of the works, as part of regular contract/project status reporting.



e. Access for progress monitoring

The Purchaser'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.

18.0 Commissioning Management

For commissioning of the various equipment/system covered under the scope of contract. Purchaser will form an organization structure which may consist of the following committees. The contractor shall nominate his representative on one or more of the Committee as decided by the Purchaser.

- Steering committee
- Commissioning Panel
- Working Parties
- Testing Teams

Commissioning documents shall be prepared by the Contactor in the following manner and submitted for Purchaser's approval.

a. Paper

This document shall be prepared for the various equipments/systems under commissioning and shall have the following objectives to fulfill and shall be submitted for Purchaser's approval at least twelve (12) 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, program, 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.



19.0 Test Reports

After the completion of commissioning activity of equipment systems, the Contractor 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 activities as actually adopted vis-à-vis as recommended in the procedures, program schedules achieved and any other such information as required. These test reports shall be submitted in requisite number of copies to the Purchaser and this should be duly signed jointly by the Purchaser/Purchaser's Engineer and the Contractor/Equipment supplier, who are involved during the commissioning activities.

20.0 PURCHASER'S RIGHTS

The Purchaser reserves the right to evaluate and audit the Contractor'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, Testing, Commissioning,
- ❖ Sub-contract Control and Site management.

The contractor shall provide all necessary assistance to enable the Purchaser carry out such audits and evaluations. Such audits and evolutions shall not in any way relive the contractor of any of his liabilities and responsibilities under the contract. A corrective action program shall be agreed and implemented in respect of any deficiencies revealed by such monitoring, without any cost implication to the Purchaser and impact on the time schedule for the project.

21.0 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 the Contractor 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 contractor 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 contractor and the Purchaser/Purchaser's Engineer will be decided upon as part of erection co-ordination procedure.

Chapter 3

Scope of supply & Service



CHAPTER 3 SCOPE OF SUPPLY AND SERVICES

The Scope Shall cover Design, Engineering, Manufacture, supply, assembly, Inspection & Testing at manufacturer's works, Shop painting, packing for transportation, insurance during transit, Delivery to site, unloading at site, site transportation, safe storage at site, Civil, structure & architectural design, Demolition of existing structures, site grading / levelling and civil construction works & structure fabrication works at site, erection, pre-commissioning, commissioning, testing, Performance test at site, training of the Owner's personnel, handing over and other related items of work including supply of mandatory spares, special tools & tackles and 3 years operation and maintenance spares for Complete Steam Generator & Steam Turbine Generator along with their auxiliaries (BTG & its Auxiliaries) including of all Mechanical, Electrical, Civil, Instrumentations works as specified and as required for safe and trouble-free operation of 1X800MW Coal Based Supercritical North Chennai Thermal Power Project Stage-III in the premises of existing NCTPS at Ennore & Puzhuthivakkam Village, Ponneri Taluk, Tiruvallur District, Tamil Nadu, India.

2.1 Mechanical Works

- a) Steam Generator and its Auxiliaries
- b) Steam Turbine Set and its Auxiliaries
- c) Electrostatic Precipitator
- d) HP / LP Heater & Deaerator
- e) Power Cycle Pumps
- f) Equipment Cooling Water System
- g) Power Cycle Piping and Valves including HP/LP Bypass
- h) Low pressure Piping and valves
- i) Condensate Polishing unit
- j) Air Conditioning and ventilation System for TG Hall, ESP Control Room and DG Room
- k) Cranes and Hoist
- l) Elevators in TG Building, Service Building, ESP Control Room and Steam Generator etc.,
- m) Chemical Dosing System
- n) Condenser Online Tube Cleaning System
- o) Hot well Makeup System
- p) Boiler Initial fill System
- q) Mill Reject Handling System
- r) Auxiliary Boiler
- s) Fuel Oil Forwarding System
- t) Service & Potable Water System
- u) Service Air and Instrument air system
- v) Sewage Water System
- w) Effluent Water System

2.2 Electrical Works

- a) Generator Set & Its Auxiliaries



- b) Excitation System for Generator
- c) Generator Bus Duct(Isolated Phase Bus Duct)
- d) Generator Circuit Breaker
- e) Power Transformers(GT, UTs, UATs & ST)
- f) NGR for Transformers
- g) Control and Protection System for Generator, GT, UT and Unit Auxiliaries
- h) Unit Service Transformers – 11/0.433 kV or 6.6/0.433 kV
- i) Segregated and Non-Segregated Bus duct for Unit Switchgears
- j) HT / LT Switchgears
- k) Motors, Actuators, HT/LT cables along with trays and tray supports,
- l) Variable Frequency Drive
- m) Illumination system for SG, All floors of TG Building, ESP, ESP Control room, Service building, Compressor room, Transformer yard and DG Room
- n) Diesel Generator and its Auxiliaries
- o) Emergency MCC including supply feeders station emergency loads.
- p) DC System for Unit Auxiliaries(Unit Battery & Battery Chargers and DC Distribution board)
- q) Above & Below ground Earthing for SG, All floors of TG Building, ESP, ESP Control room, Service building, DG Room, mill reject Compressor room, Transformer yard and Unit Auxiliaries
- r) Lightning Protection System for SG, TG Building, ESP, ESP Control room, DG Room, Service building, mill reject Compressor room, Transformer yard and Unit Auxiliaries
- s) EDMS
- t) Lighting Arrestors for GT & ST bays with Gantry Supports, no supports shall be taken from TG Building structure.
- u) Terminal Connectors for GT and ST HV terminals suitable for Overhead conductors.
- v) Construction Power Supply.
- w) All electrical system for Steam Generator, Steam Turbine Generator, Electrostatic precipitator, Service building, DG room ,Air Conditioning and Ventilation system, Mill reject handling system, Auxiliary Boiler, Cranes and Hoists etc.,

2.3 Instrumentation Works

- a) DDCMIS control systems of SG, TG, ESP
- b) Control system for Air Conditioning, ventilation system for TG Hall, ESP Control Room and DG Room
- c) Control System for Condensate polishing unit
- d) Instrument & Control System of the Scope
- e) Performance Analysis Diagnostics Optimization(PADO) System
- f) C&I Laboratory and testing Instruments
- g) Steam & Water Analysis System (SWAS)
- h) Ambient Air Quality Monitoring System (AAQMS)
- i) Stack emission monitoring system
- j) Flue gas analysis
- k) Master & Slave Clock System
- l) Control & Monitoring of OFF Site plants
- m) Remote I/O Panel for Fuel Oil Forwarding system and Circulating water System along with Fibre Optic cable for Communication between DDCMIS and Remote I/O Panel.



- n) MMIPIS(Man Machine interface and Plant information system)
- o) PLC based miscellaneous system
- p) Field instrumentation, Signal cables, trays and accessories
- q) Station LAN, MIS System, WAN & ERP based System
- r) Electronic Earthing and panel Grounding
- s) Plant Security and Surveillance System
- t) Public Address System and Plant Communication System
- u) Vibrating Monitoring System (VMS)
- v) Operator Training Simulator for DDCMIS

2.4 Civil & Structural Works

- a) Demolition of Existing Building& Existing RCC structures in the BTG Area
- b) Geotechnical Investigation
- c) Tree Cutting, Site Levelling & Grading
- d) Roads & Trenches as indicated in Terminal Points
- e) TG Deck & TG Auxiliaries Foundation
- f) TG Building foundation
- g) TG Building Superstructure
- h) Service Building foundation
- i) Service Building superstructure
- j) Steam Generator & its Auxiliaries Foundation
- k) Steam Generator Superstructure
- l) ESP Foundation
- m) ESP Superstructure
- n) Pipe rack foundation and its superstructure with in BTG Battery limit
- o) Fan Foundations
- p) Transformer Yard
- q) ESP Control room
- r) DG Room
- s) Fuel Oil Pump house and equipment foundations.
- t) Mill reject Air Compressor Room
- u) Condensate Polishing unit civil foundations
- v) Necessary Air Conditioning and ventilation system civil works for TG Building; ESP Control Room and DG Room
- w) Floor wash, drains, Sump pits in BTG Area, oil water waste sump pit in BTG and Transformer yard.
- x) CPU Neutralization pit
- y) Storm water drain system within BTG Battery Limit
- z) Any other civil and structural works

2.5 General Works

- a) Erection Tools & Tackles
- b) Erection & Commissioning Hardware and Consumables
- c) Maintenance Tools & Tackles



1X800 MW COAL BASED NORTH CHENNAI THERMAL
POWER PROJECT STAGE III

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- d) Special Tools & Tackles
- e) Mandatory Spares
- f) Recommended Spares for 3 years O&M
- g) Training of Plant O&M Personnel
- h) Complete Furniture's including Chairs, Tables, cupboards, racks etc.,
- i) Central Documentation facility either at Project Site or TANGEDCO HQ Project Wing

- 2.6 Solar Roof top is planned in this project. Hence Bidder to refer the Volume II Section 2 Part 2.4 Mechanical Works Clause 2.1.20
- 2.7 The works not covered above, but included in other areas of the specification shall also be considered.
- 2.8 The works not covered in the entire specification, but are essentially required for the effective commissioning of the BTG package offered should also be taken care of.



1x800 TANGEDCO NORTH CHENNAI TPP

**AIR CONDITIONING SYSTEM
PAINTING SPECIFICATIONS**

SPECIFICATION No: PE-TS-423-553-A001

SECTION : I

SUB-SECTION : C 2C

REV. 01

DATE: NOV 2017

SECTION: I

SUB-SECTION: C 2C

CUSTOMER SPECIFICATIONS

PAINTING SPECIFICATIONS



CHAPTER 8

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

2.0 CODES AND STANDARDS

Painting of equipment shall be carried out as per the specifications indicated below and shall conform to the relevant IS specification for the material and workmanship.

The following Indian Standards may be referred to for carrying out the painting job:

IS:5	Colours for ready mixed paints and enamel
IS:1303	Glossary of terms relating to paints
IS:2379	Colour code for identification of pipelines
IS:1477	Code of practice for painting of ferrous metals in buildings (Parts I & II)
IS:2524 :	Code of practice for painting of non-ferrous metals in buildings (Parts I & II)
IS:2395	Code of practice for painting of concrete, masonry and plaster surfaces (Parts I & II)
IS:2338	Code of practice for finishing of wood and wood based materials (Parts I & II)
IS:158	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and heat resisting.
IS:2074	Ready mixed paint, air drying, red Oxide Zinc Chrome, priming
IS:104	Ready mixed paint, brushing, Zinc Chrome, priming



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IS:2932	Enamel Synthetic exterior (a) Undercoating (b) finishing
IS:4682	Code of practice for lining of vessels & equipment
SIS 559000	Swedish standard for blasting
ISO 8504-2	Preparation of steel substrates before application of paints and related products. Surface preparation methods Part 2 Abrasive blast cleaning
ISO 8501-1	Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness. Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.
SIS 05 5800	Surface preparation by acid pickling
SSPC SP08	Surface preparation by acid pickling
IS 2629	Recommended practice for hot dip galvanizing of iron and steel
ASTM A780	Standard practice for repair of damaged galvanized coatings
SSPC	Steel structures painting council
NACE	National association of Corrosion Engineers
DIN	Deutsehes Institute for Normung
BS	British Standard
ASTM	American Society for Testing material
AWWA	American Water works association

3.0 SURFACE PREPARATION

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

3.1 BLASTING

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

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



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

The grades of surface finish

	ISO 8501-1	SIS 055900	SSPC	NACE
White metal	Sa3	Sa3	SP5	1
Near White metal	Sa 2½	Sa 2½	SP10	2
Commercial Blast	Sa2	Sa2	SP6	3
Brush off blast	Sa1	Sa1	SP7	4

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

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

3.2 Manual Rust Removal

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

3.3 Cleaning

Removal of impurity

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

3.4 Acid Pickling

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

4.0 PROCESSING

4.1. General Application Conditions

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



4.2. Application Procedure

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

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

4.3. Touching Up

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

4.4. Uncoated Surfaces

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

4.5. Bond Strength

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

5.0 SURFACE CONDITIONS OF COATING SURFACES

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

6.0 COATING SYSTEMS

6.1 General Requirements for Coating Systems

Coating materials according to SSPC, BS 5493 or DIN 55 928 shall be used. Intermediate coats are to be pigmented with micaceous iron oxide. The materials shall be matched with each other so that they are compatible. Coatings deviating this specification shall be subject to approval. Standards of surface preparation and painting shall give a time to first maintenance of 10 years.

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

6.2 Standard Coating System (External Coatings)

(a) Steel Surfaces

- i. All steel structures shall receive two primer coats and two sandwich coat of MIO Epoxy paint and one finish coat of painting. First coat of primer shall be given in shop after fabrication before dispatch to erection site after surface preparation as described below. The second coat of primer shall be applied after erection and final alignment of the erected structures. Two intermediate coats and one finished coat shall also be applied after erection.
- ii. Steel surface which is to be painted shall be cleaned of dust and grease and the heavier layers of rust shall be removed by chipping prior to actual surface preparation. The



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

- iii. Two intermediate MIO Epoxy paint, and one top polyurethane coating of approved brand shall be applied. Dry film thickness of each intermediate coat shall be 90 microns and top polyurethane coating shall be 30 microns. The under coat and finish coat shall be of different tint to distinguish the same from finish paint. The total dry film thickness shall be 330 microns. All paints shall be of approved brand and shade as per owner's requirement.
- iv. Joints to be site welded shall have weldable primer applied within 100 mm of welding zone. Similarly where friction grip fasteners are to be used removable anti corrosive coating shall be provided. On completion of the joint the surfaces shall receive the paint as specified.
- v. Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly. Surfaces inaccessible after erection including top surfaces of floor beams, supporting gratings or chequered plate shall receive one additional coat of finish paint over the above number of coats specified before erection. Portion of steel member embedded/ to be encased in concrete shall not be painted.

(b) Gratings and Step Threads

- i. Surface Preparation
Gratings and step threads shall be cleared by acid pickling as per SSPC-SP-08
- ii. Hot Dip galvanizing
The hot dip galvanizing shall be done as per IS 2629. The average mass of coating shall be 610 gm/m²
- iii. Post Treatment
Immediately after galvanizing post treatment such as chromating shall be applied to retard white rust attack.
- iv. Touch up mechanical damages
The repair of damages coatings shall be done as per the recommended practice ASTM A780.

6.3 Painting of Indoor components such as valves, pumps, motors, electrical parts, tanks etc.
At Works
Surface Preparation
Blasting according to SIS 055900 grade Sa 2½. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 25 µm may be used.

Prime Coat

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



At Site

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

Finish Coat

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

Remarks

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

- 6.4 Painting of Outdoor equipment (external surfaces) such as piping, valves, pumps, motors, electrical parts, tanks etc.

Weather exposure, weather resistance, temperature up to 120°C as per clause 6.1 & 6.3.

Surface Preparation

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

Prime Coat

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

Intermediate Coat

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

Finish Coat

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

- 6.5 Special Coating

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

- i. At Works

Surface Preparation

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

Prime Coat

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

- ii. At Site

Pre-treatment

Derusting 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

1 pack silicon acrylic dry film thickness 35 µm.

Final Coat

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

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

i. At Works

Surface Preparation

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

Prime Coat

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

ii. At Site

Pre-treatment

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

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

i. Insulated parts exposed to condensing water

At Works

Surface Preparation

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

Prime Coat

Inorganic ethyl Zinc silicate, total dry film thickness 75µm

ii. Insulated parts exposed to temperatures

Parts exposed to temperatures up to < 400°C

Surface Preparation

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

Temporary Primer

Varnish



- (d) Intermittent exposure due to condensing water/ chemicals (Indoors)
- (i) At Works
- Surface Preparation
- Blasting according to Sa 2½ and ISO 8501-1:1988. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm may be used.
- Prime Coat
- Two layers of Zinc phosphate primer, total dry film thickness 75µm.
- (ii) At Site
- Pre-treatment
- Dersuting of all mechanical damages, according to standard Sa3 to ISO 8501-1:1988, touch up with 2 pack high build epoxy with volume solid content of more than 85%, 75µm.
- Intermediate Coat
- 2 pack high build epoxy, dry film thickness 80 µm.
- Finish Coat
- 2 pack silicon acrylic, dry film thickness of 50µm. Total system dry film thickness 205µm. When exposed o weathering, weather resistance finish coat shall be applied.
- (e) Water Exposure
- i. At Site/ Works
- Pre-treatment
- Removal of all welding pearls. Blasting according to Sa 3 to ISO 8501-1:1988
- Coat
- 4 coats 2 pack coal tar epoxy, dry film thickness 125 µm each. Total system dry film thickness 500µm Touch up after erection as required.

6.6 Painting of Pipes

6.6.1. Buried Piping

Internal surfaces

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

The total dry film thickness of 150 microns.

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



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

External surfaces

- i. Surface cleaning by Sand Blasting.
- ii. Coal tar primer compatible with coal tar enamel grade. The number of coats shall be two with a DFT of 35 microns each.
- iii. Coal tar enamel shall be applied. A single spiral inner wrap of glass fibre tissues shall be applied overlapping at least 25 mm ensuring impregnation of glass fibre tissues in the first coat. The second coat of enamel and second outer wrap of glass fibre felt, Type – I to IS: 7193-1974 will be applied in the same way confirming to Table – 10 of IS – 10221 – 1982. The total thickness of the coating will not be less than 4.0 mm
- iv. Alternatively Wrapping with coal tar based anticorrosion tape conforming to IS 15337: 2003 is also acceptable in lieu of s.no. (iii) above. Wrapping thickness shall be 4.0 mm. Tests to be carried out after application: Bond/ Adhesion test, Holiday test

6.6.2. Overground Piping

Internal surfaces

- i. Surface cleaning by sand blasting.
- ii. Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.
- iii. Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns. The total dry film thickness of 150 microns.
Note: All steel pipes carrying sea water shall be internally coated with corrocoat/ polyurea coating having thickness 1500 DFT.

External surfaces

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

6.7 Internal Coatings

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

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

Prime Coat

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

Pre-treatment



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

Intermediate Coat

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

Finish Coat

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

- 6.7.2. Rubber Lining of Pipes, Valves and Tanks for DM Water
Pre-treatment
Blasting according to Sa 2½ and ISO 8501-1:1988

Rubber Lining

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

6.8 Painting for Electrical items

- 6.8.1. All the steel work shall be thoroughly cleaned of rust, scale, oil, grease, dirt and swarf by pickling, emulsion cleaning etc. The sheet steel shall be phosphate/ oven dried and then painted with two coats of zinc rich primer paint. After application of the primer, two coats of finishing epoxy paint shall be applied. The colour of the finishing coats inside shall be glossy white and exterior of the treated sheet steel shall be shade 631 of IS-5/ RAL 7032 for all switchboard/ MCC/ Distribution boards, control panels etc.
- 6.8.2. All electrical equipment shall be given tropical and fungicidal treatment and outdoor equipment shall be provided with rain hood to prevent entry of rain water into the equipment.
- 6.8.3. Painting of I & C equipment: Epoxy coating required for all I & C equipment.

6.9 SUGGESTED COLOUR CODES FOR PAINTING

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



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EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



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

Notes:

1. This colour code basically refers to IS: 2379 for piping with necessary modifications
2. Where band colour is specified, same shall be provided at 30 meter intervals on long uninterrupted lines and also adjacent to valves and junctions.

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



1x800 TANGEDCO NORTH CHENNAI TPP

**AIR CONDITIONING SYSTEM
TECHNICAL SPECIFICATION
(ELECTRICAL PORTION)**

SPECIFICATION No: PE-TS-423-553-A001

SECTION : I

SUB-SECTION : C-3

REV. 01

DATE: NOV 2017

SECTION: I

SUB-SECTION: C-3

TECHNICAL SPECIFICATION (ELECTRICAL PORTION)

**TAMILNADU GENERATION AND DISTRIBUTION
CORPORATION LIMITED**

**1X800 MW COAL BASED NORTH CHENNAI THERMAL
POWER PROJECT STAGE III**

**AIR CONDITIONING SYSTEM
TECHNICAL SPECIFICATION
(ELECTRICAL PORTION)**



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



TITLE: ELECTRICAL EQUIPMENT SPECIFICATION FOR AIR CONDITIONING SYSTEM 1X800MW COAL BASED SUPERCRITICAL NORTH CHENNAI THERMAL POWER PROJECT STAGE III	SPECIFICATION NO.
	VOLUME NO. : II-B
	SECTION: C
	REV NO. : 00 DATE: 12.10.17
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TECHNICAL SPECIFICATION FOR
AIR CONDITIONING SYSTEM
(ELECTRICAL PORTION)

SPECIFICATION NO.
VOLUME II B
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DATE 12.10.2017

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 equipment's.
- d) Electrical load requirement for **AIR CONDITIONING SYSTEM**.
- e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
- f) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer/BHEL approval without any commercial and delivery implications to BHEL.
- g) Various drawings, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All documents shall be subject to customer/BHEL approval without any commercial implication to BHEL.
- h) Motor shall meet minimum requirement of motor specification.
- i) Vendor to clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.
- j) Cable BOQ worked out based on routing of cable listing provided by the vendor for “both end equipment in vendor's scope” shall be binding to the vendor with +10 % margin to take care of slight variation in routing length & wastages.

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 The electrical specification without any deviation from the technical & quality assurance requirements stipulated shall be deemed to be complied by the bidder in case bidder furnishes the overall compliance of package technical specification in the form of confirmation cum compliance sheet & cost of withdrawal sheet as in price schedule.
- 3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

4.0 List of enclosures:

- a) Electrical scope between BHEL & vendor (Annexure –I)
- b) General Technical Requirement for LV Motors.
- c) Datasheets & 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)



TECHNICAL SPECIFICATION FOR
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- g) Technical Specification for motors
- h) Technical Specification for actuators
- i) Technical Specification for Cabling
- j) Technical Specification for earthing & lighting protection

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGES : AIR CONDITIONING SYSTEM

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

PROJECT: 1x800MW NORTH CHENNAI STAGE-III

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	415 V AC (3 PHASE 4 WIRE) supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	BHEL BHEL BHEL	BHEL Vendor BHEL	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	Vendor	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 10-12 mtrs) and trunk cable.
5	Any special type of cable like compensating, co-axial, prefab, MICC, optical fibre etc.	Vendor	Vendor	Refer C&I portion of specification for scope of fibre Optical cables if used between PLC/ microprocessor & DCS.
6	Cable trays, accessories & cable trays supporting system 100/ 50 mm cable trays/ Conduits/ Galvanised steel cable troughs for local cabling	BHEL Vendor	BHEL Vendor	Local cabling from nearby main route cable tray (BHEL scope) to equipment terminal (vendor's scope) shall be through 100/ 50 mm. cable trays/ conduits/ Galvanised steel cable troughs, as per approved layout drawing during contract stage.
7	Cable glands ,lugs and bimetallic strip for equipment supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power and control cables.
8	Conduit and conduit accessories for cabling between equipment supplied by vendor	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537.
9	Lighting	BHEL	BHEL	

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGES : AIR CONDITIONING SYSTEM

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

PROJECT: 1x800MW NORTH CHENNAI STAGE-III

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
10	Equipment grounding (including electronic earthing) & lightning protection	BHEL	BHEL	Refer note no. 4 for electronic earthing
11	Below grade grounding	BHEL	BHEL	
12	LT Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
13	Mandatory spares	Vendor	-	Vendor to quote as per specification.
14	Recommended O & M spares	Vendor	-	As specified elsewhere in specification
15	Any other equipment/ material/ service required for completeness of system based on system offered by the vendor (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
16	a) Input cable schedules (Control & Screened Control Cables) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for Control and Instrumentation Cable and electronic earthing cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
17	Electrical Equipment & cable tray layout drawings	Vendor	-	For ensuring cabling requirements are met, vendor shall furnish Electrical equipment layout & cable tray layout drawings (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipment requiring cabling, and shall incorporate cable trays routing details marked on the drawing as per PEM interface comments. Cabling arrangement of the same (wherever overhead cable trays, trenches, cable ducts, conduits etc.) shall be decided during contract stage. Electrical equipment layout & cable tray layout drawing shall be subjected to BHEL/ customer approval without any commercial implications to BHEL.
18	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

NOTES:

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGES : AIR CONDITIONING SYSTEM

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

PROJECT: 1x800MW NORTH CHENNAI STAGE-III

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
3. In case the requirement of Junction Box arises on account of Power Cable size mis-match due to vendor engineering at later stage, vendor shall supply the Junction Box for suitable termination.
4. Vendor shall indicate location of Electronic Earth pit in their Civil assignment drawing.

[illegible]

CABLE SCHEDULE FORMAT

ANNEXURE III

[illegible]

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

1. 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:

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

(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) CABLE VOLTAGE CODES:

A = 11KV (Power cables)

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) CABLE CODES

PVC Copper

A = Armoured FRLS	B = Armoured Non-FRLS
C = unarmoured FRLS	D = Unarmoured Non-FRLS

PVC Aluminium

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:

LV MOTORS (NON FLAME PROOF)	ABB
	BHARAT BIJLEE LTD.
	CROMPTON GREAVES
	GE-POWER
	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.

	TITLE LV MOTORS <u>DATA SHEET-A</u>		SPECIFICATION NO.	
			VOLUME	II B
			SECTION	D
			REV NO. 00	DATE 12.10.17
			SHEET 1	OF 1
1.0	Design ambient temperature	:	50 °C	
2.0	Maximum acceptable kW rating of LV motor	:	Upto 200KW	
3.0	Installation (Indoors/ Outdoors)	:	As required	
4.0	Degree Of Protection	:	IP55	
5.0	Cooling	:	TEFC	
6.0	Details of supply system			
	a) Rated voltage (with variation)	:	415V $\pm$ 10%	
	b) Rated frequency (with variation)	:	50 Hz (Variation: +3% TO –5%)	
	c) Combined voltage & freq. variation	:	10% (sum of absolute values)	
	d) System fault level at rated voltage	:	50 kA for 1 sec	
	e) Short time rating for terminal box	:	50 kA for 0.25 sec	
	f) LV System grounding	:	Solidly	
7.0	Class of insulation	:	Class 'F', with temp rise limited to class B.	
8.0	Minimum voltage for starting (As percentage of rated voltage)	:	80% of rated voltage	
9.0	Power cables data	:	Shall be given during Detailed engg.	
10.0	Earth Conductor Size & Material	:	Shall be given during Detailed engg.	
11.0	Space heater supply (30KW & ABOVE)	:	240 V, 1 Φ , 50 Hz	
12.0	Rating up to which Single phase motor	:	Acceptable below 0.20 Kw	
13.0	TYPE OF STARTER PROVIDED IN MCC	:	DOL	
14.0	Locked rotor current			
	a) Limit as percentage of FLC	:	As per IS 12615	
	b) Permissible tolerance, if any	:		
15.0	Additional tests	:	As per QP	
16.0	Flame-proof motor			
	a) Enclosure suitable (As per IS:2148)	:	As per requirement	
	b) Classification of Hazardous area (As per IS: 5572 part-I)	:	As per requirement	
	c) Degree of protection	:	IP65	
17.0	Makes	:	AS PER ANNEXURE-IV	
18.0	Terminal box	:	Suitable to rotate at 90 degrees	
19.0	Paint shade	:	RAL 5012	



TITLE

LV MOTORS

DATA SHEET-A

SPECIFICATION NO.

VOLUME II B

SECTION D

REV NO. 00 DATE 12.10.17

SHEET 2 OF 1

20.0 Efficiency class : IE3

NOTE :

1. Also detailed Customer spec. for Motors is to be referred as enclosed with technical spec.



TITLE :
GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO. PE-SS-999-506-E101
VOLUME NO. : II-B
SECTION : D
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SHEET : 1 OF 1

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

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

बी एच ई एल 	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO. PE-SS-999-506-E101
		VOLUME NO. : II-B
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		SHEET : 1 OF 4

1.0

INTENT OF SPECIFIATION

The specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer’s work, and packing of Low voltage (LV) squirrel cage induction motors along with all accessories for driving auxiliaries in thermal power station.

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors.

2.0

CODES AND STANDARDS

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:

IS:325	Three phase Induction motors
IS : 900	Code of practice for installation and maintenance of induction motors
IS: 996	Single phase small AC and universal motors
IS: 4722	Rotating Electrical machines
IS: 4691	Degree of Protection provided by enclosures for rotating electrical machines
IS: 4728	Terminal marking and direction of rotation rotating electrical machines
IS: 1231	Dimensions of three phase foot mounted induction motors
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 13555	Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment
IS: 2148	Flame proof enclosures for electrical appliance
IS: 5571	Guide for selection of electrical equipment for hazardous areas
IS: 12824	Type of duty and classes of rating assigned
IS: 12802	Temperature rise measurement for rotating electrical machnines
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 12075	Mechanical vibration of rotating electrical machines

In case of imported motors, motors as per IEC-34 shall also be acceptable.

3.0

DESIGN REQUIREMENTS

3.1

Motors and accessories shall be designed to operate satisfactorily under conditions specified in data sheet-A and Project Information, including voltage & frequency variation of supply system as defined in Data sheet-A

3.2

Motors shall be continuously rated at the design ambient temperature specified in Data Sheet-A and other site conditions specified under Project Information
Motor ratings shall have at least a 15% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified above.

3.3

Starting Requirements

3.3.1

Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

3.3.2

Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.

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		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 minimum 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: 4691 and 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.		

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		SHEET : 3 OF 4
4.4.	Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.	
4.5	Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.	
4.6	In case Class ‘F’ insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class ‘B’ insulation. In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.	
4.7	Terminals and Terminal Boxes	
4.7.1	Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A. Unless otherwise stated in Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet “A”.	
4.7.2	unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.	
4.7.3	Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or U W & V respectively.	
4.7.4	Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.	
4.7.5	Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.	
4.7.6	Degree of protection for terminal boxes shall be IP 55 as per IS 4691.	
4.7.7	Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.	
4.7.8.	Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.	
4.7.9	Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.	
4.8	Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.	
4.9	General	

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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.		

	TITLE LV MOTOR DATA SHEET - C	SPECIFICATION NO.
		VOLUME II B
		SECTION D
		REV NO. 00 DATE
		SHEET 1 OF 2

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

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

	TITLE LV MOTOR DATA SHEET - C	SPECIFICATION NO.
		VOLUME II B
		SECTION D
		REV NO. 00 DATE
		SHEET 2 OF 2

S. No.	Description	Data to be filled by successful bidder
	c) At starting	
C.	Constructional Features	
1	Method of connection of motor driven equipment	
2	Applicable Standard	
3	DOP of Enclosure	
4	Method of cooling	
5	Class of insulation	
6	Main terminal box	
	a) Type	
	b) Power Cable details (Conductor, size, armour/unarmour)	
	c) Cable Gland & lugs details (Size, type & material)	
	d) Permissible Fault level (kArms & duration in sec)	
7	Space heater details (Voltage & watts)	
8	Flame proof motor details (if applicable)	
	a) Enclosure	
	b) suitability for hazardous area	
	i Zone	O / I / II
	ii Group	IIA / IIB / IIC
9	No. of Stator winding	
10	Winding connection	
11	Kind of rotor winding	
12	Kind of bearings	
13	Direction of rotation when viewed from NDE	
14	Paint Shade & type	
15	Net weight of motor	
16	Outline mounting drawing No (To be enclosed as annexure)	
D.	Characteristic curves/ drawings (To be enclosed for motors of rating $\geq 55KW$)	
	a) Torque speed characteristic	
	b) Thermal withstand characteristic	
	c) Current vs time	
	d) Speed vs time	

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

		QUALITY PLAN		CUSTOMER :		PROJECT		SPECIFICATION :				
				BIDDER/ VENDOR :		TITLE		NUMBER :				
		SHEET 1 OF 2		SYSTEM		QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01		SPECIFICATION TITLE				
				ITEM AC ELECT. MOTORS BELOW 55KW (LV)		SECTION		VOLUME III				
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	2	-	-	
		2.DIMENSIONS	MA	-DO-	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	2	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE	MA	VISUAL	100%	MFG.SPEC./ RELEVANT IS	MFG.SPEC. RELEVANT IS	-DO-	2	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MANUFR'S SPEC/BHEL SPEC./RELEVANT STANDARD	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	NOTE -1 & NOTE-3
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	IS-325/ BHEL SPEC./ DATA SHEET	SAME AS COL.7	TEST REPORT	2	1		NOTE -1 & NOTE-3
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPN. REPORT	2	1	-	
BHEL			PARTICULARS		BIDDER/VENDOR							
			NAME									
			SIGNATURE									

		QUALITY PLAN		CUSTOMER :			PROJECT			SPECIFICATION :		
				BIDDER/ :			TITLE			NUMBER :		
		SHEET 2 OF 2		VENDOR			NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION :		
		SYSTEM			ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2	1	-	
NOTES: 1 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON 2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. 3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW , ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY. <u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY												
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN		CUSTOMER :			PROJECT TITLE		SPECIFICATION : NUMBER :			
				BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03		SPECIFICATION : TITLE			
		SHEET 1 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SECTION		VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	P	W	V	11
1.0	RAW MATERIAL & BOUGHT OUT CONTROL											
1.1	SHEET STEEL, PLATES, SECTION, EYEBOLTS	1.SURFACE CONDITION	MA	VISUAL	100%	-	FREE FROM BLINKS, CRACKS, WAVINESS ETC	LOG BOOK	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	-DO-	3	-	-	
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	-DO-	-DO-	-DO-	INSPEC. REPORT	3	-	2	
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, UN-EVENNESS ETC.	-DO-	3	-	-	
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	MANFR'S DRG./SPEC BOOK	RELEVANT IS/SPEC.	SUPPLIERS TC & LOG	3	-	2	PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, BLOW HOLES ETC.	LOG BOOK	3	-	2	
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1/HEAT NO.	MANFR'S DRG./SPEC	RELEVANT IS/	SUPPLIER'S TC	3	-	2	HEAT NO. SHALL BE VERIFIED
		3.DIMENSIONS	MA	MEASUREMENT	100%	MANUFR'S DRG.	MANUFR'S DRG.	LOG BOOK	3	-	2	
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	LOG BOOK	3	-	2	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN		CUSTOMER :		PROJECT			SPECIFICATION :				
				BIDDER/ :		TITLE			NUMBER :				
				VENDOR		QUALITY PLAN			SPECIFICATION :				
SHEET 2 OF 9		SYSTEM		NUMBER PED-506-00-Q-007, REV-03			TITLE			SECTION			
ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		VOLUME III											
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS	
									P	W	V		
1	2	3	4	5	6	7	8	9	10			11	
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED	
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	MFG. DRG. SPEC.	RELEVANT IS	SUPPLIER'S TC	3	-	2		
		3. DIMENSIONS	MA	MEASUREMENT	100%	-DO-	MANUFR'S DRG.	LOG BOOK	3	-	2		
		4.INTERNAL FLAWS	CR	UT	-DO-	ASTM-A388	MANUFR'S SPEC. BHEL SPEC.	-DO-	3	2	1		
1.6	SPACE HEATERS, CONNNECTORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING	MA	VISUAL	-DO-	MANUFR'S DRG. SPEC.	MANUFR'S DRG. SPEC.	-DO-	3	-	2	FOR DIA OF 55 MM & ABOVE	
		2. PHYSICAL COND.	MA	-DO-	-DO-	-	NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY	-DO-	3	-	2		
		3.DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG./ SPEC.	MANUFR'S DRG. / SPEC.	-DO-	3	-	2		
		4.PERFORMANCE/ CALIBRATION	MA	TEST	100%	-DO-	-DO-	INSP. REPORT	3	-	2		
BHEL			PARTICULARS		BIDDER/VENDOR								
			NAME										
			SIGNATURE										
			DATE					BIDDER'S/VENDORS COMPANY SEAL					

		QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :		
				BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE		
		SHEET 3 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION		VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	P	W	V	11
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC.	MA	VISUAL	100%	-	NO VISUAL DEFECTS	INSPT. REPORT	3	-	2	FOR MV MOTOR INSULATION/VARNISH THICKNESS SHALL BE MORE THAN THE BURS HEIGHT * MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY BHEL/CUSTOMER.
		2. OTHER CHARACTERISTICS	MA	TEST	SAMPLE	MANUF'S SPEC.	MANUF'S SPEC.	LOG BOOK AND OR SUPPLIER'S TC	3	-	2	
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND.	MA	VISUAL	100%	-	NO VISUAL DEFECTS (FREE FROM BURS)	LOG BOOK	3	-	-	
		2.DIMENSIONS INCLUDING BURS HEIGHT	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG. .	MANUFR'S DRG.	-DO-	3	-	2	
		3. ACCEPTANCE TESTS	MA	ELECT. & MECH TESTS	-DO-	MANUF'S SPEC./ RELEVANT IS	RELEVANT IS	SUPPLIER'S TC	3	-	2	
1.9	CONDUCTORS	1. SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	LOG BOOK	3*	-	2*	
		2.ELECT. PROP, & MECH. PROP	MA	ELECT. & MECH.TEST	SAMPLES	RELEVANT IS/ BS OR OTHER STANDARDS	RELEVANT IS/ BS OR OTHER STANDARDS	SUPPLIERS TC & VENDOR'S INSPN. REPORTS	3	-	2	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE			SPECIFICATION : NUMBER :			
				BIDDER/ VENDOR :		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
		SHEET 4 OF 9		SYSTEM		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION		VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.10	BEARINGS	3.DIMENSIONS	MA	MEASUREMENT	-DO-	-DO-	-DO-	Log Book	3	-	2	
		1.MAKE & TYPE	MA	VISUAL	100%	MANFR'S DRG./ APPROVED DATASHEET	MANFR'S DRG./ APPROVED DATASHEET	-DO-	3	-	2	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	BHEL DATA SHEET	BHEL DATA SHEET BEARING MANUF'S CATALOGUES	-DO-	3	-	2	
		3.SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	2	
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-DO-	-DO-	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	-DO-	MANUF'S SPEC./ BHEL SPEC.	MANUF'S SPEC./ BHEL SPEC.	-DO-	3	-	2	
		4.HV/IR	MA	-DO-	100%	-DO-	-DO-	-DO-	3	-	2	
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	MANUF'S DRG/SPECS	MANUF'S DRG./ SPECS.	-DO-	3	-	-	
		2.SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	
BHEL			PARTICULARS		BIDDER/VENDOR							
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN		CUSTOMER :			PROJECT		SPECIFICATION :			
				BIDDER/ :			TITLE		NUMBER :			
		SHEET 5 OF 9		VENDOR			QUALITY PLAN		SPECIFICATION :			
		SYSTEM			NUMBER PED-506-00-Q-007, REV-03		TITLE					
					ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SECTION		VOLUME III			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
2.0	IN PROCESS											
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNES	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	3/2	2	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	2	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	-DO-	RELEVANT SPEC./ ASTM-E165	MANUF'S SPEC./ BHEL SPEC./	-DO-	2	-	1	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	MANFR'S SPEC/BHEL SPEC./ RELEVANT STAND	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-DO-	-DO-	-DO-	2	-	-	
		3.SHADE	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	-DO-	-DO-	-DO-	Log Book	2	-	-	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE			SPECIFICATION : NUMBER :				
				BIDDER/ : VENDOR		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE				
		SHEET 6 OF 9		SYSTEM		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION		VOLUME III		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS	
1	2	3	4	5	6	7	8	9	10	P	W	V	11
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	MANUFR'S SPEC.	MANUFR'S SPEC.	Log Book	2	-	-		(FOR MOTORS OF 2MW AND ABOVE) * ON 10% RANDOM SAMPLE
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-DO-	-DO-	Log Book	2	-	-		
		3.CORE LOSS & HOTSPOT	MA	ELECT.TEST	-DO-	-DO-	-DO-	Log Book	2	1*	1		
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	MANUFR'S SPEC./BHEL SPEC.	MANUFR'S SPEC./BHEL SPEC.	Log Book	2	-	-		
		2.CLEANLINESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-		
		3.IR-HV-IR	CR	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2	-	1		
		4.RESISTANCE	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1		
		5.INTERTURN INSULATION	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-		
		6.SURGE WITH STAND AND TAN. DELTA TEST	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1		
2.6	IMPREGNATION	1.VISCOSCITY	MA	PHY. TEST	AT STARTING	-DO-	-DO-	Log Book	2	-	-		FOR MV MOTOR
		2.TEMP. PRESSURE VACCUM	MA	PROCESS CHECK	CONTINUOUS	-DO-	-DO-	Log Book	2	-	-		
		3.NO. OF DIPS	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1		
BHEL			PARTICULARS		BIDDER/VENDOR								
			NAME										
			SIGNATURE										
			DATE						BIDDER'S/VENDORS COMPANY SEAL				

		QUALITY PLAN		CUSTOMER :			PROJECT TITLE		SPECIFICATION : NUMBER :			
				BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03		SPECIFICATION : TITLE			
		SHEET 7 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SECTION		VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	10			11
2.7	COMPLETE STATOR ASSEMBLY	4.DURATION	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	VERIFICATION FOR MV MOTOR ONLY
2.8	BRAZING/COMPRESSION JOINT	1.COMPACTNESS & CLEANLINESS	MA	VISUAL	100%	-DO-	-DO-	Log Book	2	-	-	
2.9	COMPLETE ROTOR ASSEMBLY	1.COMPLETENESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.SOUNDNESS	CR	MALLET TEST & UT	-DO-	-DO-	-DO-	Log Book	2		1	
		3.HV	MA	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2		1	
2.10	ASSEMBLY	1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	-DO-	MFG SPEC./ ISO 1940	MFG. DWG.	Log Book	2		1	
		2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	-DO-	MFG. SPEC.	MFG. SPEC.	Log Book	2		1	
		1.ALIGNMENT	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.WORKMANSHIP	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.AXIAL PLAY	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.DIMENSIONS	MA	-DO-	-DO-	MFG.DRG./ MFG SPEC.	MFG. DRG/ RELEVANT IS	Log Book	2	-	-	
		5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2	-	-	
		6. RTD, BTD & SPACE HEATER MOUNTING.	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2		1	
BHEL			PARTICULARS		BIDDER/VENDOR							
			NAME									
			SIGNATURE									
			DATE									
												BIDDER'S/VENDORS COMPANY SEAL

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE			SPECIFICATION : NUMBER :			
				BIDDER/ : VENDOR		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
		SHEET 8 OF 9		SYSTEM		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION		VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS AS PER BHEL SPEC.	MA	ELECT.TEST	1/TYPE/SIZE	IS-325/ BHEL SPEC./ DATA SHEET	IS-325/ BHEL SPEC./ DATA SHEET	TEST REPORT	2	1*	1	* NOTE - 1
		2.ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1\$	1	\$ NOTE - 2
		3.VIBRATION & NOISE LEVEL	MA	-DO-	100%	IS-12075 & IS-12065	IS-12075 & IS-12065	-DO-	2	1\$	1	\$ NOTE - 2
		4.OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPC. REPORT	2	1	-	
		5.DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	RELEVANT IS	BHEL SPEC. AND DATA SHEET	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1\$	1	\$ NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1\$	1	\$ NOTE - 2
		8. NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPC. REPORT	2	1\$	1	\$ NOTE - 2
		9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	IS-3682 IS-8239 IS-8240	IS-3682 IS-8239 IS-8240	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	BHEL SPEC. & DATA SHEET	BHEL SPEC. & DATA SHEET	TC	2	1\$	1	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY \$ NOTE - 2
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE									
									BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER :				
				BIDDER/ VENDOR		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03		SPECIFICATION : TITLE				
		SHEET 9 OF 9		SYSTEM		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SECTION		VOLUME III		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	P	W	V	11
NOTES: 1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED. 2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON. 3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THESE TEST MAY NOT BE REPEATED. 4 WHEREVER CUSTOMER IS INVOLVED IN INSPECTION, AGENCY (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. <u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY												
BHEL			PARTICULARS		BIDDER/VENDOR							
			NAME									
			SIGNATURE									
			DATE									
											BIDDER'S/VENDORS COMPANY SEAL	

Motors



EPC TENDER SPECIFICATION FOR BTG PACKAGE

2.2.12 MOTORS

2.2.12.1 Design Criteria

- i. For the purpose of design of equipments /systems, an ambient temperature of 50 °C and relative humidity of 95% shall be considered. The equipment shall operate in a highly polluted environment.
- ii. Transient voltage dip on starting of the largest motor with DOL shall be limited to 20% of the nominal system voltage at the voltage terminals.

1. Rating

- i. The motor rating shall be arrived at considering 15% margin over the duty point input or 10% over the maximum demand of the driven equipment, whichever is higher, considering highest system frequency.
- ii. All motors shall be continuously rated (S1 duty). However, crane motors shall be rated for S4 duty, 40% cyclic duration factor.
- iii. Whenever the basis for motor ratings are not specified in the corresponding mechanical specification sub-sections, maximum continuous motor ratings shall be at least 10% above the maximum load demand of the driven equipment under entire operating range including voltage and frequency variations.

2. Starting Voltage requirement for all motors (except mill motors):

- i. 85 % of rated voltage for motors up to 1000 kW
- ii. 80 % of rated voltage for above 1000 kW and up to 4000 kW
- iii. 75 % of rated voltage for above 4000 kW

For Mill Motors:

- iv. 85 % of rated voltage for motors above 1000 kW
- v. 90 % of rated voltage for motors up to 1000 kW

3. Canopy shall be provided for outdoor motors.
4. Contractor shall provide fully compatible electrical system, equipments, accessories and services.
5. All the equipment, material and systems shall, in general, conform to the latest edition of relevant National and international Codes & Standards, especially the Indian Statutory Regulations.



EPC TENDER SPECIFICATION FOR BTG PACKAGE

6. Voltage and frequency variations:

- i. Frequency : (+) 3% and (-) 5%
- ii. Voltage :
 - A) AC:
 - a. $\pm 10\%$ for 11 kV/6.6 kV
 - b. $\pm 10\%$ for 415 V

B) DC: +10% to -15% for 220 V DC

- iii. Combined 10 % (absolute sum)

7. All LV motors above 10 kW with S1 duty.

8. Continuous duty LT motors rated above 0.37kW upto 200 KW Output rating (at 50 deg. C ambient temperature), shall be Efficiency class-IE3, conforming to IS 12615, or IEC:60034-30. However this is not applicable for geared motors (motors completely integrated with driven equipment) which are specifically designed to suit the driven equipment duty.

The responsibility of coordination with electrical agencies and obtaining all necessary clearances shall be of the contractor.

9. Type

- i. AC Motors:
 - a. Squirrel cage induction motor suitable for direct-on-line starting.
 - b. Crane duty motors shall be slip ring type induction motor
- ii. DC Motors
 - a. Shunt wound

10. Temperature Rise

- i. **Air cooled** motors - 70°C by resistance method.
- ii. Water cooled - 80° C over inlet cooling water temperature mentioned elsewhere, by resistance Method.

11. Degree of Protection

Degree of protection for various enclosures shall be as follows:

1. Indoor motors	-	IP 54
2. Outdoor motors	-	IP 55



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3.	CW motors (in case of screen prot. Drip proof)	-	IP 23
4.	Cable box – indoor area	-	IP 54
5.	Cable box – outdoor area	-	IP 55

2.2.12.2 Codes and Standards

1. All motors shall confirm to the latest editions including all applicable amendment of relevant IS, IEC and CBIP standards/Publications. In case any other standard is followed that ensures equal or better quality, may be accepted. However the English version of the Standard adopted shall be submitted.
2. Major Standards, which shall be followed, are listed below. Any other applicable Indian standards for any component part even if not covered in the list shall also be followed.
 - i. Three phase induction motors : IS:325, IEC:60034
 - ii. Single phase AC motors : IS:996, IEC:60034
 - iii. Crane duty motors : IS:3177, IEC:60034
 - iv. DC motors/generators : IS:4722
 - v. Degree of protection by enclosures for rotating electrical machines : IS: 4691 , IS: 4728, IS: 6362, IS: 2253
 - vi. Noise levels for rotating electrical machines : IS: 12065
 - vii. Mechanical Vibrations for rotating electrical machines : IS 12075

2.2.12.3 Operational Requirements

1. Starting Time
 - i. For motors with starting time less than 20 secs at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 secs more than starting time.
 - ii. For motors with starting time more than 20 secs and up to 45 secs at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 secs more than starting time.



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- iii. For motors with starting time more than 45 secs at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.
- iv. Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.
- v. Motors shall be capable of restarting under full load after a momentary loss of voltage with the possibility of 150 % nominal voltage during fast bus transfer.

2. Torque Requirements

- i. Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.
- ii. Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty motors.

2.2.12.4 Design and constructional features

- 1. Suitable single phase space heaters shall be provided on motors rated 30 kW and above to maintain windings in dry condition when motor is standstill. Separate terminal box for space heaters & RTDs shall be provided.
- 2. All motors shall be suitable for direct on line starting through any type of breaker.
- 3. All motors shall be either totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or Closed air circuit air cooled (CACA) type. However, motors rated 3000KW or above can be Closed air circuit water cooled (CACW). CW motors can be screen protected drip proof (SPDP) type. Motors located in hazardous areas shall have flame proof enclosures conforming to IS: 2148 as detailed below:
 - a. Fuel oil area : Group - IIB
 - b. Hydrogen generation plant area : Group - IIC

4. Winding and Insulation

Type	Non-hygroscopic, oil resistant, flame resistant
Starting Duty	Two hot starts in succession, with motor initially at normal running temperature.
11 kV / 6.6 kV AC motors	Class F: with winding temperature rise limited to class B. They shall withstand 1.2/50 micro sec switching surges of $4U+5$ KV (U=Line voltage in KV).



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415V AC & 220V DC

The coil inter-turn insulation shall be suitable for 0.3/3 micro sec. surge of 32 KVp and 12 kVp for 11 kV and 6.6 kV system respectively followed by 1 min power frequency high voltage test of appropriate voltage on inter turn insulation

Class 'F' with temperature rise limited to class 'B'

5. Motors rated above 1000 kW shall have insulated bearings to prevent flow of shaft currents.
6. Motors with heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate inlet and outlet primary air temperature.
7. Noise level and vibration shall be limited within the limits prescribed in IS: 12065 & IS: 12075 respectively. Motors shall withstand vibrations produced by driven equipment.
8. In MV/HV motors, 12 nos. simplex or 6 nos. duplex RTDs (two per phase), each having D.C. resistance of 100 ohms at 0°C, embedded in the stator winding at locations where highest temperatures may be expected, shall be provided. The material of the RTD's shall be platinum. Each bearing shall be provided with dial type thermometer with adjustable alarm contact and resistance type temperature detector. All HV motors shall be provided with shaft grounding rings for bearing protection and earthing shaft current.
9. MV/HV motors shall also be capable of satisfactory operation at full load at a supply voltage of 80% of the rated voltage and shall be capable of either two starts in quick succession with third start after 5 minutes in cold condition or two starts at 15 minutes intervals in hot condition, both cases with voltage and frequency variation within specified limits.
10. Locked rotor current of the MV motors shall be limited to 600% (subject to IS tolerance) of the full load current of the motors and for HV motors (like BFP) shall be limited to 450% (inclusive of IS tolerance) of full load current of the motor. Locked rotor current of the LV motor shall not exceed 600% of full load current inclusive of IS tolerance.
11. MV Motors shall be provided with differential protection. These motors shall be provided with star connected stator windings. The 3 nos. current transformers, one for each phase shall be mounted in a separate compartment in the neutral side terminal box. The three phases shall be connected to form the star point after they pass through the CTs. These differential protection CTs for motors on 11/ 6.6 kV switchgear shall be supplied as loose.



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12. Motor body shall be grounded at two earthing points on opposite sides with two separate and distinct grounding pads complete with tapped holes, GI bolts and washers.
13. HV motors can be offered with either elastimould termination or dust tight phase separated double walled (metallic as well as insulated barrier) cable boxes. In case elastimould terminations are offered, then protective cover and trifurcating sleeves shall also be provided. Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non magnetic material for single core cables) shall be provided in case of cable boxes.
14. All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.
15. Motors rated 18.5kW and below shall be contactor controlled having MPCB incomers with intelligent controllers. Motors rated 18.5kW and above but below 90 kW shall be contactor controlled having MCCB incomers with intelligent controllers. Motors rated 90 kW and & above up to 200KW shall be ACB controlled with numerical relays. HV & MV Motors rated above 200 KW shall have vacuum breakers. HV motors rated 1000kW and above shall be provided with insulation bearings for avoiding bearing currents. HV Motors rated 1000KW and above shall also have differential protection. Care shall be taken by BTG Bidder to ensure that parameters of the differential CT being supplied along with motors (rated above 1000kW) match with the parameters of the differential CT being supplied by BTG bidder in 11kV Switchgear.
16. The motors shall be suitable for bus transfer schemes provided on the 11 kV, 6.6 Kv and 415V systems without any injurious effect on its life.
17. For motors rated 1000 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box.
18. All motors shall be provided with an emergency stop push button near the motor as per the Indian Statutory regulations.
19. The motor terminal box shall be suitable for withstanding the maximum system fault current for a duration of at least 0.25 seconds.
20. Neutral in case of HV motors shall be kept accessible.
21. Motors shall be designed to easy access for drilling holes through motor feed of mounting flange for installation of dowel pins after assembly of the motor and driven equipment.



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22. Well spacious working platforms shall be provided around the motor area for carrying out maintenance & testing works. Platform shall be minimum of 300 mm below the level of motor base plate.
23. Flow switches shall be provided for monitoring oil flow of forced lubrication bearings, if used. Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 10 A at 230 V AC.
24. For bearing temperature measurement, duplex RTDs shall be provided for each bearing and shall be wired up to the terminal box.
25. Lube oil pressure transmitters shall be provided to DCS for remote monitoring. Lube oil pressure very low trip to HV equipment shall be 2 out of 3 logic.
26. Capillary type temperature gauge cum switch shall be provided for DE / NDE of HV Motors.
27. Motors with CACA/CACW heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate the following:
 - a) Hot and cold air temperatures of the closed air circuit for CACA motors.
 - b) Hot and cold, air and water temperatures for CACW motors.
28. The Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 10 A at 230 V AC.
29. DIRECTION OF ROTATION

As needed by driven equipment. The 3 phase motor shall, however, be suitable for operation in both directions of rotation. A plate showing direction of rotation as determined by the phase sequence on the terminals marking shall be screwed at non-driving end of the body of the motor. If, in the case of HV & MV motors, fan is suitable for only one direction of rotation, the fan shall be so designed that with the slight modification work, it can be made suitable for other direction of rotation also. No extra material shall be required for doing above modification work.
30. BEARINGS

Greased ball, roller and/or sleeve bearing shall be rated for minimum standard life of 40000 hours taking bearing and driven equipment loads into account. Loss of grease shall be scarce and it shall not creep along shaft into motor housing. Bearing shall be effectively sealed against dust ingress and shall be pressure grease gun lubricated.

If the bearings are oil lubricated, a drain plug shall be provided for draining residual oil and oil level gauge shall be provided to show precisely oil level required under standstill and running conditions.



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Unless otherwise approved, bearing lubricating system shall be such that no external forced oil or water is necessary to maintain required oil supply to keep bearing temperature within design limits.

For MV & HV motors rated 1000KW and above, the bearings shall be insulated wherever necessary to prevent damage to motor bearings from shaft current.

When pressure oiling is required for horizontal motors, bearings shall be sleeve type arranged for pressure oiling supplied from lubrication system of driven machine, with ring oiling for starting and emergency duty. Ring oiling system shall be adequate for starting and continuous operation of motor for at least half an hour, without pressure oiling system in operation. Oil sight flow gauges shall be provided to indicate oil flow through each bearing.

Lubricants shall be selected for prolonged storage and normal use of motors in tropical climate and shall contain corrosion and oxidation inhibitors. Greases shall have suitable bleeding characteristics to minimize setting. The selected lubricants shall be indigenously available.

Sleeve bearings for use with motors having flexible coupling with limited end play, shall have adequate axial end play to prevent transmission of thrust from driven equipment to motor bearings.

Bearings shall be of reputed make subject to the approval of the Purchaser/Consulting Engineer.

Large motors shall preferably have spherically seated babitted, ring forced, feed lubricated, water-cooled bearings. If anti-friction bearings are provided, these shall be roller bearings rated for a minimum standard life of 30000 hours taking all bearing and driven equipment loads into account.

31. TERMINAL BOXES

General

- i) Motors shall be provided with separate terminal boxes for main, space heaters, embedded temperature detectors, bearing temperature indicators and moisture detectors terminals, Neutral CT terminals. When it is not possible to provide LT motors with separate terminal box for space heater terminals, space heater terminals shall be adequately segregated from the main terminals in the single box. Terminal boxes shall be weatherproof and water-tight conforming to minimum IP-55 degree of protection with removable front cover for making connections. IP-55 degree of protection shall be achieved without application of compound. Space between and



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around terminals shall be adequate for easily connecting aluminium conductor cables. Terminal box arrangement shall be to the approval of the Purchaser /Consulting Engineer. All terminal boxes shall be suitable for proper termination cable to be finalized during detailed engineering.

- ii) The terminal boxes shall be complete with cable glands and termination accessories as required. Suitable non-magnetic material construction shall be adopted for terminal boxes where single core cables are to be terminated. All HV & MV motors shall be provided with phase segregated terminal box.
- iii) Terminal bushings and clamps shall be non-absorbent, non- inflammable, insulated material for connecting with cable.

Main Terminal Box

- i) LV Motors Main terminal box shall be capable of being turned through 360 degrees in steps of 90 degrees.
- ii) MV & HV Motors shall be provided with two (2) terminal boxes for stator terminals. One (1) terminal box shall be for phase terminals while other one for forming star connection. For motors rated below 1000 KW should be interchangeable to facilitate cable routing.
- iii) Neutral terminal box for HV motors rated 1000 KW and above shall be suitable for mounting of three (3) Nos. wound/bar primary/ring type cast resin insulated current transformers for differential protection. These CTs shall be mounted in the motor neutral terminal box. Stator phase terminal box shall be phase segregated terminal box suitable for both top or bottom entry of cables (i.e. they should be capable of being turned through 180 Degrees). The terminal box shall be designed for termination of XLPE cables using heat shrinkable terminating Kit. Terminal leading shall be stud type or leading wire type.
- iv) Terminal Boxes shall be provided with cable end boxes having cable lugs and cable glands for cables.
- v) The terminal boxes shall be capable of withstanding at the terminals the system fault level (as indicated below) without rupture for a duration of atleast 0.25 seconds.
 - a) Min. fault level for 11kV Motors - 50kA
 - b) Min. fault level for 6.6 kV Motors - 40kA
 - c) Min. fault level for 415V Motors -50kA



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- d) Min. fault level for 220V DC Motors -25kA
- vi) Phase to Phase/ Phase to Earth Air Clearance:-
- a) Minimum inter-phase and phase-earth air clearances for LT motors with lugs installed shall be as follows:-

Motor MCR in KW	Clearance
UP to 110 KW	10mm
Above 110 KW and upto 150 KW	12.5mm
Above 150 KW	19mm

- vii) Terminal Accessories.....Each terminal end shall be furnished with bimetallic washers, spring washers, nuts and crimp type aluminium (preferably tinned) lugs suitable for cables of sizes.

32. TYPE AND SIZE OF CABLES

Space Heaters

- i) For LV Motors: Two point five (2.5) mm², two (2) core copper conductor PVC insulated, armoured and FRLS PVC sheathed heavy duty 650/1100 V grade cable to IS: 1554 (Part-I).
- ii) For MV & HV Motors: Six (6) mm² two core aluminium conductor XLPE insulated armoured and FRLS PVC sheathed heavy duty 650/1100V grade cable to IS: 1554 (Part-I).
- iii) For Embedded Temperature Detectors two sets of six (6) Twisted triad 0.5 mm² ATC copper conductor armoured, shielded cable, 650/1100 V Grade IS: 1554 (Part-I). For bearing temperature, RTDS, two (2) sets of four (4) twisted triad 0.5 mm², ATC copper conductor armoured shielded 650/1100 V Grade, IS: 1554 (Part-I).
- iv) Bearing Temperature Indicators - For each indicator, 0.5 mm² six (6) tarnished triad ATC copper conductor, PVC insulated, shielded armoured and FRLS PVC



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sheathed heavy duty 650/1100 V grade cable as per IS: 1554 Part-I. Two (2) cables one (1) for each bearing temperature indicator.

- v) For Moisture Detectors.....As for space heaters

For Main Terminals:-

- i) LT Motors

- a) Three (3) core cables Stranded aluminium conductor, XLPE insulated, colour coded, laid up, FRLS PVC type ST2 sheathed, GI wire / strip armoured, FRLS PVC type-ST2 jacketed overall, 650 / 1100V grade, heavy-duty cables as per IS: 1554 (Part-I).
- b) Single core cables Stranded aluminium conductor, XLPE insulated, hard drawn aluminium wire/ strip armoured FRLS PVC type ST2 jacketed overall, 1100V grade, heavy duty cable as per IS: 1554 (Part-I).

- ii) HV & MV Motors

Three (3) core cables stranded aluminium conductor, XLPE insulated, screened colour coded, laid up, FRLS PVC type ST2 sheathed, GI wire/strip armoured FRLS PVC type ST2 jacketed overall, 6.6 KV / 11 KV un earthed grade, heavy duty cables as per requirement for unearthed system as per IS: 7098 (Part-II).

33. GROUNDING

General..... Two (2) grounding terminals one (1) on either side at the bottom suitable for connecting mild steel/GI flat/GI wire grounding conductor, size of grounding conductor shall be decided during detailed engineering.

LV Motors.....At each earthing point, two (2) drilled and tapped holes with hexagonal head bolts, plain washers, spring washers and tinned lugs (for motors upto 5.5 KW) for size of conductor specified shall be provided.

HV & MV Motors.....Non-corrodible metallic grounding pad shall be welded or brazed at each earthing point. The size of grounding pad shall be 75x65x25 mm. Grounding pad shall have 40 mm apart two (2) drilled and tapped holes with hexagonal head bolts, plain washers and spring washers for size of conductor



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specified. In addition, one suitable earthing terminal shall be provided inside the stator phase terminal box for earthing metallic shield of XLPE cables.

34. EMBEDDED TEMPERATURE DETECTORS

HV & MV motor shall be provided with four (4) Nos. simplex or two (2) Nos. duplex platinum resistance temperature detectors (RTDs) in each phase embedded in stator winding at locations where high temperatures are expected. In addition one (1) duplex type RTD shall be provided in each bearing. The RTDs shall be 3 wire duplex platinum resistance type having a value of 100 ohms at 0 Deg.C

35. BEARINGS TEMPERATURE INDICATORS

HV & MV motors shall be provided with dial type two (2) bearing temperature indicators and shall have two (2) sets of contacts, each set having 2 NO + 2 NC contacts rated for 5A at 240V AC and 0.5A at 220V DC. One set shall be set to operate at lower value to give alarm and other set at a higher value to trip the motor.

36. SPACE HEATERS

Valve / Damper actuator motors; and Motors 30 KW and above shall be provided with one (1) or two (2) space heaters suitable for 240V, 50 Hertz single phase AC supply and of adequate capacity to maintain motor internal temperature above dew point to prevent moisture condensation or deterioration of insulation during shut down. Heaters shall be mounted inside the motor in accessible locations so that their removal and replacement is simple.

The terminals of space heaters shall be brought out to a separate totally enclosed dust proof and weatherproof terminal box.

The space heater shall be wired to maintain the motor internal temperature above dew point when the motor is in idle condition.

37. HOT AIR TEMPERATURE DETECTOR

If the motor is of CACA or CACW enclosure, dial type temperature indicator shall be provided (one each for hot and cold air temperature monitoring for CACA and CACW and one each for inlet and outlet water temperature monitoring for CACW). If alarm and trip are required for cooling air temperature, temperature switch shall be provided.

38. WATER FLOW INDICATOR



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If the motor is of CACW enclosure a provision shall be made for visual indication of water flow and flow switch shall also be provided with alarm contacts. Thermometers shall be provided in water inlet and outlet circuits.

39. MOISTURE DETECTORS

Motors with type of cooling 1C 81W or 1C 91 W shall be provided with moisture detectors for raising alarm in the event of water tube failure.

40. BED PLATE

Whenever motor is supplied with driven equipment the Supplier shall ensure that bed plate suits both motor and driven equipment and is adequately braced to keep vibration and misalignment within allowable limits to the approval of driven equipment and motor manufacturers.

41. Painting

Motor including fan shall be painted with corrosion proof paints of colour shade RAL 5012.

42. Local Push Button Stations

The LPBS shall be installed near the motors to be controlled. Individual channel supports shall be used for each LPBS. These shall be installed as per approved erection detail drawing. LPBS for hazardous areas shall be CMRS certified and CCE approved.

All LPBS shall have necessary canopies. Wiring of LPBS shall be checked before giving control supply.

Local push button station having only stop push button shall be provided for all the drive motors (HV, MV & LV motors).

The degree of protection of LPBs shall be IP65 with canopy.

All PBs shall be push to actuate type and the stop PB shall be lockable in off position as per the scheme requirement.

Emergency local stop push button should not be lockable. Stop Push buttons shall be mushroom type with latched or stay put feature with protective lid/cover. Start push button shall be self-reset type.



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All push buttons shall be provided with 2 nos. NO and 2 nos. NC contacts for various interlocking purposes. One contact of stop PB shall be directly wired to the switchgear module for direct tripping and another contact to control system.

Terminals to be suitable for 2 cores of 2.5 sq.mm conductors with 20% spare terminals. All LPBs shall be of Di-cast aluminium/ FRP.

LPB shall be of following types:

1. Type-A: With Stop Push Button in FRP enclosure
2. Type-B: With Start & Stop Push Buttons in FRP enclosure
3. Type-C: With Forward, Reverse & Stop Push Buttons in FRP enclosure
4. Type-D: With Stop Push Button in flame-proof enclosure
5. Type-E: With Start & Stop Push Buttons in flame-proof enclosure
6. Type-F: With Forward, Reverse & Stop Push Buttons in flame-proof enclosure

43. OTHER ACCESSORIES

Motor shall be supplied with all accessories and parts other than those, specified above which are necessary and/or useful for efficient operation.

44. NOISE LEVEL

Noise level for all the motors shall be limited to 85dB(A) except for BFP motor for which the maximum limit shall be 90dB(A). at 1m from operating motor measured in accordance with IS: 10265.

2.2.12.5 Documents and Drawings

1. INFORMATION WITH PROPOSAL

AC Motor Data Sheet
Dimension Drawing/Foundation load details of motor and driven equipment.
Manufacturer's catalogue showing constructional details.

2. INFORMATION ON AWARD OF CONTRACT

Motor Data Sheet

Certified binding dimension drawing of motor complete with all accessories and fittings specifically showing terminal boxes, terminal spacing and sizes, earthing connections and sizes thereof, mounting details, lifting lugs, final foundation loads and dimensions with tolerances of centering spigot (where needed), shaft extension and key.



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Following characteristics curves:-

- i) Torque-speed curves for motor at eighty (80), hundred (100) and hundred ten (110) percent rated voltage as well as torque-speed curve for driven equipment except for mill motor. For mill motor torque speed curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage as well as torque-speed curve for driven equipment
- ii) Current-speed curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage except for mill motor. For mill motor current speed curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage
- iii) Current-time curves at eighty (80), hundred (100) and hundred ten (110) percent rated voltage except for mill motor. For mill motor current time curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage.
- iv) Thermal withstand curves for hot and cold at eighty (80), hundred (100) and hundred ten (110) percent rated voltage except for mill motor. For mill motor thermal withstand curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage.
- v) Efficiency, power factor, current and speed versus power output curves.
- vi) Speed-time curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage except for mill motor. For mill motor speed time curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage.
- vii) Negative phase sequence current withstand characteristics.

2.2.12.6 List of tests to be conducted for HV, MV and LV Motors

1. Type tests
 - i. No load saturation and loss curves up to approximately 115% of rated voltage.
 - ii. Momentary overload test.
 - iii. Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp., core temp., coolant flow and its temperature shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose.



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- iv. Surge withstand test on the sample coil after placing it in stator core at (4U + 5 KV) and with at least five impulse of 1.2/50 micro sec. wave, for HV motors only, where U is the line to line voltage in kV.
- v. Surge-withstand test with 0.3/3 micro sec. wave on each type of 6.6/11 kV motor coils with at least five such impulses, followed by one minute power frequency high voltage test on turn to turn insulation, after cutting the coil and bringing out the turns suitably. The power frequency test voltage shall be decided during detailed engineering.
- vi. Dimensions (for motors covered by IS 1231:1974 and IS 2223:1983 only).
- vii. Measurement of resistance of windings of stator and wound rotor.
- viii. Reduced voltage running up test at no load (for squirrel cage motors up to 37kw only).
- ix. Full load test to determine efficiency, power factor and slip.
- x. Insulation resistance test.
- xi. Test for vibration severity of motor.
- xii. Test for noise levels of motor.
- xiii. Test for degree of protection by enclosure.
- xiv. Temperature rise test at limiting values of voltage and frequency variations.
- xv. Over speed test.

2. Routine Tests

The following shall constitute the routine tests.

- i. Insulation resistance test
- ii. Measurement of resistance of windings of stator and wound rotor.
- iii. No load test
- iv. Locked rotor readings of voltage, current and power input at a suitable reduced voltage
- v. Reduced voltage running up test (for squirrel cage motor)



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- vi. Open circuit voltage ratio of stator and rotor windings (for slip ring motors); rotor;
- vii. High voltage test

2.2.12.7 Inspection and Testing at site

1. Insulation resistance of 415V motors shall be measured between the winding of the machine and its frame by means of a 500/1000V megger. A minimum value of 1 mega ohm for 415V motors shall be considered a safe value. In case of lower I.R. Value, the insulation value shall be brought up by any of the following methods as desired by the Site Engineer.
 - i. Blowing hot air in case of big motors.
 - ii. Putting the motor in electric oven in case of smaller motors.
 - iii. Placing heaters or lamps around and inside in case of small motors after making suitable guarding and covering arrangements so as to conserve the heat.
2. Site Test
 - i. Measurement of vibration.
 - ii. Measurement of insulation resistance and polarization index.
 - iii. Measurement of full load current.
 - iv. Test running of the motors, checking the temperature rise and identifying the hot spot etc.
3. 6.6 kV motors shall be tested for insulation by 500/1000V megger and its value should not be less than the safe minimum insulation of $\geq 20 \text{ M}\Omega$ resistance at 60 deg. C. In case the insulation is low, the following method of drying has to be adopted.
 - i. By locking the motor so that it cannot rotate and then applying such a low voltage to the stator terminals that full load current flows in the stator, keeping the stator winding temperature below 90 deg. C. In this a close watch shall be kept for any possible overheating and I.R. Values vs. temperature shall be plotted and heating continued till I.R. Value becomes steady.
 - ii. By blasting hot air from external source, Maximum temperature of winding while drying should be 70 deg. C to 80 deg. C. (Thermometer) or 90 deg. C. to 95 deg. C. by resistance method. Heating should be done slowly till steady



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POWER PROJECT STAGE III**



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temperature of winding is reached after 4 to 5 hours and for large machines after 10 hours. A record has to be kept for drying process, with half an hour readings and, after steady temperature is reached, at an interval of 2 hours. In case it is essential, the drying process can be supplemented by blower.

Actuators



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2.2.13 ACTUATORS

2.2.13.1 SCOPE

This Specification covers the general requirements of Electric Motor Actuators for valves, dampers and gates.

All electric motor actuators shall be furnished in accordance with this general specification and the accompanying driven equipment specification.

2.2.13.2 CODES & STANDARDS

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) / IEC as given below except where modified and / or supplemented by this specification.

Code	Name of standard
IS: 325	Specification for three phase induction motor
IS: 900	Code of Practice for installation and maintenance of induction motors.
IS: 996	Single Phase AC Motor
IS: 1271	Thermal evaluation and classification of electrical insulation.
IS:2223	Dimensions of flange mounted AC induction motors.
IS: 3043	Code of practice for earthing
IS: 4029	Guide for testing three phase induction motors.
IS: 4691	Degree of protection for enclosures of rotating electrical machinery.
IS: 4722	Specification for rotating electrical machinery.
IS: 4728	Terminal marking and direction of rotation for rotating electrical machinery.
IS: 4889	Methods of determination of efficiency of rotating electrical machines.
IS: 5571	Guide for selection of electrical equipment for hazardous areas.
IS:6362	Designation of Method of Cooling of Rotating electrical machines.
IS: 8789	Values of performance characteristics for three phase



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	induction motors.
IS: 9334	Electrical Motor Operated Actuators
IS: 12065	Noise level of motors.
IS: 12075	Measurement and evaluation of vibration of rotating electrical machines.
IS: 12615	Induction motors-Energy efficient, three-phase, squirrel cage – Specification
IS: 12802	Temperature rise measurement of rotating electrical machines.
IS: 12824	Type of duty and classes of rating assigned.
IEC: 60034-1	Rotating electrical machines
NEMA, MG-1	Motors and Generators

Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be furnished during detail engineering.

The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

2.2.13.3 General

- The Actuators shall be integral starters along with overload relays with built in SPP (Single Phase Preventer) with provision for operation from Control room, Local and by wireless set.
- The actuator motors shall be suitable for use on 415 Volt 3 phase 50Hz power supply. The actuator comprising motor, integral reversing starter, local control facilities and terminals for remote control and indication shall be housed within a self contained, sealed enclosure.
- Actuator working platforms shall be provided for maintenance purpose.
- Commissioning tools shall not form an integral part of the actuator and must be removable for secure storage/authorized release. In addition, provision shall be made for the protection of configured actuator settings by a means independent access to the commissioning tool.
- For some specific applications, integral starter shall also be separately mountable



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casting type and plug-in. Such applications shall be decided during detail engineering.

2.2.13.4 Actuator Sizing

The actuator shall be sized to guarantee valve closure at the specified differential pressure. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10% below nominal. The operating speed shall be such as to give valve closing and opening at approximately 4 to 5 mm per second unless otherwise stated in the job specification. Transient voltage dip on starting of the largest motor with DOL shall be limited to 20% of the nominal system voltage at the voltage terminals.

2.2.13.5 Environmental

Actuators shall be suitable for indoor and outdoor use. The actuator shall be capable of functioning in an ambient temperature ranging from 10°C to 50°C, upto 95% relative humidity. Actuators for explosion-hazardous applications shall in addition be certified Flameproof for Zones 1 and 2 (Divisions 1 and 2 Group gases).

2.2.13.6 Enclosure

Actuators shall be 'O' ring sealed, watertight to IP68 degree of protection. The motor and all other internal electrical elements of the actuator shall be protected from ingress of moisture and dust when the terminal cover is removed at site for cabling.

2.2.13.7 SPECIFIC REQUIREMENT

- i) The actuator shall essentially comprise the drive motor, torque/ Position limit switches, gear train, clutch, hand wheel, position indicator and transmitter, inbuilt thermostat for overload protection, space heater and internal wiring. Actuator shall be integral type. Integral starters shall have facility to hook-up with plant DCS for positioning of limit and torque switches.
- ii) The actuator enclosure shall be totally enclosed, dust tight, weather proof (NEMA-6/IP-68) suitable for outdoor use without necessity of any canopy.
- iii) All electrical equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.
- iv) The actuator shall be designed for mounting in any position without any lubricant leakage or operating difficulty.
- v) A lockable local/remote selector switch shall also be provided for selecting mode of operation.



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- vi) Gear Train:-Metal (Fibre gears are not acceptable) self-locking to prevent drift under torque switch (where ever applicable) spring pressure when motor is de-energised.
- vii) Manual Wheel:- Shall disengage automatically during motor operation.
- viii) Duty cycle of actuators shall suit the system requirement. The actuators shall be capable of giving the required torque at the output shaft. The actuators shall be designed to take the full thrust
- ix) The integral starter which shall have sophisticated electronic controls with field programming feature. It shall be designed for remote control from DCS/Respective control system. Required interposing relays for receiving open/close/stop command from DCS/Respective control system shall be provided. Potential free contacts and transducers shall be provided to provide status indication at remote DCS/Respective control system.
- x) A three position selector switch (marked as LOCAL-OFF-REMOTE) and push buttons OPEN-STOP-CLOSE (for local operation) with indication lamps for running OPEN and running CLOSE shall be provided.
- xi) The Remote command signal (OPEN-STOP-CLOSE) from DCS/Respective control system/Control panel shall be isolated from control electronics through opto-isolator.
- xii) The following individual status annunciation LED's (Colour-Green) shall be provided locally (Integral to actuator) to annunciate the following for easy local monitoring.
 - 1. Actuator in local mode
 - 2. Actuator in remote mode
 - 3. Actuator running in OPEN direction
 - 4. Actuator running in CLOSE direction
 - 5. Actuator in inching mode.
 - 6. Actuator in self-retaining mode
 - 7. Limit switch OPEN trip
 - 8. Limit switch CLOSE trip
 - 9. Control voltage availability
- xiii) The following individual fault annunciation LED's (Colour-Red) shall be provided locally. (Integral to Actuator)
 - 1. Torque switch OPEN
 - 2. Torque switch CLOSE
 - 3. Thermo switch trip
 - 4. Electronic overload relay trip
 - 5. Motor single phasing
 - 6. Common fault (Inclusive of any one or combination of above fault)



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- xiv) View port shall be provided on integral starter unit to monitor the above status annunciation and fault annunciation.
- xv) Electronic overload relay shall be provided to trip actuator in case of overload. Plug in connections/design shall be provided between:-
 - 1. Integral starter unit and basic actuator
 - 2. Between external customer connections and actuator
- xvi) OPEN-CLOSE indication /LED shall be provided for indication of full open/close position.
- xvii) Automatic phase correction facility and potential free contact for annunciation of power failure shall be provided.

2.2.13.8 Motor

The electric motor shall be Class F insulated, with a time rating of at least 15 minutes at 50°C or twice the valve stroking time, whichever is more, at an average load of at least 33% of maximum valve torque.

- i) The squirrel cage induction motor shall be designed for full voltage direct-on-line start, with starting current limited to 6 times full-load current. The motor shall be capable of starting at 85% of rated voltage and running at 80% of rated voltage at rated torque and also at 85% of rated voltage at 33% excess rated torque for a period of 5 minutes each. The motors shall otherwise generally conform with technical specification for motors mentioned elsewhere in this specification.
- ii) The actuators shall be sized so as to open or close valves/ dampers at rated speed enclosure shall not be more than 70 degree 'C' over ambient temp. of 70 deg.C as these are subjected to higher ambient conditions due to their vicinity to operate fluid on continuous load operation. The actuators shall be suitable for a relative humidity of 95%. Class of insulation shall be class-F and type of enclosure shall be IP-615.0
- iii) Insulation:- The motor winding shall be insulated with class-F insulation having temperature rise limited to Class-B.
- iv) Performance:-The motor shall be capable of:
 - a) Starting at 85% of rated voltage
 - b) Running at 80% of rated voltage at rated torque for 5 minutes
 - c) Running at 85% rated voltage at 33% excess rated torque for 5 minutes.
- v) Maximum continuous motor rating shall be atleast 10% above the maximum load derived of the driven equipment under entire operating range including voltage & frequency variation.



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Vi) Bearing

The motor bearing shall be double shielded, grease lubricated and antifriction type.

vii) Earthing

At least two earthing terminals shall be provided for the motor body. Separate earthing terminal should be provided for terminal box.

2.2.13.9 Motor Protection

Protection shall be provided for the motor as follows:

- i. The motor shall be de-energized in the event of a stall when attempting to unseat a jammed valve.
- ii. Motor temperature shall be sensed by a thermostat de-energising the motor in case of overheating.
- iii. Lost phase protection.
- iv. Overload protection.
- v. Short circuit protection by suitably rated long acting fuse.

2.2.13.10 Gearing

The actuator gearing shall be totally enclosed in an oil-filled gear casing suitable for operation at any angle. All drive gearing and components must be of metal construction and incorporate a lost-motion hammer blow feature. For rising spindle valves the output shaft shall be hollow to accept a rising stem, and incorporate thrust bearings of the ball or roller type at the base of the actuator. The design should be such as to permit the opening of the gear casing for inspection or disassembling without releasing the stem thrust or taking the valve out of service.

2.2.13.11 Hand Operation

A hand wheel shall be provided for emergency operation, engaged when the motor is declutched by a lever or similar means, the drive being restored to power automatically by starting the motor. The hand wheel or selection lever shall not move on restoration of motor drive. Provision shall be made for the hand/auto selection lever to be locked in both hand and auto positions. It should be possible to select hand operation while the actuator is running or start the actuator motor while the hand/auto selection lever is locked in hand without damage to the drive train.

The hand wheel drive must be mechanically independent of the motor drive and any hand wheel gearing should be such as to permit emergency manual operation in a



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reasonable time. Clockwise operation of the hand wheel shall give closing movement of the valve unless otherwise stated in the job specification.

2.2.13.12 Drive Bushing

The actuator shall be furnished with a drive bushing easily detachable for machining to suit the valve stem or gearbox input shaft. Normally the drive bush shall be positioned in a detachable base of the actuator. Thrust bearings, when housed in a separate thrust base should be of the sealed for life type.

2.2.13.13 Limit Switches

- a) Each motor actuator shall have Six (6) rotary drum position limit switches with two for open each with 2 NO + 2NC contacts and two for close each with 2 NO + 2 NC contacts positions, each with adjustable setting between fully open and fully closed positions. Each rotary drum limit switch shall have two (2) limit switches for intermediate open position each with 2 NO + 2 NC contacts. The limit switches shall have capacity of 5A at 240V AC or 0.5A at 220V DC.
- b) Each motor actuator shall also have two (2) torque limit switches with two (2) normally opened and two (2) normally closed contacts each.
- c) The torque switches shall have a minimum accuracy of 3% of set value. The torque switches shall be provided with calibrated knobs for setting desired torque and separate knobs shall be provided for open and close torque switches. The torque and position limit switches shall be housed in a separate enclosure with protection class as that of actuator.
- d) The motor operators/actuators shall be capable of meeting 150 percent of unseating torque at specified voltage.
- e) The motor actuators shall have 2 nos. potentiometric type transmitters of 100 ohm rating.
- f) Torque switches shall function to stop the motor on closing/opening. Upon actuation by the torque clutch it is restricted its attempt to open or close, thereby causing an overloading torque. Torque switches shall be self-resetting type only (i.e.) once a particular direction torque switch operates, it shall get resetted only when the equipment is operated in other direction.
- g) All six (6) limit switches shall be changeover type and adjustable besides having the snap facility. All limit switches, contacts shall be wired up independently upto the terminal block.

2.2.13.14 Remote Valve Position/Actuator Status Indication



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- iv. Four contacts shall be provided which can be selected to indicate any position of the valve. Provision shall be made for the selection of a normally closed or open contact form. Contacts shall maintain and update position indication during hand wheel operation when all external power to the actuator is isolated.
- v. The contacts shall be rated at 5A for 240V AC, 0.5A for 220V DC.
- vi. As an alternative to providing valve position any of the four above contacts shall be selectable to signal one of the following:
 - a. Valve opening, closing or moving
 - b. Thermostat tripped, lost phase
 - c. Motor tripped on torque in mid travel, motor stalled
 - d. Remote selected
 - e. Actuator being operated by hand wheel
- vii. Position feedback has to be provided for all inching type applications. These shall be interfaced with plant DDCMIS.
- viii. Actuator local and remote indications shall be grouped and taken separately

2.2.13.15 Local Position Indication

The actuator shall include a digital position indicator with a display from fully open to fully close in 1% increments. Red, green and yellow lights corresponding to open closed and intermediate position shall be included on the indicator. End of travel indication colours shall be reversible. The digital display shall be maintained and updated during handwheel operation when all external power to the actuator is isolated. The display shall incorporate valve, actuator and control status indication. Provision shall be made to orientate the display through increments of 90°.

Provision shall be made in the design for the addition of a contactless transmitter to give a 4-20mA analogue signal corresponding to valve travel for remote indication when required.

2.2.13.16 Integral Starter and Transformer

The reversing starter, control transformer and local controls shall be integral with the valve actuator suitably housed to prevent breathing and condensation. The starter shall be suitable for 60 starts per hour and of rating appropriate to motor size. The starter logic shall be microprocessor- based. The controls supply transformer shall be fed from two of the incoming three phases and incorporate overload protection. It shall have the necessary tapings and be adequately rated to provide power for the following functions:



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- i. Energization of the contactor coils.
- ii. DC output where required for remote controls.
- iii. Supply for all the internal electrical circuits.

2.2.13.17 Integral Local Control and Control Mode Selector

The actuator shall incorporate local controls for Open, Close and Stop and a local/ Stop/ Remote mode selector switch lockable in any one of the following three positions: local control only, stop (no electrical operation), remote control plus local stop only. It shall be possible to select maintained or non-maintained local control.

The local controls shall be arranged so that the direction of valve travel can be reversed without the necessity of stopping the actuator.

Provision shall be made to orientate the local controls through increments of 90°.

2.2.13.18 Control Facilities

- i. The necessary wiring and terminals shall be provided in the actuator for the following control functions:
- ii. Open and close external interlocks to inhibit local and remote valve opening and/or closing control. Provision shall be made to configure the interlocks to be active in remote control only.
- iii. Remote controls fed from an internal 24V DC supply and/or from an external supply rated 110V AC to be suitable for any one or more of the following methods of control:

Open, close and stop control :

- a. Open and close maintained or 'push to run' (inching) control
- b. Overriding Emergency Shut-down to Close (or Open) valve from a normally closed or open contact .
- iv. The following individual potential free relay contacts shall be provided in the actuator for remote annunciation to facilitate continuous monitoring of the actuator.
 - a. Actuator in local mode
 - b. Actuator in remote mode
 - c. Actuator (valve) running in OPEN direction.



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- d. Actuator (valve) running in CLOSE direction.
 - e. Limit switch OPEN trip
 - f. Limit switch CLOSE trip
 - g. Actuator in local mode.
 - h. Actuator in inching mode.
 - i. Actuator in self-retaining mode.
 - j. Actuator power switched off /single phasing.
 - k. Torque switch trip, thermo switch trip and overload relay trip (or close)
- v. Automatic phase correction facility and potential free contact for annunciation of power failure shall be provided.
- vi. It shall be possible to reverse valve travel without the necessity of stopping the actuator. The starter contactors shall be protected from excessive current surges during travel reversal by an automatic time delay on energization of the contactor coils.

2.2.13.19 Monitoring Facilities

Facilities shall be provided for monitoring actuator operation and availability as follows:

- i. Monitor (availability) relay, having one changeover contact, the relay being energised from the control transformer only when the Local/Off/Remote selector is in the Remote position to indicate that the actuator is available for remote (control room) operation.
- ii. Where required, it shall be possible to provide indication of Thermostat trip and Remote selected as discreet signals. The actuator shall include a diagnostic module, which will store and enable download of historical actuator operation and torque data to permit analysis of actuator and valve in-service performance. Data download shall be carried out without removing any covers and all shall be available locally to the actuator or remotely via telecom data transfer.
- iii. Diagnostic and configuration software shall be made available in a Lap Top PC for user.

2.2.13.20 Wiring and Terminals

- i. Internal wiring shall be tropical grade PVC insulated stranded cable of appropriate size for the control and 3-phase power. Each wire shall be clearly identified at each end.
- ii. The terminals shall be embedded in a terminal block of high tracking resistance compound.



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- iii. The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight sea land shall be provided with a minimum of 3 threaded cable entries with provision for a minimum of 4.
- iv. All wiring supplied as part of the actuator to be contained within the main enclosure for physical and environmental protection. External conduit connections between components are not acceptable.
- v. A durable terminal identification card showing plan of terminals shall be provided attached to the inside of the terminal box cover indicating:
 - a. Serial number
 - b. External voltage values
 - c. Wiring diagram number
 - d. Terminal layout
- vi. This must be suitable for the contractor to inscribe cable core identification along side terminal numbers.

2.2.13.21 Startup Kit

Each actuator shall be supplied with a start-up kit comprising installation instruction manual, electrical wiring diagram and cover seals to make good any site losses during the commissioning period. In addition, sufficient actuator commissioning tools shall be supplied to enable actuator set up and adjustment during valve/actuator testing and site installation commissioning.

2.2.13.22 Performance Test Certificate

- i. Each actuator must be performance tested and individual test certificates shall be supplied free of charge. The test equipment should simulate a typical valve load, and the following parameters should be recorded:
 - a. Current at maximum torque setting
 - b. Torque at max. torque setting
 - c. Flash test voltage
 - d. Actuator output speed or operating time
- ii. In addition, the test certificate should record details of specification such as gear ratios for both manual and automatic and second stage gearing if provided, drive closing direction, wiring diagram number.

- 2.2.13.23** The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer's recommendation shall also be carried out.
- a. Measurement of insulation resistance.
 - b. Measurement of full load current.



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c. Test running of the motors.

2.2.13.24 Drawing and Manuals

Following drawings/ data and Manuals to be submitted for approval:-

- i) Instruction manuals on Installation, tests
- ii) Actuator Data sheet.
- iii) Internal wiring diagram and control schematic.
- iv) Torque switch and Limit switch contact development.
- v) QAP for Test reports.
- vi) Manufacturers Catalogue
- vii) Instruction manuals on installation methods. tests etc.
- viii) Motor sizing calculation
- ix) Integral starter details
- x) General arrangement drawings
- xi) Test reports
- xii) Manufacturing quality plan
- xiii) Field quality plan

Cabling System



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2.2.17 CABLING SYSTEM

2.2.17.1 SCOPE OF WORK

The scope of work covers supply, erection, testing and commissioning of complete electrical system including cabling, fire stop mortar seal, fire retardant cable coating system etc. the scope shall broadly cover, but not be limited to:

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

The scope of work shall also include all civil and structural works necessary for successful installation, commissioning & commercial operation of all electrical equipment to be erected under this specification.

2.2.17.2 SCOPE OF SUPPLY

- 1 The scope of work shall include complete supply, installation, testing, commissioning and putting into successful commercial operation of the cabling system for the entire plant covering all indoor & outdoor areas of BTG area.
- 2 The equipments and materials within the scope of supply shall include but not limited to
 - i. Power & control cabling works (including that of special cables):
Supply and installation of cable and cable trays/raceways, supports, conduits, duce bank, cable accessories such as jointing/termination kits, cable glands, lugs, ferrules, etc. as required for all the systems & equipments.
 - ii. Supply and installation (including laying & termination) of control cables, special cables, instrumentation cables for all equipments and systems.



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- iii. Supply and installation (including laying & termination) of all power cables (HV and LV) of all power cables (HV and LV) for all equipments and systems.
- iv. Cable routing has to be planned such that it shall not cross the steam lines, oil lines.
- v. Fire Sealing Arrangement: All cable entries into the panel (HV & MV & LV SWGR panels) should be provided with fire sealing arrangements.
- vi. Cable/cable tray openings in walls and floors or through pipe sleeves from one area to another or from one elevation to another within the unit shall be sealed by a fire proof sealing system (FPSS). The FPSS shall effectively prevent the spread of fire from the flaming to non-flaming side of a fire
- vii. Galvanized steel rigid/ flexible conduits and accessories, ferrules, lugs, glands, terminal blocks, galvanized sheet steel junction boxes, cable fixing clamps, nuts & bolts etc as required.
- viii. All necessary erection materials, consumables and sundry items including arc welding rods to complete the installation for satisfactory and trouble free operation.
- ix. Any item of works or erection materials which have not been specifically mentioned but are necessary to complete the work involved shall be deemed to be included in the scope of this specification and shall be furnished by the Bidder without any extra charge to the purchaser.

2.2.17.3 CODES AND STANDARDS

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards/ codes as applicable.

IS:513	Cold rolled low carbon steel sheets and strips.



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IS:1079	Hot Rolled carbon steel sheet & strips
IS:1239	Mild steel tubes, tubular and other wrought steel fittings
IS:1255	Code of practice for installation and maintenance of power cables upto and including 33 KV rating
IS:1367 Part-13	Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).
IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS:9537	Conduits for electrical installation.
IS:9595	Metal – arc welding of carbon and carbon manganese steels - recommendations.
IS:13573	Joints and terminations for polymeric cables for working voltages from 3.3kv up to and including 33kv performance requirements and type tests.
BS:476	Fire tests on building materials and structures
DIN 46267 (Part-II)	Non tension proof compression joints for Aluminium conductors.
DIN 46329	Cable lugs for compression connections, ring type ,for Aluminium conductors
VDE 0278	Tests on cable terminations and straight through joints
BS:6121	Specification for mechanical Cable glands for elastomers and plastic insulated cables.
	Indian Electricity Act.
	Indian Electricity Rules.

Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Contractor shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

2.2.17.4 DESIGN AND CONSTRUCTIONAL FEATURES

1 Inter Plant Cabling



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

2 Transformer yard

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

3 Cable entry

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

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

4 Trenches

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

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

All field switches for equipments corresponding to a stream located within a radius of 4-5 m shall be wired out to a field junction box and from field junction box to control panel/Input – Output cabinet by screened instrumentation cables.

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

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

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



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5 Cable Vault:

- i) Cable vault of not less than 3.5 metres clear height shall be provided.
- ii) Clear access passage of at least 750 mm wide & 2.0 Mts clear height shall be provided at entrances & along cable ways. Wherever the passage is through cable routes clear height shall not be less than 1.5 Mts.
- iii) Cable vaults shall be provided with adequate drainage facility for drainage of fire water.
- iv) Each cable vault should have two fire proof doors.
- v) Exit signs shall be provided near doors for personnel escape in case of emergency.

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

2.2.17.5 EQUIPMENT DESCRIPTION

Cable trays, Fittings & Accessories

- 1 Cable trays shall be ladder type as specified complete with matching fittings (like brackets, elbows, bends, reducers, tees, crosses, etc.), accessories (like side coupler plates, etc.) and hardware (like bolts, nuts, washers, G.I. strap, hook etc.) as required. Cable tray shall be ladder type for power & control cables and perforated for instrumentation cables.
- 2 These shall be either prefabricated hot dip galvanized sheet steel trays or site fabricated angle iron trays free from flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per relevant IS.
- 3 Cable trays shall have standard width of 150 mm, 300 mm & 600 mm and standard lengths of 2.5 metre. Minimum thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2 mm. The thickness of side coupler plates shall be minimum 3 mm.
- 4 Cable troughs shall be required for branching out few cables from main cable route. These shall be U-shaped, fabricated of mild steel sheets of minimum thickness 2 mm and shall be hot dip galvanized as per relevant IS. Troughs shall be standard width of 50 mm & 75 mm with depth of 25 mm.
- 5 Prefabricated hot dip galvanized sheet steel cable trays shall be used for maximum support span of 2000 mm unless design is approved for larger span. Cable trays shall be suitable for a cable weight of 100 kg/meter running length of tray. Minimum thickness of sheet steel/galvanizing shall be 2mm/86 microns respectively. The



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amount of zinc deposit shall not be less than 610 gm per square meter.

- 6 Cable trays fabricated from standard rolled sections shall be 50x50x6/75x75x6 sections for runners for supporting spans limited to 2000 mm/more than 2000 mm respectively. Cross support shall be 32x6 mm / 50x6 flat for widths up to 500mm/more than 500mm respectively.
- 7 Separate coloured paint strips 2 inch width each numbers equally spaced at 5 metres interval shall be applied for identification of different type of trays depending upon types of usage/applications/area as below:

High/ medium voltage cables:

11kV/6.6kV : red strips

1.1kv power cables : yellow strips

1.1kv control cables : blue strips

Instrumentation cables : green strips

8 Support System for Cable Trays

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

Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of two types:

- (i) C1:- having provision of supporting cable trays on one side and
- (ii) C2:- having provision of supporting cable trays on both sides. The support system shall be the type described hereunder
 - a. Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor plates, all hardware such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc.
 - b. The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardware's fittings and accessories shall be prefabricated factory galvanised.
 - c. The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc. to form various arrangements required to support the cable trays. Welding of



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- the components shall not be allowed. However, welding of the bracket (to which the main support channel is bolted) to the overhead beams, structural steel, insert plates or reinforcement bars will be permitted. Any cutting or welding of the galvanized surface shall be brushed and red lead primer, oil primer & aluminium paint shall be applied.
- d. All steel components, accessories, fittings and hardware shall be hot dip galvanized after completing welding, cutting, drilling and other machining operation.
 - e. The main support channel and cantilever arms shall be fabricated out of minimum 2.5 thick rolled steel sheets conforming to IS.
 - f. Cantilever arms of 300 mm, 600 mm and 750 mm in length are required. The arm portion shall be suitable for assembling the complete arm assembly on to component constructed of standard channel section. The back plate shall allow sufficient clearance for fixing bolt to be tightened with tray in position.
 - g. Cable trays in areas subjected to excessive coal dust or mechanical damage shall have hot dip galvanized sheet steel metal trays cover installed on front tray in vertical run and inverted 'V' type on upper tray in horizontal run with consideration for ventilation.

The size of structural steel members or thickness of sheet steel of main support channel and cantilever arms and other accessories as indicated above are indicative only. Nevertheless, the support system shall be designed by the contractor to fully meet the requirements of type tests as specified. In case the system fails in the tests, the components design modification shall be done by the Contractor without any additional cost. The contractor shall submit the detailed drawings of the system offered by him along with the bid.

9 FRP CABLE TRAYS

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

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

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



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

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

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

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

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

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

- i) Individual tray systems shall be established for the following services: -
 - a) 6.6 kV and higher voltage power cables.
 - b) 415 Volt power cables.
 - c) Special noise-sensitive circuits or instrumentation cables.
 - d) Control cables. (Control cables shall be laid along with LV power cables and instrumentation cables if required for short length near the equipment with GI separators).
 - e) Further subdivision of tray systems shall be provided if required to meet special segregation/separation requirements.
- ii) In areas having coal dust, cable trays shall be run in vertical formation while horizontal trays shall be provided in other areas. Cable depth not to exceed two cables for vertical trays.
- iii) The minimum design vertical spacing for trays shall be 300 mm measured from the bottom of the upper tray to the top of the lower tray. At least a 250 mm clearance shall be maintained between the top of a tray and beams, piping, or



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

10 Pipes, Fittings & Accessories

Pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.) The size of the pipe shall be selected on the basis of maximum 40% fill criteria

GI Pipes shall be of medium duty as per IS: 1239

Duct banks shall be High Density PE pipes encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes.

11 Junction Boxes

Junction Boxes shall comprise of a case with hinged door constructed from cold rolled sheet steel of minimum thickness 2mm. Top of the boxes shall be arranged to slope towards rear of the box. Gland plate shall be 3 mm thick sheet steel with neoprene/synthetic rubber gaskets. All junction boxes shall be of adequate strength and rigidity, hot dip galvanised as per relevant IS, and suitable for mounting on wall, columns, structures etc. The boxes shall include brackets, bolts, nuts, screws M8 earthing stud etc. required for installation.

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

Junction boxes shall be Glass Fibre Reinforced with saturated polyester conforming to standards like DIN 16911 type 803/16913 type 834, 5 self extinguishing in accordance with ASTM D635/UL 94 VO. Junction boxes for use in outdoor or damp locations shall be sturdy construction. Temperature resistance shall be between – 10 to 100°C. Impact resistance shall be greater than 7 Nm, (EN 50014). Protective insulation shall be in line with VDE 0100, dielectric strength shall be greater than 10 KV/mm, halogen free toxicity, the enclosure and door cover shall be painted and electro statically power coated (preferably in RAL7032). Earth connection (studs size shall be M 6) shall be provided on the cover as well as door.

Protection Class

Protection Category shall be IP 66 to EN 60529. There shall be guaranteed perfect seal to meet Protection class IP 66 providing arrangement like highly elastic foamed in special type seal like polyurethane/chloroprene. The sealing rubber shall not have aging effect and shall retain its sealing characteristics for more than 20 years. Contractor shall indicate this in data sheet. The rubber seal should be pasted at its



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place with pasting technology for like more than 20 years (double sealing arrangement is preferred).

Mounting clamps and accessories

Junction boxes shall be suitable for mounting on walls, columns and structure. Brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass. The accessories like mounting plates etc. of steel shall be powder coated. The support rails for terminal box shall be zinc coated.

General

1. JBs shall have small canopy at the top.
2. There shall be rainwater collection arrangement from top and side of the outer ages to ensure that any leakage into the junction box shall be avoided and it shall fall outside.
3. Cable entry shall be from bottom side only.
4. Ensure gland plate sealing perfect. It shall be of the same quality and arrangement as that of door to cover arrangement.

Steel Junction Boxes

No. of Ways 12/24/36/48 with 20% spares terminals.

Junction boxes shall be designed in accordance with NEC, article 370, paragraph 18, 19 & 20 or equivalent standards.

Enclosure

Junction boxes for use in outdoor or damp locations shall be sturdy steel construction. The enclosure and door cover shall be surface finished clean, degreased, phosphated, deep coated primed (preferably in RAL 7044) and electrostatically powder coated (preferably in RAL 7032). Earth connection (studs size shall be M6) shall be provided on the cover as well as door. The sheath steel thickness shall be more than 2 mm.

Doors

The doors shall be hinged and lockable. The doors shall have industrial heavy duty hinges. The doors shall be easily but firmly lockable with quick release fastener and with integrated viewing window of 3mm resistant plexi glass or equivalent. The doors shall be industrial heavy duty hinges. The doors shall be easily but firmly lockable with quick release fastener.

Junction boxes shall be provided with two nos. earthing terminals (externally available) suitable for connection of 8 SWG G.I. wire. Knockouts shall be provided at bottom and both sides. These shall be provided by fixing plates in order to make



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them detachable type with suitable neoprene gaskets. Bottom and side plates for cable/conduit connection shall be provided. All unused holes shall be sealed with suitable grommets.

Junction boxes shall be provided with external designation label. The label inscriptions shall be informed to the Contractor by the Owner. Junction boxes shall be provided with danger sign in case of 415V circuit.

Junction boxes shall be of two types, viz. One suitable for control cabling and the other suitable for power cabling.

Junction boxes for control cabling shall have 24 way/ 48 way terminal blocks suitable for up to 2.5 sq.mm. Cu. Cable. However, for instrumentation junction boxes there shall be 24/48 ways suitable for terminating cable of 0.5 sq.mm. Cu. Cable.

Junction boxes for power circuit cabling shall be suitable for 1 no. 3 core 16 sq.mm.AL. Incoming cable and 1 no. 3 core 2.5 sq.mm Cu. Outgoing cable.

12 Terminal blocks

Terminal blocks shall be 650 volts grade, rated for 10 Amps and in one piece, rigid, Bakelite moulded, with disconnecting /shorting link. It shall be complete with insulating barriers, Klip-on-type terminals and identification strips, terminal studs, washers, nuts, lock nuts, marking strips etc.

Marking on terminal strip shall correspond to the terminal numbering on wiring diagrams. It shall be Elmex type CSLT-1 with insulating material of Melamine conforming to ESI Standard 12.1 or equivalent. Cage clamp type terminal block suitable for terminating 2 wires of 2.5 sq mm. on both sides arranged to facilitate easy termination shall be provided. 20% spare terminals shall be provided

13 Terminations & Straight through Joints

Termination and jointing kits for 11/6.6 kV grade XLPE insulated cables shall be of proven design and make which have already been extensively used and type tested. Termination kits and jointing kits shall be pre-moulded type, taped type or heat shrinkable type. 11/6.6 kV grade joints and terminations shall be type tested as per IS: 13573. Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ESI specification. Kit contents shall be supplied from the same source as were used for type testing. The kit shall be complete with the aluminium solder less crimping type cable lugs & ferrule as per DIN standard.

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



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

14 Cable glands

Cable glands shall conform to BS: 6121 and be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating. Rubber components shall be of neoprene and of tested quality. Necessary cable dimensions shall be furnished to the successful contractor.

Cable glands shall be single compression for indoor use, double compression type for outdoor use. Glands for classified hazardous areas shall be double compression type flameproof and weather proof duly certified by CMRS and approved by CCE.

15 Cable lugs/ferrules

The cables lugs shall be conforming to IS: 8309.

Machine ferruling shall be adopted.

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

The cable lugs for control/instrumentation/ telephone cables shall be provided with insulating sleeve and shall suit the type of terminals provided on the equipments.

Cable lugs shall be suitable for termination of different cross-sections of control/instrumentation/telephone cables and shall be of following types.

- i) Copper tubular terminal end for solder less crimping to copper conductors.
- ii) Cable lugs for control cable termination shall be insulated type. These lugs shall be flat type/ring type/U type to suit the terminals provided in the pan
- iii) Pin type lugs shall not used.
- iv) Aluminium tubular terminal ends for solder less crimping of to Aluminium conductor. Solder less crimping of terminals shall be done by using corrosion inhibiting compound. The cable lugs shall suit the type of terminals provided on the equipment. Lugs for control/instrumentation cables shall be PVC insulated/sleeved type.



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16 Cable Clamps & Straps

The cable clamps required to clamp multicore cables on vertical runs shall be made up of Aluminium strip of 25x3 mm size. For clamping the multicore cables on horizontal trays, self-locking, de-interlocking type nylon clamps/straps shall be used. The clamps/straps shall have sufficient strength and shall not get affected by direct exposure to sun rays and outdoor environment.

Trefoil clamps for single core cables shall be pressure die cast aluminum or fibre glass or nylon and shall include necessary fixing accessories like G.I. nuts, bolts, washers, etc. Trefoil clamps shall have adequate mechanical strength to withstand the forces generated by the system short circuit current of 105 KA peak.

17 Galvanizing

Galvanizing of steel components and accessories shall conform to IS: 2629 & IS: 2633. Additionally galvanizing shall be uniform, clean smooth, continuous and free from acid spots

The amount of zinc deposit over threaded portion of bolts, nuts, screws and washers shall be as per IS: 1367. The removal of extra zinc on threaded portion of components shall be carefully done to ensure that the threads shall have the required zinc coating on them as specified.

18 Welding

The welding shall be carried out in accordance with IS: 9595. All welding procedures and welders qualification shall also be followed strictly in line with IS: 9595

2.2.17.6 INSTALLATION

1 Cable tray and Support System Installation

Cables shall run in cable trays mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures. All cable trays shall be in vertical configuration in boiler, CHP & ESP areas. Horizontally running cable trays shall be clamped by bolting to cantilever arms and vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 1500 mm. For vertical cable risers/shafts cable trays shall be supported at an interval of 1000mm. Fixing of cable trays to cantilever arms or main support channel by welding shall not be accepted. Cable tray installation shall generally be carried out as per relevant Standard. The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm unless otherwise indicated in the relevant



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approved tray layout drawings.

All cable way sections shall have identification, designations as per approved cable way layout as and painted/stenciled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 75 mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted/ stenciled with identification numbers at every floor.

In certain cases it may be necessary to site fabricate portions of trays, supports and other non standard bends where the normal prefabricated trays, supports and accessories may not be suitable. In such cases the Contractor shall fabricate at site suitable sections of trays, supports and accessories to make the installation complete for the specific purpose after obtaining owner's prior approval, which shall be neat in appearance and shall match with the prefabricated sections in the dimensions. They shall be applied with one coat of red lead primer, one coat of oil primer followed by two finishing coats of aluminium paint.

2 Conduits/Pipes/Ducts Installation

- (a) The Contractor shall be fully responsible for properly embedding conduit pipe sleeves wherever necessary for cabling work. All openings in the floor/roof/wall / cable tunnel/cable trenches made for conduit installation shall be sealed and made water proof by the Contractor.
- (b) GI pull wire of adequate size shall be laid in all conduits before installation. Metallic conduit runs at termination shall have two lock nuts wherever required for junction boxes etc.
- (c) Conduit runs/sleeves shall be provided with PVC bushings having round edge at each end. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed with Glass wool/Cement Mortar/Putty to prevent entrance of moisture and foreign material.
- (d) Cable routing between lined cable trench and equipment/motors shall be taken through GI pipe sleeves of adequate size. Pipe sleeves shall be laid at an angle of maximum 150 to the trench wall. In case of larger dia cables i.e. 50mm and above, adequately sized pipe with larger bend radius shall be provided for ease of drawing of cable or for replacement. In places where it is not possible, a smaller trench may be provided if approved by Site Engineer.
- (e) Exposed conduit/pipe shall be adequately supported by racks, clamps, straps or by other approved means. Conduits /pipe support shall be installed square and true to line and grade with an average spacing between the supports as given below, unless specified otherwise



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Conduit /pipe size (dia).	Spacing
Up to 40 mm	1 M
50 mm	2.0 M
65-85 mm	2.5 M
100 mm	3.0 M

- (f) In areas like WTP, chemical handling, battery room etc. exterior surface of the conduits shall be further coated with chromate or polymer for better resistance to corrosion.
- (g) All G.I. pipes shall be laid as per approved layout drawings and site requirements.
- 1 Before fabrication of various profiles of pipe by hydraulically operated bending machine (which is to be arranged by the contractor), all the burrs from the pipes shall be removed. The bends formed shall be smooth. GI Pipes with bends shall be buried
 - 2 in oil/concrete in such way that that the bends shall be totally concealed. For GI pipes shall be undertaken well before paving is completed and necessary co- ordination with paving agency shall be the responsibility of Electrical Contractor. The open ends of pipes shall be suitably plugged with G.I. plugs after they are laid in final position. G.I. plugs shall be supplied by the contractor at no extra cost.

3 Junction Boxes Installation

Junction boxes shall be mounted at a height of 1200mm above floor level or as specified in the approved drawings or as decided by Owner and shall be adequately supported/mounted on masonry wall by means of anchor fasteners/ expandable bolts or shall be mounted on an angle, plate or other structural supports fixed to floor, wall, ceiling or equipment foundations.

4 Cable Laying and Installation

- 1) Cable network shall include power, control, lighting, communication and fire alarm system cables, which shall be laid in trenches, cables trays/conduits as detailed in the approved drawings and cable schedules. Erection of cable trays and aligning and leveling as required shall be the responsibility of the contractor.
- 2) Cable installation shall be carried out as per IS: 1255 and other applicable standards.



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- 3) Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall be drum be stored flat i.e. with flange horizontal. Rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cables. For unreeling the cable, the drum shall be mounted on suitable jacks or on cable wheels and shall be rolled slowly so that cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.
- 4) Laying of cables directly buried in ground is not acceptable.
- 5) For coal handling plant the cables shall not be routed along conveyor galleries. The cables shall be routed on independent cable trestles. All tray levels shall be checked after erection and marked in as built drawings. Cable routing given on the layout drawings shall be checked in the field to avoid interference with structures, heat sources, drains, piping, air-conditioning duct etc. and minor adjustments shall be done to suit the field conditions wherever deemed necessary. All tray runs shall be installed parallel to the trench/building walls and floors except otherwise noted in the approved drawings. The contractor shall have to secure rack/tray supports by welding to those inserts or other available building steel surfaces. Outdoor trays shall be installed by welding on the steel/concrete structure with inserts by the contractor. As far as practicable, cable trays shall be supported from one side only in order to facilitate installation and maintenance of cables from the other side.
- 6) While laying cable, ground rollers shall be used at every 2 metre interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangements. Pulling tension shall not exceed the values recommended by cable manufacturer. Selection of cable drums for each run shall be so planned so as to avoid using straight through joints. Care should be taken while laying the cables so as to avoid damage to cables.
- 7) All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all cables shall be tapped with an approved PVC or rubber insulating tape. Use of friction type or other fabric type tape is not permitted.



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- 8) Cables installed above grade shall be run in trays, exposed on walls, ceilings or structures and shall be run parallel or at right angles to beams, walls columns. Cables shall be so routed that they will not be subjected to heat from adjacent hot piping or vessels.

5 Laying of cables in cable trays

- 1) Cables shall be laid on cable trays strictly in line with cable schedule furnished. Where specific cable layouts are not shown on approved drawings, contractor shall route these as directed by the Owner.
- 2) Power and control cables shall be laid on separate tiers. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables. In horizontal tray stacks, H.V. cables shall be laid on topmost tier and cables of subsequent lower voltage grades on lower tiers of trays. Single core cable in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil center lines and clamped at every two metre. All multicore cables shall be laid in touching formation. LT power cables above 95 sq.mm size shall be laid in single layer touching formation in trays while cables upto & including 95 sq.mm shall be laid in maximum of 2 layers. Control and Instrumentation cables can be laid upto a maximum of three layers in each tray.
- 3) All communication cables (telephone, P.A. System) RTD Cables shall run on instrument trays/ducts/trenches. Wherever these are not available, cables shall be taken in a separate trench/trays with a minimum clearance of 600mm away from electrical trench/trays as per the direction of Site Engineer and Communication cables shall cross power cables at right angles
- 4) Power and control cables shall be secured fixed to trays/support with self locking type nylon cable straps with de-interlocking facilities. For horizontal trays arrangements, multicore power cables and control cables shall be secured at every five meter interval. For vertical tray arrangement, individual multicore power cables and control cables shall be secured at every one meter by nylon cable strap. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by aluminium strips at every five meter interval and at every bend.

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

- 5) Individual cables or small groups which run along structures/walls etc will



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be clamped by means of 16 SWG GI saddles on 25x6mm saddle bars. The cost of saddle and saddle bars shall be deemed to have been included in the installation of cables. Alternatively small group of cables can be taken through 100mm slotted channel/ISMC 100. They shall be rightly supported on structural steel and masonry, individual or in groups as required, if drilling of steel must be drilled where the minimum weakening of the structure will result.

- 6) Cables shall be supported so as to prevent unsightly sagging. In general distance between supports shall be approximately 300mm for cables upto 25mm diameter and maximum 500mm for cables larger than 25mm dia and cables laid in vertical run of cable trays shall be clamped at an interval of 900mm.
- 7) Where cables cross roads/rail tracks, the cables shall be laid in Hume pipe/PVC pipe.
- 8) At road crossing and other places where cables enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends.
- 9) Power and Control Cables, as far as possible, shall be laid in complete, uncut lengths from one termination to the other. Straight through joints in power cable shall be allowed only in nearest of rare situation only after approval of owner.
- 10) Joints for less than 250 Meters run of cable shall not be permitted.
- 11) In each cable run some extra length shall be kept at suitable point to enable one LV/two HV straight through joints to be made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.
- 12) Wherever few cables are branching out from main trunk route troughs shall be used.
- 13) Cables shall be neatly arranged in the trenches/trays in such a manner so that criss-crossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of cables within the trenches/trays shall be the responsibility of the contractor.
- 14) The contractor shall ascertain the exact requirement of cable for a particular feeder by measuring at site and avoiding interference with structure, foundation, pipelines or any other works. Before the start of



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cable laying, cable drum schedule shall be prepared by electrical contractor and get that approved by site engineer to minimize/avoid straight through joints. The actual number of straight through joints required shall be worked out by the contractor. During the erection period the contractor shall furnish a monthly report on cable position in an approved proforma so as to keep the owner apprised of the position.

- 15) The installation work shall be carried out in a neat workman like manner & areas of work shall be cleaned of all scraps, water, etc. after the completion of work in each area every day. Contractor shall replace RCC/Steel trench covers after the Installation work in that particular area is completed or when further work is not likely to be taken up for some time.
- 16) Minimum number of spare cores required to be left for interconnection in control cables shall be as cl.3.07.00, chapter 16.
Electrical cable trays exposed to hazardous process fluid shall be covered with detachable G.I. covers. The covers shall be suitable to resist wind forces.
- 17) For cables laid above ground in cable racks, asbestos sheeting of 3mm thickness shall be provided below the bottom cable tray to protect the cables from fire.
- 18) Supporting steel shall be painted before laying of cables. The painting shall be done with one coat of red lead paint and two coats of approved bituminous aluminium paint unless otherwise specified.
 - a) Separation
 - b) Sufficient spacing not less than 300 mm shall be provided between different tiers of trays and the same shall be maintained to permit adequate access for installation and maintenance of cables.
 - c) At least 300mm clearance shall be provided between HV power & LV power cables, LV power & LV control/instrumentation cables,
 - d) Segregation
 - e) Segregation means physical isolation to prevent fire jumping.
 - f) Cables from two different services viz. supply from Station Board and Unit Board shall be segregated.
 - g) Interplant cables of station auxiliaries and unit critical drives shall be



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segregated in such a way that not more than half of the drives are lost in case of single incident of fire. Power and control cables for AC drives and corresponding emergency AC or DC drives shall be laid in segregated routes. Cable routes for one set of auxiliaries of same unit shall be segregated from the other set.

- h) For Coal Handling Plant all the cables of one stream shall be segregated from the cables of the other stream and shall run on either side of the trestle.

6 Cable fire sealing

- i) Cable/cable tray openings in walls and floors or through pipe sleeves from one area to another or from one elevation to another within the unit shall be sealed by a fire proof sealing system (FPSS). The FPSS shall effectively prevent the spread of fire from the flaming to non-flaming side of a fire.
- ii) Wherever the cables/cable trays pass through walls/floors, fire proof cable penetration seals rated for one hour shall be provided. This shall be by suitable block system using individual blocks with suitable framework or by silicon RTV foaming system. In case foaming system is offered, damming board, if used, shall not be considered for fire rating criteria. Any of the system offered shall be of proven type as per BS: 476 (Part-20) or equivalent standard.
- iii) In order to prevent fire propagation through cable penetrations, after laying, dressing & clamping of cables, all the openings shall be properly sealed by using Fire Stop Mortar Seal and Fire Retardant Cable coating compound. Also the cable runs both before and after the fire scale shall be suitably sprayed with anti-fire propagation liquid.

7 Cable laying in trenches between switchyard and Transformer yard

- 1 RCC cable trenches with removable covers will be provided by the contractor. Cables shall be laid in 3 or 4 tiers in these trenches. Concrete cable trenches shall be filled with sand where specified to avoid accumulation of hazardous gases. RCC covers of trenches in process area shall be effectively sealed to avoid ingress of chemicals etc. Removal of concrete covers for purposes of cable laying and reinstating them in their proper positions after the cables are laid shall be done by the contractor at no extra cost.

For cable trays are laid in trench in more than two tiers a space of minimum 600 mm shall be available for maintenance. In case two or



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more tiers of cable trays are running parallel along both sides of trench walls there shall be space of minimum 600 mm between them.

Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cable leaving trenches shall be coiled and provided with a protective pipe or cover till such times the final termination to the equipment is completed.

- 2 Prior to laying of cables inside trenches, the contractor shall properly clean inside of those trenches.
- 3 When cables are laid in multiple tiers, spacing between individual tiers shall be as approved by Site Engineer. Space between individual tiers shall be filled and compacted with soil and sand.
- 4 As each row of cables is laid in place and before covering with sand every cable shall be given on insulation test in the presence of Site Engineer. Any cable, which proves defective, shall be replaced before the next groups of cables are laid.
- 5 All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building/lined trench.
- 6 Where cables rise from trenches to motor, control station, lighting panels etc., they shall be taken in G.I. Pipes for mechanical protection up to a minimum of 150mm above grade.
- 7 Cable ends shall be carefully pulled through the conduit, to prevent damage to these cables. Where required, approved cable lubricant shall be used for this purpose. Where cable enters conduit the cable should be bent in large radius. Radius shall not be less than the recommended bending radius of the cables specified by the manufacturer.
Following guide of the pipe fill shall be used for sizing the pipe size:

1. 1 Cable in pipe - 53% full
2. 2 cables in pipe - 51% full
3. 3 or more cables - 43% full
4. Multiple cables - 40% full.

After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound/'PUTTI' for sealing purpose. Alternatively, G.I. Lids or PVC bushes shall be employed for sealing purposes. The cost for the same shall be deemed to have been included in the installation of G.I. pipe and



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- no separate payment shall be allowed.
- 8 Where cables pass through foundation walls or other underground structures, the necessary ducts or openings will be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or structures, the electrical contractor shall determine their location and obtain approval of the Site Engineer before cutting is done.

2.2.17.7 CABLE IDENTIFICATION

1. Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry & exit, and at every 20 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centers, control and relay panels etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2 mm thick aluminum with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. Alternatively, the Contractor may also provide cable tags made of nylon, cable marking ties of 'TY-CAB' or equivalent type with cable number heat stamped on the cable tags.
2. If laying of underground cable is specifically agreed by Owner as a special case then the underground cables shall be provided with identity tags of Stain less steel securely fastened every 30 M of its underground length with at least one tag at each end before the cable enters the ground. In unpaved areas cable trenches shall be identified by means of markers. These posts shall be placed at location of changes in the direction of cables and at intervals of not more than 30 M for straight run and at cable joint locations with additional inscription 'Cable Joint'. For buried cables the marker shall project 150mm above ground.
3. Drum number of each cable from which it is taken shall be recorded against the cable number in the cable schedule.

2.2.17.8 CABLE TERMINATIONS & CONNECTIONS

1. The termination and connection of cables shall be done strictly in accordance with cable termination kit manufacturer's instructions, drawings and/or as directed by Site Engineer. Cable jointer shall be qualified to carryout satisfactory cable jointing/termination. Contractor shall furnish for review documentary evidence/experience reports of the jointers to be deployed at site.



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2. Work shall include all clamps, fittings etc. and clamping, fitting, fixing, plumbing, soldering, drilling, cutting, taping, preparation of cable end, crimping of lug, insulated sleeving over control cable lugs, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job to the satisfaction of the Engineer in charge of TANGEDCO.
3. Responsibility of proper termination shall lie on the contractor. Guarantee for termination shall also have to be given by the contractor.
4. The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for punching of gland plates, painting and touching up. Holes shall not be made by gas cutting. The holes shall be true in shape. All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively sealed by 2mm thick aluminium sheets.
5. Contractor shall drill holes for fixing glands wherever necessary at no extra cost. Gland plate shall be of non-magnetic material/aluminium sheet in case of single core cables. If the cable end box or terminal chamber provided on the equipment is found unsuitable and requires major modifications the same shall be carried out by the contractor at the discretion of the Engineer- in-Charge.
6. Control cable cores entering control panel/switchgear/MCC/ miscellaneous panels shall be neatly bunched, clamped and tied with self locking type nylon cable ties with de interlocking facility to keep them in position.
7. The panels where a larger number of cables are to be terminated and cable identification may be difficult, each core ferrule shall include the complete cable number. The ferrules shall be indelible interlocking type and shall fit tightly on cores. Spare cores shall have similarly ferrules with a suffix letter 'S' alongwith cable numbers and coiled up after end sealing.
8. All cable terminations shall be appropriately tightened to ensure secure and reliable connections.
9. It is the responsibility of the Contractor to terminate the cables at motor terminals in correct phase sequence to ensure the proper direction of rotation.
10. All cables upto 1.1KV grade shall be terminated at the equipments by means of compression type cable glands. They shall have a screwed



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nipple with conduit electrical threads and check nut.

11. All cable entries shall be through bottom only and top entry terminations are made only after getting approval of Site Engineer.
12. Power cables, wherever colour coding is not available, shall be identified with red, yellow and blue PVC tapes. Where copper to aluminium connections is made, necessary bimetallic washers shall be used. For trip circuit identification additional red ferrules shall be used only in the particular cores of control cables at the termination points in the Switchgear/Control panels and Control Switches.
13. In case of control cables all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules. Wire numbers shall be as per schematic/ wiring/ inter-connection diagram. Contractors shall have the samples of PVC markers approved before starting the work. All unused spare cores of control cables shall be neatly bunched and ferruled with cable tag at both ends. Control cables shall be neatly bunched and served with PVC perforated tape to keep it in position at the terminal block.
14. Where threaded cable gland is screwed into threaded opening of different size, suitable brass threaded reducing bushing shall be used provided.
15. The cable shall be taken through glands inside the panels or any other electrical equipment such as motors. The individual cores shall then be dressed and taken along the cable ways (if provided) or shall be fixed to the panels with polyethylene straps. Only control cables of single strand and lighting cables may be directly terminated on to the terminals. In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom, close fit hole should be drilled in the bottom plate for all the cables in one line, and then bottom plate should be split in two parts along the centre line of holes. After installation of bottom plate and cables it should be sealed with cold setting compound. Cables shall be clamped over the open armouring to connect it to earth bus.
16. Cable leads shall be terminated at the equipment terminals by means of crimped type solder less connectors. Crimping shall be done by hand crimping/hydraulically-operated tool and conducting jelly shall be applied on the conductor. Insulation of the leads should be removed immediately before the crimping. Conductor surface shall be cleaned and shall not be left open the terminals.



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17. All cable entry points shall be properly sealed and made dust and vermin proof.
Unusual opening, if any, shall be effectively closed. Sealing work shall be carried out with approved sealing compound having fire withstand capability for at least three hours.

18. Cable accessories for H.V. Systems

1. The H.V. cables terminations/joints shall be done by skilled, certified and experienced jointers duly approved by the Site Engineer.
2. The termination and straight through joint kits for use on high voltage system shall be suitable for the type of cables offered by the contractor or the type of cables issued by owner for installation. The materials required for termination and straight through joints shall be supplied in kit form. The kit shall include all insulating and sealing materials apart from conductor fittings and consumable items. An installation instruction shall be included in each kit.
3. The termination kits shall be suitable for termination of the cables to an indoor switchgear or to a weatherproof cable box of an outdoor mounted transformer/motor. The termination kits shall preferably be as of the following types.
 - a. 'PUSH ON' type for LV cables.
 - B Heat-shrinkable sleeve type for LV & HV cables.However, termination kits for HV cables shall be of Heat Shrinkable type of makes with specific approval of owner.
For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.
4. The straight through jointing kits shall be suitable for underground buried installation with uncontrolled backfill and possibility of flooding by water. The jointing kit shall be one of the following types.
 - a. 'TAPEX' of M-seal make or equivalent for LV cables
 - b. Heat-shrinkable sleeve type for LV & HV cables.However, termination kits for HV cables shall be of Heat Shrinkable type of makes with specific approval of owner. For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

2.2.17.9 QUALITY ASSURANCE PROGRAMME

Contractor shall furnish detailed Quality Assurance Programme and Quality Plans for all materials and accessories to be supplied and installed under the



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scope of the specification as per General Technical Conditions of technical specification. The Quality Plans shall include all tests/ checks as per relevant National/International Standards and the requirements of this specification including tests listed in this section.

2.2.17.10 LIST OF TESTS TO BE CONDUCTED

1 Type tests on Cable Trays support system

a) Test 1A

On main support channel type-C2 for cantilever arms fixed on one side only.

A 3.5 metre length of main support channel shall be fixed vertically at each end to a rigid structure as per appropriate fixing arrangement. Eight (8) nos. 750 mm cantilever arms shall be fixed to the main channel and each arm shall be loaded over the outboard 600 mm with a uniform working load of 100 kg. Subsequently a point load of 100 kg shall be applied on arm 2. A uniform proof load on all the arms equal to twice the working load shall be then be applied. Deflections shall be measured at the following load intervals and other necessary points:

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

The deflection measured at working loads shall not exceed 16 mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied.

b) Test 1B: Test 1A shall be repeated with Eight Cantilever arms uniformly loaded and with the same point load on arm 2

On Main support channel type -C2 for cantilever arms fixed on both sides

- a) Test 2A:** A 3.5 m length of main support channel C2 for cantilever arms fixing on both sides shall be fixed at each end to rigid structure as per appropriate fixing arrangement. Six (6), 750 mm cantilever arms shall be attached to each sides and each arm uniformly loaded to a working load of 100 kg over the out board 600 mm. A point load of 100 kg shall than be applied to arm 2, followed by a uniform proof load



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of twice the working load on all the arms; deflection shall be measured at the following load intervals and other necessary points.

- i) Working load
- ii) Working load + Point load
- iii) Off load
- iv) Proof load + Point load
- v) Off load

The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied

- b) Test 2B:** The test 2 A shall be repeated with the assembly but with an asymmetrical load on the C2 column and point load applied to arm 8. The 100 kg and 200 kg uniformly distributed loads shall be applied to the upper three arms on one side and the lower three arms on the opposite side.

- c) Test 3:** Tests on Channel Fixed on Beam/Floor
A length of main support channel section shall be fixed to steel structure/floor and have loads applied as detailed below and other important points not mentioned herein.

- c) Test 3A** A length of steel structure shall be rigidly supported it should be fitted on a metre length of channel section using beam clamps welded/bolted. A point load of 1200 kg shall be applied to the centre point via two brackets. No distortion or pulling of the components shall take place.

- d) Test 3B** With the components assembled as in Test 3A, two perpendicular point loads of 600 kg shall be simultaneously applied at positions 150 mm either side of the centre line, no distortion or pulling of the components shall take place.

- e) Test 3C** With the components assembled as in Test 3A, a perpendicular point load shall be applied at a point 150 mm on one side of the centre line. The load shall be gradually increased to the maximum value that can be applied without causing distortion or pulling of the components. This value shall be recorded.



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- d) Test 4 Channel nut slip characteristics (what ever applicable)

Tests 4A1, 4A2, 4A3:

A length of channel C1 section 200 mm long shall have fitted bracket with the two bolts fixing. With loads applied at the appropriate position nut slip shall be determined with bolt torque of 30 NM, 50 NM and 65 NM. No fewer than three measurements shall be made for each torque setting. A minimum loading of 720 kg shall be obtained before nut slip with bolt torque of 65 NM.

Tests 4B1, 4B2, 4B3:

The length of channel C1 section 200 mm long shall have fitted bracket with the one bolt fixing. With loads applied at the appropriate position, nut slip shall be determined with bolt torques of 30 NM, 50 NM and 65 NM. No fewer than three measurements shall be made for each torque setting. A minimum loading of 350 kg shall be obtained before nut slip with a bolt torque of 6 NM.

Test 5 Weld Integrity Test

After deflection test as per test 1A, 1B, 2, 3 & 4 weld integrity shall be checked by magnetic particle inspection to detect sub-surface cracks developed, if any. Cable termination kit and straight through joints should have been tested as per IS: 13573 for 6.6kV and 11kV class. Fire proof Cable Penetration system should have been tested for the following tests:

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

2 Routine/ Acceptance Tests

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

a) Galvanizing Tests

The quality of galvanizing shall be inspected visually and shall be smooth, continuous, and free from flux stains.

- i) Uniformity of coating – The coating of any article shall withstand four 1 minute dips in standard copper sulphate solution without the formation of an adherent red spot of metallic copper upon the basic metal.



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- ii) The quality of cadmium/zinc plating on items with screw threads shall be inspected visually and shall be free from visible defects such as unplated areas, blisters and modules.
- iii) In addition, the plating thickness shall be determined microscopically/chemically or electronically.

3 Welding

The quality of welding shall be visually inspected, particular attention being paid to the following points.

- 1) The welded joints shall be continuous along its length on both sides and of uniform width and thickness. It should be free from blow holes.
- 2) The weld metal shall be properly fused with the parent metal without undercutting.
- 3) The outside surface of the weld shall be clean. All slag shall have been removed. All welding shall be regularly checked for cracking using magnetic particle inspection or their equivalent technique.
 - 1. Physical and dimensional checks for all items.
 - 2. All conduits/pipes, etc. shall be routine/acceptance tested as per relevant standards.
 - 3. All acceptance and routine tests on cable glands as for BS: 6121. Additionally Proof torque test shall be carried out as acceptance on each body group of cable glands.
 - 4. Deflection test cable trays.
 - 5. All acceptance and routine tests on Junction boxes.
 - 6. Following tests shall also be carried out on each type of equipments, devices and materials/items supplied:
 - 1) Physical and Dimensional checks
 - 2) Check/measurement of thickness for Nickel chrome plating for cable glands and tinning for cable lugs.
 - 3) Check chemical composition of brass parts for cable glands.
 - 4) Hardness check on gaskets.
 - 5) Test for uniformity of galvanization.

4 Cable trays / supports and accessories

- 1) Check for proper galvanizing/painting and identification number of the cable trays/supports and accessories.
- 2) Check for continuity of cable trays over the entire route.
- 3) Check that all sharp corners, burrs, and waste materials have been removed from the trays supports.
- 4) Check for earth continuity

Earthing and Lightning Protection System



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2.2.18 EARTHING AND LIGHTNING PROTECTION SYSTEM

2.2.18.1 Earthing System

2.2.18.2 Scope

- ii. The Contractor shall provide all required material and carry out main earth grid, treated earth pits, raisers and inter connections, equipment earthing, interconnection to the existing, BOP area earth mats etc. for the following areas and all areas/buildings/structures including but not limited to:
 - a) Main Plant Building (TG Building)
 - b) Boiler Area, ESP area, Circulating water system, DG room & other electrical systems.
 - c) Service building
 - d) Air washer room
 - e) Transformer yard
 - f) All other miscellaneous building not mentioned herein but in BTG supplier scope.
- iii. Earthing system shall consist of earth grids and electrodes buried in soil in the plant area, embedded in concrete inside the buildings to which all the electrical equipment, metallic structures are connected to have earth continuity for safety reasons. The earthing system shall conform to IS 3043 and Indian Electricity Act/rules.
- iv. The Contractor shall furnish the detailed design, layout and calculations for Owner's approval. Contractor shall obtain all necessary statutory approvals for the system.

2.2.18.3 Codes and Standards

- i. All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards / codes as applicable.
- ii. Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed below. In such a case, the Contractor shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.



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

2.2.18.4 Design Criteria

1. Fault Current & Duration



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

2. Conductor Material

- i. The earthing system conductors and accessories as proposed are to be as:
 - (a) Conductors above ground level and in trenches : Galvanized steel
 - (b) Conductors buried in ground or embedded in concrete : Mild Steel
 - (c) Electrodes : GS Pipe / Rod
- ii. The contractor shall undertake the soil resistivity measurements at site and shall select suitable type of conductors.
- iii. The earth conductors shall be free from pitting, laminations, rust, scale and other electrical, mechanical defects.

3. Size of Conductors

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

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



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

4. Soil Treatment to lower Resistivity

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

5. Rod Electrodes

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

6. Earthing of Electrical equipment on cranes and travelling machines



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- i. Every electrical equipment shall have double earthing. A ring earthing system shall be provided within the crane/machine to which electrical equipment shall be connected at least at two places.
- ii. The earth ring on the crane/machine shall be connected to the plant earthing system through gantry rails. Two sets of earth collector brushes shall be provided on each side of crane/machine to connect its earth ring to the gantry rails. Each end of each gantry rail shall be bonded to the plant earthing system.
- iii. In addition, intermediate earthing bond shall also be provided on the rails at every 60 m in case of longer tracks. Flexible copper bonds shall be provided across any gap in the running gantry rails. For mobile equipment with flexible cables, one separate copper conductor of adequate size shall be provided for earthing.

7. Equipment Earthing Leads

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

2.2.18.5 Earthing System Layout

1. General

- i. Metallic frames of all current carrying equipment, supporting structures adjacent to current carrying conductors, structures in contact with switchyard earth, lightning protection system conductors and neutral points of various systems shall be connected to a single earthing system.
- ii. All the offsite areas shall be interconnected together by minimum two parallel conductors.
- iii. Crane rails, tracks, metal pipes and conduits shall be effectively earthed at two points. Steel RCC columns, metallic stairs, and rails etc. of the building housing electrical equipment shall be connected to the nearby earthing grid conductor by one earthing lead ensured by bonding the different sections of hand rails and metallic stairs.
- iv. For all other equipments, two earthing leads shall be used if rated voltage of equipment is above 250V. In case the rated voltage is 250 V or below, one earth lead can be used. Metallic structures adjacent to electrical equipment shall be earthed by one earthing lead.
- v. Earthing conductors in outdoor areas shall be installed at a minimum depth of 600 mm.



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- vi. Each continuous laid lengths of cable tray shall be earthed at minimum two places by G.S. flats to earthing system, the distance between earthing points shall not exceed 30 metre. Wherever earth mat is not available Contractor shall do the necessary connections by driving an earth electrode in the ground.
- vii. Portable tools, appliances and welding equipment shall be earthed by flexible insulated cable .
- viii. The cable sheaths, screens armour shall be earthed at both ends for multi-core cables. For single core cables the same shall be done at one end (switchgear end) only.
- ix. Electronic earthing shall be provided as per relevant international standard for all control systems (such as DDCMIS,PLC,SAS,EDMS,etc.,). For electronic equipment chemical earthing pit shall be provided. The earth pit shall be tested and type proven and shall be guaranteed for service life of 40 years. The chemical earth pit shall comprise pipe electrode,crystalline conductive mixture, bentonite, etc., constructed in a pit of not less than 4000mm depth. The pit shall be effective in all weather conditions and offer medium resistance. For electronic earthing system, earthing conductor shall be copper.
- x. Neutral of Service transformers shall be earthed through minimum of 400 sq.mm single core cable through two numbers treated earth pit and inturn shall be connected to station earth grid.
- xi. LV Neutral points of the following transformers shall be connected to Neutral Grounding Resistors(NGR). NGR shall be connected to earth through two numbers treated earth pit.
 - a) Unit transformers
 - b) Station Transformer
 - c) Unit , station and other Auxiliary transformers
- xii. Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingress.
- xiii. Metallic sheaths and armour of all multi-core power cables shall be earthed at both equipment and switchgear end, Sheath and armour of single core power cables shall be earthed at switchgear end only.
- xiv. Earthing conductors along their run on cable trench, ladder, walls etc., shall be supported by suitable welding/cleating at intervals of 1000mm. Wherever it passes through walls, floors etc., pipe sleeves shall be provided for the passage of the conductor and both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.



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- xv. Railway tracks within the plant area shall be bonded across fish plates and connected to earthing grid at several locations.
- xvi. Electronic panels and equipments shall be grounded utilizing an insulated copper ground wire terminated at separate earth electrodes.

2. Earthing Conductor layout

- i. Main earthing conductors shall be laid in the form of a grid. Spacing between conductors, number of parallel conductors, etc., shall be decided such that step and touch potential are within safe limits.
- ii. The maximum permissible step and touch potentials shall be calculated in accordance with the formula, given in IEEE-80.
- iii. Earthing conductors shall be provided around the outside edge of fence at a distance of approximately 6000 mm. This shall be connected to the main earthing grid.
- iv. Grounding conductor around the building shall be buried in earth at a minimum distance of 1200 mm from the outer boundary of the building.
- i. Every alternate post of the fence shall be connected to earthing grid by one GS flat and gates by flexible lead to the earthed post.
- ii. Each of the earth leads of transformer neutral, lightning arrester shall be directly connected to two separate electrodes. Neutral points of HV transformer shall be earthed through NG resistors. The Contractor shall connect the NGR earthing point to earth electrodes by suitable earth conductors. Lightning protection down conductor shall be directly connected to a separate earth electrode.
- iii. All earth electrodes in turn shall be connected to main earthing system. The earth grids of different areas of the plant shall be interconnected through test pits to enable measurement of earth resistance for each area separately.
- iv. Earthing grid design shall be done in such a manner that the grid resistance is less than one ohm.
- v. Earth pit shall be constructed as per IS: 3043. Electrodes shall be embedded below permanent moisture level. Minimum spacing between electrodes shall be atleast equivalent to twice the length of the electrode.



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3. Earthing Conductors inside the building

- i. Main earthing conductors shall be buried in earth around the building. Minimum two taps-off from this earthing loop shall be taken inside the building and connected to the earthing grid embedded in the floor slab with approximately 50 mm concrete cover. The requirement of electrodes around the building shall be specified.
- ii. In case the building has more than one floor, each floor shall be provided with separate earth grid. These floor earthing grids shall be interconnected.
- iii. Each RCC / Steel column of the building shall be interconnected to the floor earthing grid in the ground floor.
- iv. Instrumentation system and computer system shall be provided with a dedicated earthing system suitable for the equipment. Separate electronic earthing for the PLC equipments, SAS panels and all other equipments wherever necessary shall also be provided.
- v. Earthing grids of all the buildings, outdoor yards shall be interconnected to form a single grid for the plant.
- vi. Earthing grid design shall be done in such a manner that the grid resistance is less than one ohm.
- vii. Suitable earth risers as approved by Owner shall be provided above finished floor/ground level, if the equipment is not available at the time of laying of main earth conductor.
- viii. A minimum earth coverage of 300 mm shall be provided between the ground grid conductor and the bottom of trenches, tunnels, underground pipes, foundations, railway tracks etc. The ground grid conductor shall be re-routed in case it fouls with equipment foundations.

2.2.18.6 Earthing System Installation

- i. The spacing between two electrodes shall be at least equivalent to twice the length of the electrode.
- ii. Earthing conductors along their run on columns, walls, etc. shall be supported by suitable welding / cleating at interval of 1000mm and 750mm respectively. 8 SWG earth wire should be run along with lighting conduits and shall be earthed at both ends. The wire should be suitable clamped with conduit at equal interval at not more than 500 mm.



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- iii. The earthing conductor crossing the road / track shall be laid in hume pipe or laid at a greater depth to avoid damage.
- iv. When earth conductor passes through floors, walls, etc., suitable pipe sleeves shall be provided and the same shall be sealed after installation.
- v. The connection between earthing pads / terminal to the earth grid shall be made short and direct and shall be free from kinks & splices.
- vi. Cable trays, metal pipes / conduits, steel columns, etc., shall not be used as earth continuity conductors.
- vii. Street lighting poles, flood light poles & towers, their junction boxes shall be connected to the earthing conductor to be run along with supply cable. This earth conductor shall be in turn connected to earth grid at two extreme points.
- viii. Flexible earth conductors shall be provided at expansion joints for earthing the gates, operating handles, etc.
- ix. Equipment bolted connection after being checked and tested shall be painted with anti-corrosive paint / compound be welded. For rust protection, the welds shall be treated with zinc chromate primer and coated with zinc rich paint.
- x. Proper earth connections for cable glands, cable boxes, cable armour, screens, etc. to be provided.
- xi. All bimetallic connections shall be treated with suitable compound to prevent moisture ingress.
- xii. The contractor shall demonstrate the effectiveness of earthing system by measurement of earth resistance, step and touch potential at different locations. Earth resistance at earth terminations shall be measured in presence of Owner's representatives. All equipment required for testing shall be furnished by contractor.
- xiii. Connections between earth leads and equipment shall normally be of bolted type. Contact surfaces shall be thoroughly cleaned before connections. Equipment bolted connections after being tested and checked shall be painted with anti-corrosive paint/compound.
- xiv. Connections between equipment earthing leads and between main earthing conductors shall be of welded type. For rust protection the welds should be treated with red lead compound and afterwards thickly coated with bitumen compound. All welded connections shall be made by electric arc welding. The overlapping of earthing conductor in welded joints should be 6 times diameter. Cleats should be



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

- xv. Resistance of the joint shall not be more than the resistance of the equivalent length of conductors.
- xvi. Back filling material to be placed over buried conductors shall be free from stones and harmful mixtures. Back filling shall be placed in layers of 150 mm. Trenches after laying earth rods should be closed with approved filling materials in layers and not with debris.

2.2.18.7 Other Requirements of Earthing System

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

2.2.18.8 Lightning Protection System

- i. The main purpose of lightning protection system are to :
 - Provide protection to structures from lightning strokes.
 - Provide a low resistance-conductive path to lightning discharge.
- ii. Lightning protection system shall be in strict accordance with IS: 2309 for the structures, equipments and buildings within the battery limits.

2.2.18.9 Conductor material

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

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



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

2.2.18.10 Lightning System Layout

- i. Lightning system shall comprise of air terminations, down conductors, test links, earth electrode etc.
- ii. Air termination network consisting of vertical or horizontal conductors or combination of both shall be provided for the building. Down conductors shall follow the most direct path possible between the air terminal network and the earth termination network. Each down conductor shall be provided with a test link for testing. An earth electrode shall be connected to each down conductor.
- iii. Suitable lightning protection shall be provided to protect
 - a) Main Power House building as per IS requirement
 - b) Boiler Area, ESP area, DG room, Service building & other electrical systems.
 - c) All other miscellaneous building & electrical systems not mentioned herein but in scope of main plant (BTG) supplier.
- iv. Installation of lightning conductors on the roofs of buildings shall include construction of support, laying, anchoring, fastening and cleating of horizontal conductors, grouting of vertical rods wherever necessary, laying, fastening / cleating / welding of the down comers on the walls / columns of the building and connection to the test links to be provided above ground level.

2.2.18.11 Air Terminations

- i. The vertical air terminal rods shall be installed at the roof of buildings for MCC/Switchgear rooms, ESP Control rooms etc to protect these objects from lightning strokes.
- ii. ii) The projected length of the Air termination rod shall be as required to protect the object (on which the rod is fixed) from lightning stroke.
- iii. The air terminal rod shall be properly fixed on the top of the building/structure to withstand very high wind pressure. In case the air terminal rod is embedded at the top of roof of building, the portion embedded inside the concrete shall not touch the reinforcement bars and shall be duly insulated from them.
- iv. All the vertical air terminal rods shall be electrically connected together by means of horizontal conductors of size 25 x 6 mm galvanized steel flats. Horizontal air



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

2.2.18.12 Shielding Masts

- v. The shielding mast for lightning protection shall be installed at the top of steel columns cap plates of the associated building.
- vi. The shielding mast shall be made of galvanized steel rod and the height of the same shall be decided considering the zones to be protected.
- vii. Each shielding mast shall be connected to grounding grid by a down conductor 50 x 6 mm minimum. Galvanised steel flat run along the building column. In addition all building columns joints shall be electrically bonded.

2.2.18.13 Down conductors

- i. Down conductors shall be as short and straight as practicable and shall follow a direct path to earth electrode.
- ii. Each down conductor shall be provided with a test link at 1000 mm above ground level for testing but it shall be in accessible to interference. No connections other than the one direct to an earth electrode shall be made below a test point.
- iii. All joints in the down conductors shall be welded type.
- iv. Down conductors shall be cleated on outer side of building wall, at 750 mm interval or welded to outside building columns at 1000 mm interval.
- v. Lightning conductor on roof shall not be directly cleated on surface of roof. Supporting blocks of PCC/insulating compound shall be used for conductor fixing at an interval of 1500 mm.
- vi. All metallic structures within a vicinity of two meters of the conductors shall be bonded to conductors of lightning protection system.
- vii. Lightning conductors shall not pass through or run inside GI Conduits.
- viii. Testing link shall be made of galvanized steel of size 25x 6mm.
- ix. Pulser system for lightning shall not be accepted.
- x. Hazardous areas handling inflammable/explosive materials and associated storage areas shall be protected by a system of aerial earths.



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- xi. Lightning protection conductors/ air termination rods and circumferential band provided at the top position of chimney stack shall be lead coated in order to avoid melting by exposure to hot flue gases.
- xii. For tall buildings and structures, early streamer emission (ESE) type, air terminal system is preferred.
- xiii. Horizontal air termination flats provided on top of boilers, main plant building & other buildings shall be laid such that no part of the roof shall be more than 9 metres.
- xiv. Conductors of lightning protection system shall not be connected with conductors of earthing system above ground level.
- xv. Lightning protection shall have as few joint as possible and avoid sharp bends. Down conductors shall have as far as possible, no joint except at test point and end termination.
- xvi. Termination at the metallic equipments on roof should be made by suitable nuts, bolts, pressure washer and bitumen washers with good electrical conductivity.
- xvii. All lightning protection conductors shall be exposed to atmosphere unless specifically mentioned. The lightning protection in the transformeryard shall cover the following equipments in the protection zone.
 - a) Generator Transformer
 - b) Station Transformer
 - c) Unit Transformers
 - d) Auxiliary Transformers
- xviii. All areas of the power station shall be provided with lightning protection. The lightning protection system for buildings shall consist of Air termination network, Down conductors, Test link and earth electrodes.
- xix. Air termination network consisting of vertical or horizontal conductors or combination of both shall be provided on the building. Down conductors shall follow the most direct path possible between the air terminal network and the earth termination network. Each down conductor shall be provided with a test link for testing. An earth electrode shall be connected to each down conductor.
- xx. For lightning protection, material thickness of galvanizing shall be at least 610 gm / sq.mm for all galvanised steel conductor.



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- xxi. The lightning protection system shall not come in direct contact with other equipment / systems such as cables, conduits, electrical equipment, under ground metallic ducts etc., All metallic structures within vicinity shall be bonded to the lightning protection system.
- xxii. All welded / brazed joints shall be coated with anti-corrosive paints for rust protection.
- xxiii. Lightning conductor when used above ground level and shall be connected through test link with earth electrode / earthing system. Down conductors shall be as short and straight as practical and shall follow a direct path to earth. Down conductor shall not be connected to other earthing conductors above ground level.
- xxiv. Each down conductor shall be provided with attest link at 1500 mm above ground level for testing. But it shall be in accessible to interference. No connections other than the one direct to an earth electrode shall be made below a test point. All joints in the down conductors shall be welded type.
- xxv. Down conductors shall be cleated on outer side of the building wall / welded to out side building columns at 750 mm interval.
- xxvi. Lightning conductor on the roof shall be cleated on surface of roof using insulated clamps / saddles for conductor fixing at an interval of 1000 mm for horizontal run and 750 mm for vertical run.
- xxvii. Conductor of the lightning protection system shall not be connected with the conductors of the safty earthing system above ground level.
- xxviii. Installation of lightning conductors on the roofs of the buildings shall include construction of supports, laying , anchoring, fastening and cleating of horizontal conductors, grounding of vertical rods wherever necessary, laying , fastening / cleating / welding of the down comers on the walls / columns of the buildings and the connections to the test links to be provided above ground level.

2.2.18.14 Electrodes (for Lightning Protection)

- i. The electrodes shall be 40 mm diameter 3000 mm long mild steel rod. These shall be driven into the ground.
- ii. All the electrodes shall be interconnected by means of one (1) 40 mm dia mild steel rod which shall be laid under ground at a minimum depth of 1000 mm below finished grade level unless stated otherwise. This ground mats/electrode in turn shall be connected to main grounding grid.



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2.2.18.15 Riser (for Lightning Protection)

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

2.2.18.16 Jointing & Connection

- i. All ground conductor connections below ground level shall be done by electric arc welding with low hydrogen content electrode.
- ii. The projected portion of riser above ground shall be coated with two (2) coats of bitumen paints (anti-corrosive paints) with a minimum thickness of 1 mm after connection.
- iii. The joints in the lightning conductors shall be kept to a minimum and there shall be no joint in the underground portions of conductors.
- iv. All the joints shall be done by arc welding process overlapping of the conductors at straight joints shall not be less than 150 mm. The contact surfaces shall be cleaned properly before jointing.
- v. The portion of galvanized steel flats, which undergoes welding at site, shall be coated with two (2) coats of cold galvanizing anti-corrosive paint after welding.
- vi. The bolted joint of the test link shall be covered with thick coating of bitumen paint after successful testing.
- vii. The air terminal rods and shielding mast shall be coated with weather resistant anti-corrosive paint (zinc chromate followed by two coats of aluminium paint).
- viii. The steel to copper connection shall be brazed type.
- ix. The lightning protection of inflammable liquid storage tanks wherever required, shall be provided with horizontal conductors strung between tall poles covering the entire zones or with air terminal rods mounted on top of poles/structure. These horizontal conductors/vertical air terminal rods shall be connected to rod electrodes, which in turn shall be connected to station ground mat.

2.2.18.17 Quality Assurance Program

Contractor shall furnish detailed Quality Assurance Programme and Quality Plans for all



EPC TENDER SPECIFICATION FOR BTG PACKAGE

materials and accessories to be supplied and installed under the scope of the specification. The Quality Plans shall include all tests/ checks as per relevant National/International Standards and the requirements of this specification including tests listed in this section.

2.2.18.18 Inspection and Testing

1. Earth Continuity Checks.
2. Earth resistance of the complete system as well as sub system
3. The earthing and lightning conductors should be type tested as per IS 2669. Following minimum tests shall be conducted.
 - a) Freedom from defects
 - b) Uniformity in thickness
 - c) Mass pf coating
 - d) Adhesion tests
 - e) Any other applicable tests not mentioned in the specification but required.

2.2.18.19 Drawing and Documents

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

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



1x800 TANGEDCO NORTH CHENNAI TPP
AIR CONDITIONING SYSTEM
TECHNICAL SPECIFICATION
(C&I PORTION)

SPECIFICATION No: PE-TS-423-553-A001

SECTION : I

SUB-SECTION : C-4

REV. 01

DATE: NOV 2017

SECTION: I

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



**1X800MW COAL BASED SUPERCRITICAL NORTH CHENNAI TPP
STAGE III IN THE PREMISES OF EXISTING NCTPS TAMILNADU**

C&I TECHNICAL SPECIFICATION

FOR

AC SYSTEM



**CONTROL AND INSTRUMENTATION DEPARTMENT
PROJECT ENGINEERING MANAGEMENT
BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
NOIDA**

PREPARED BY	CHECKED BY	APPROVED BY
AANCHAL CHOUDHARY	SEEMA KHATRI	SC SHARMA
SR. ENGR. (C&I)	DY. MGR. (C&I)	SR. MGR. (SH-102,C&I)

INDEX

S. No.	DESCRIPTION
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5.	FIELD & MEASURING INSTRUMENTS
6.	LOCAL PANEL & DATA SHEET
7.	QUALITY ASSURANCE PLAN/CHECK LIST
8.	SUB VENDOR LIST
9.	MANDATORY SPARES
10.	INSTRUMENT INSTALLATION DRAWING

SPECIFIC TECHNICAL REQUIREMENT

Specific Technical Requirements

- 1.0 The Air Conditioning System shall be DDCMIS based control system shall be provided for overall monitoring, control & operation, loading, Unloading of chiller units, dampers, valves, control valves, Solenoid valves, Field instruments etc. DDCMIS shall be in BHEL's scope. DDCMIS shall have redundant soft interfacing (not in daisy serial link) with each individual Chiller's microprocessor based control system. Chillers shall be microprocessor based with local TFT for individual chiller unit and these shall be in bidder's scope.
- 1.1 The vendor shall provide complete Instrumentation for control, monitoring and operation of entire AC. The requirements given are to be read in conjunction with detailed Technical specification enclosed in the specification. Further in case of any discrepancy in the requirement within the same section noted by the bidder in the specification, the same will be brought to the notice of BHEL in the form of pre- bid clarification. In absence of any pre-bid clarification, the more stringent requirement as per interpretation of BHEL shall prevail without any commercial implication
- 1.2 The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial implication in this regard shall be acceptable. In case of any conflict and repetition of clauses in the specification, the more stringent requirements as per interpretation of BHEL among them are to be complied with.
- 1.3 All instruments shall be terminated on JB/LCP in field and both instrument and JB/LCP are in vendor's scope. Number of junction boxes shall be sufficient and positioned in the field to minimize local cabling(10-12 mtrs) and trunk cables. However, minimum number of Jbs shall be provided by the vendor as indicated in the BOQ of JB attached in the specification.
- 1.4 Local control panels for TG building, ESP and service building, wherever applicable, shall be provided by the vendor.
- 1.5 Drawings/Documents and data to be furnished after award of the contract as per deliverables list.

- 1.6 All local gauges as well as transmitters, sensors and switches for parameters like pressure, temperature, level, flow etc. as required for the safe and efficient operation and maintenance under the scope of specification shall be provided. The necessary root valves, impulse piping, drain cock, gauge-zeroing cocks, valve manifolds and all the other accessories required for mounting / erection of these local instruments shall be furnished even if not specifically asked for. The proposal shall include the necessary cables, flexible conduits, junction boxes and accessories for the above purpose.
- 1.7 All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved. The enclosures of all electronic instruments shall conform to IP-65 unless otherwise specified and an anticorrosive paint shall be applied to the field mounted enclosures / instruments. All the field instruments shall also be provided with SS tag nameplate and double compression type Nickel-plated brass cable gland. Gaskets, Fasteners, Counter and mating flange shall also be included wherever required with the field instruments. Further all the instruments shall be of proven reliability, accuracy, and acceptable international standards and shall be subject to employer's approval. All instrumentation equipment and accessories under this specification shall be furnished as per technical specification, ranges, makes/ numbers as approved by the employer' during detail engineering.
- 1.8 Painting of I & C equipment: Epoxy coating required for all I & C equipment.
- 1.9 All the instruments/equipments/electrical items shall be provided & designed with maximum star rating as available in line with energy conservation policies notified by BEE, GOI at the time of supply.
- 1.10 All instruments should be supplied with valid calibration and test certificates provided by OEM. All transmitters shall be HART compatible.
- 1.11 For cable scope refer to electrical scope between BHEL and vendor defined in electrical specification.
- 1.12 It is mandatory to use sensors/signals/measurements with 2 out of 3 logic for critical control & protection (Analog & Binary) Application/service and sensors with 1 out of 2 logic for all other control & interlock (Analog & Binary) application/service.

- 1.13 For binary and analog inputs required for other modulating control, protection and interlock purpose of other equipment and other critical monitoring application etc., minimum dual sensors shall be provided. Dual sensors shall be provided for instruments required for auto starting of LT driven pumps or LT driven pump tripping due to very low level of water/discharge pressure very low.
- 1.14 Dual measurement scheme for analog inputs employing two independent transmitters/ temperature element, connected to separate tapping points shall be employed for the remaining measurements used for analog control functions.
- 1.15 All the instruments/sensors/transmitters/switches meant for redundant applications shall have completely separate and independent impulse pipes/ root valves etc. No redundant instrument shall share a single process tapping. There will be separate and independent tapping for every individual instrument.
- 1.16 Temperature transmitters shall be provided for temperature measurements.
- 1.17 Bidder to provide mandatory spares as per mandatory spares list.
- 1.18 Bidder to furnish electrical load/UPS load data during detailed engineering.
- 1.19 Bidder shall Bidder shall provide complete and independent control & instrumentation system with all accessories, auxiliaries and associated equipments for the safe, efficient and reliable operation of auxiliary systems.



**1X800 MW COAL BASED NORTH CHENNAI THERMAL
POWER PROJECT STAGE III**



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- p) Start, progress and stop of each of the sequence shall be annunciate in all the control panels.
- q) At any time only one of the sequences shall be in progress.

e. Interlocks

All interlocks for safe operation of the plant shall be provided. They shall specifically include the following as minimum requirement:

- i) Service vessels shall be taken back in service, only after they have been pressurized.
- ii) Service vessels shall be taken up for resin transfer only after they have been completely isolated from the condensate system and depressurized.
- iii) Resin shall be transferred to and from only one service vessel at a time.
- iv) Resin transfer between the service and the regeneration skids shall be permitted only when the receiving vessel is initially empty.
- v) It shall be possible for the operator to extend the timing of a particular step by isolating the timer for the duration. The timer will restart once the operator puts back the system on 'auto' and the other steps will then follow as programmed.
- vi) The regeneration sequence shall be prevented from advancing further in the event of tripping of a running motor or other fault condition which do not permit the various desired parameter of this step to be achieved. A manual override for this shall also be provided.
- vii) The immersion heater in the hot water tank can be put on only when there is adequate water level in the tank.

viii) Air Conditioning System & Ventilation System

- i) Air conditioning facilities shall be provided for areas of central control room, control equipment room, shift- in-charge room, Engineer's room, UPS room, analyser room etc. in the main plant building; ESP control room; service building; all control rooms and other rooms in the scope of the bidder requiring provision of air conditioning. The system shall consist of:
 - a. Central chilled water type air conditioning plant for main plant building and service building (Including Instrumentation Lab, Electrical lab and Computer server room , telephone exchange room, etc.,)



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- b. DX air conditioning plant for ESP control room , AHP , Switchyard Control Building & RO-DM plant (Including Chemical Lab) FOPH and CWPB
- c. Split/ window type for other areas as required.(Zero meter control Room, boiler A Elevation, SWAS and Chemical Express Lab, FWPH, Service Water Pump House , Compressor room , etc.,

It shall be preferably from plant DDCMIS Operation.

Open and Close limit switch feed backs of valves are to be connected to DDCMIS for remote viewing and for interlocks and protection.

Remote and local indications of various parameters to the process requirement shall be provided. (The same can be decided during detailed engineering)

The OLCS and CLCS philosophy shall be as per this volume in Chapter 4.

The One no of Operator work station and one no. of Operation cum Engineering work station with 24 " LED Monitor and printers as defined in the Vol. II, Annexure A shall have to be complied. In addition to OWS operation, Backup control desk with coloured Process Mimics, Hard wired Annunciation system, required Push .Button arrangements in Back Panel for complete operation of the systems, Ammeters, Parameter Indicators, LED Based indication Lamps etc., shall also be provided.

- i) Evaporative type ventilation system shall be provided for main plant building with air washer units distributed along 'A' row and 'B' row of the building. Filtered and cooled air from the air washer unit shall be distributed to various areas through diffusers. The main plant building shall be provided with adequate number of roof exhausters. Unitary air filtration system using water repellent type nylon filters shall be provided for ESP control buildings as applicable. Mechanical type ventilation system using supply air fans, exhaust air fans and roof exhausters as applicable shall be provided for other miscellaneous areas such as cable vaults, electrical switch gear rooms, battery rooms, toilets, elevator machine rooms, AC plant room, DG set room etc..
- ii) The basic function of the system shall be too closely control and monitor inside temperature and humidity conditions inside the air-conditioned spaces, to provide remote centralized monitoring & control for various mechanical facilities including sequential start/stop of the whole HVAC System, automatically calculate record and cooling load for each hour/ day/season, to generate maintenance data & alarms, to maintain records of plant operation & energy consumption for varying loads, duty cycling to operate all the equipment including standby equipment for equal duration, automatic Startup of standby equipment in case of failure of operating unit and displaying fault alarm status of the tripped unit, activating/ deactivating water valves to start up/stop water flow through chiller/condenser circuit.



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General Requirements

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

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

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

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

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.

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

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

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

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

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

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

Both supply and exhaust fans shall be operated locally.

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

BOQ OF JB

SYSTEM :	NO OF WAYS	QUANTITY
AC SYSTEM :		
AJB :	24	1 Nos.
	36	1 Nos.
	48	10 Nos.
	72	7 Nos.
BJB :	24	2 Nos.
	36	4 Nos.
	48	2 Nos.
	72	4 Nos.
	96	3 Nos.
	128	7 Nos.

JB Classification :

a) AJB- for ANALOG SIGNALS

b) BJB- for BINARY SIGNALS

NOTES:

1. All instruments shall be terminated on JB/LCP in field and both instrument and JB/LCP are in vendor's scope. Number of junction boxes shall be sufficient and positioned in the field to minimize local cabling(10-12 mtrs) and trunk cables .

LIST
OF
C&I DOCUMENTS/
DELIVERABLES

C&I DELIVERABLES LIST

C&I DELIVERABLES LIST FOR AC SYSTEM		
SI.No.	DRAWING NO.	DRAWING/DOCUMENT TITLE
1	PE-V9-423-553-I911	CONTROL & OPERATIONAL WRITE-UP FOR THE SYSTEM
2	PE-V9-423-553-I912	CONTROL SCHEME/LOGIC DIAGRAM(TO BE IMPLEMENTED IN DDCMIS)
3	PE-V9-423-553-I913	HMI PICTURES/PLANT SCHEMATICS
4	PE-V9-423-553-I914	INSTRUMENT SCHEDULE with set points
5	PE-V9-423-553-I915	I/O LIST (ANALOG & BINARY)
6	PE-V9-423-553-I916	DRIVE LIST/SOLENOID/ACTUATOR VALVE LIST WITH LOCATION DATA
7	PE-V9-423-553-I917	ANNUNCIATION & SOE LIST
INSTRUMENTATION		
1	PE-V9-423-553-I901	INSTRUMENT DATA SHEETS
2	PE-V9-423-553-I902	BOQ
3	PE-V9-423-553-I903	INSTRUMENT QP / CHECK LIST
Local Control Panel		
1	PE-V9-423-553-I950	LOCAL CONTROL PANEL DATA SHEET
2	PE-V9-423-553-I951	WIRING DIAGRAM
3	PE-V9-423-553-I952	PANEL EXTERNAL GA DRAWING (INCLUDING FOUNDATION DETAILS & FLOOR CUT-OUT)
4	PE-V9-423-553-I953	PANEL INTERNAL GA DRAWING
5	PE-V9-423-553-I954	PANEL FRONT VIEW DRAWING
6	PE-V9-423-553-I955	LIST OF SIGNAL EXCHANGE WITH DDCMIS
7	PE-V9-423-553-I956	BILL OF MATERIAL
8	PE-V9-423-553-I957	LOCAL CONTROL PANEL QUALITY PLAN
9	PE-V9-423-553-I958	LOCAL CONTROL PANEL O & M MANUAL

Notes :

1. ANY OTHER DOCUMENT DECIDED DURING DETAILED ENGINEERING SHALL BE PROVIDED BY BIDDER WITHOUT ANY COMMERCIAL/TECHNICAL IMPLICATION.
2. CONTRACTOR TO SUBMIT REUSABLE DATABASE FORMATS IN BHEL/CUSTOMER APPROVED FORMATS LIKE MS EXCEL,MS ACCESS OF DOCUMENTS LIKE INSTRUMENT SCHEDULE, I/O LIST, DRIVE LIST, FIELD JB TERMINATIONS, CABLE SCHEDULE & INTERCONNECTION, etc. SOFT COPY OF FORMATS SHALL BE PROVIDED TO SUCCESSFUL BIDDERS.

DCS INTERFACE FOR 3-WAY MIXING VALVE (MOD-AC)

OWS (Operator Workstation) is connected to the **DCS** (Distributed Control System) via a **BUS**.

The **DCS** has an **ANALOG INPUT** and an **ANALOG OUTPUT**.

The **ANALOG INPUT** receives a **POSITION FEED BACK (4-20 mA)** signal from the **3-WAY VALVE**.

The **ANALOG OUTPUT** sends a **POSITION DEMAND (4-20 mA)** signal to the **3-WAY VALVE**.

The **DCS** is connected to a **230V AC** supply via an **MCB** (Miniature Circuit Breaker).

The **230V AC** supply is connected to a **24V AC** transformer.

The **24V AC** supply is connected to the **3-WAY VALVE**.

The **3-WAY VALVE** is connected to the **DCS** via a **4P x 0.5sqmm 'F' TYPE** cable.

The **3-WAY VALVE** is also connected to the **DCS** via a **3C x 2.5sqmm CONTROL CABLE**.

The diagram includes labels for **BHEL'S SCOPE** and **VENDOR'S SCOPE**.

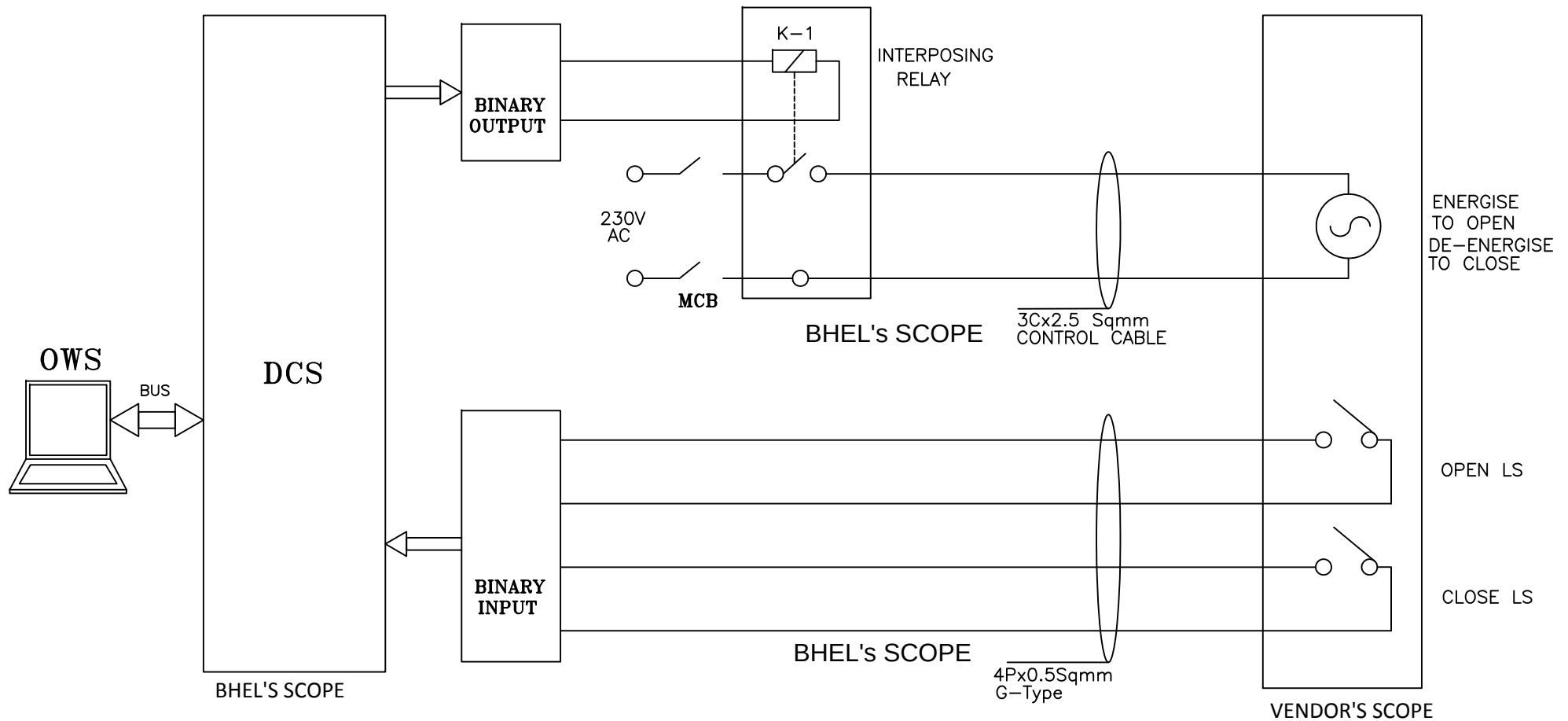


REFERENCE DRIVE INTERFACE SCHEME FOR HVAC PACKAGE

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DCS INTERFACE FOR MOTORIZED OPERATED FIRE DAMPER (BID-FD)

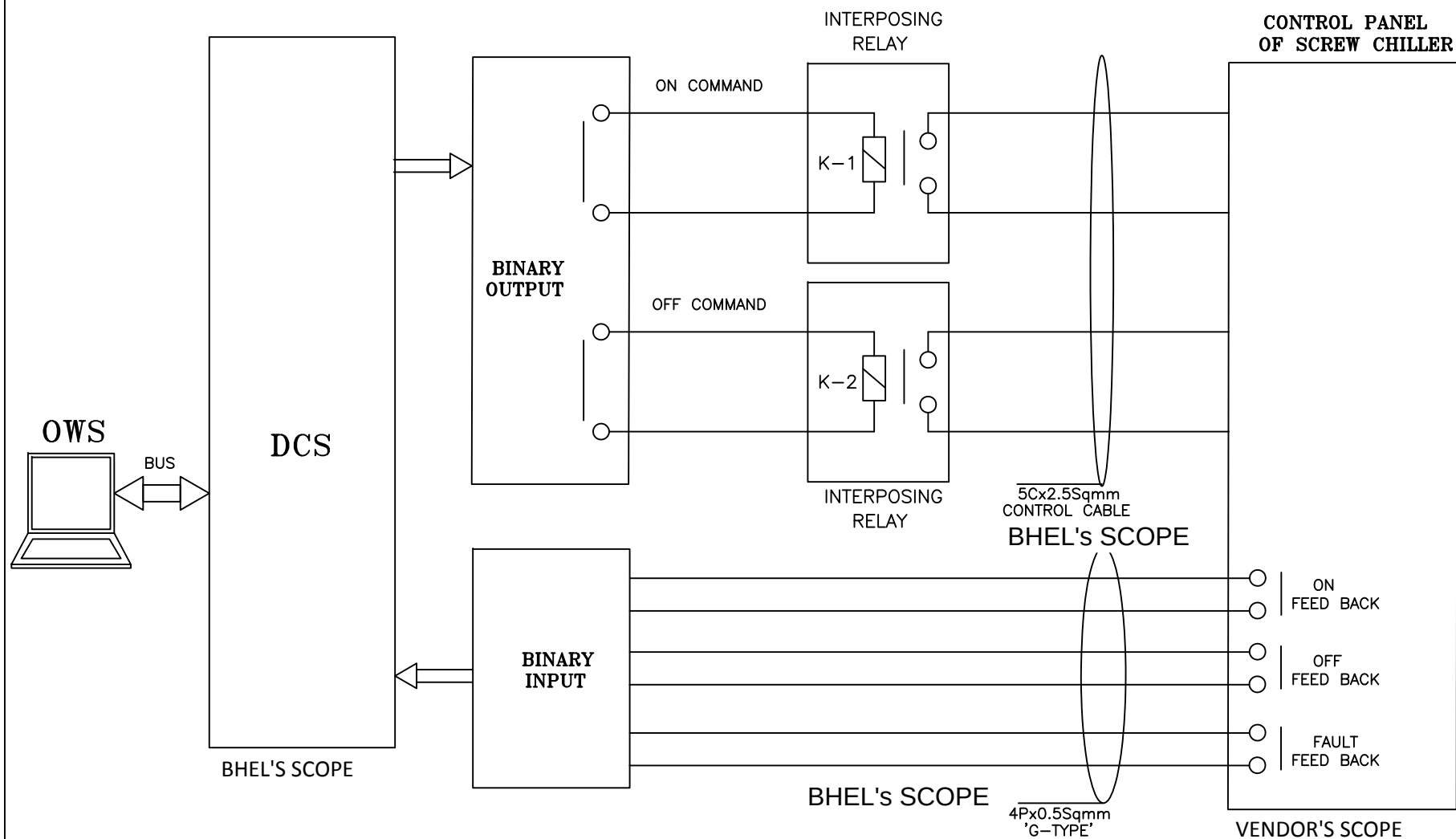


TITLE:

REFERENCE DRIVE INTERFACE SCHEME
FOR HVAC PACKAGE

DRG.NO.	
DATE	14.12.2016
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HOOK-UP DIAGRAM FOR SCREW CHILLER MACHINE

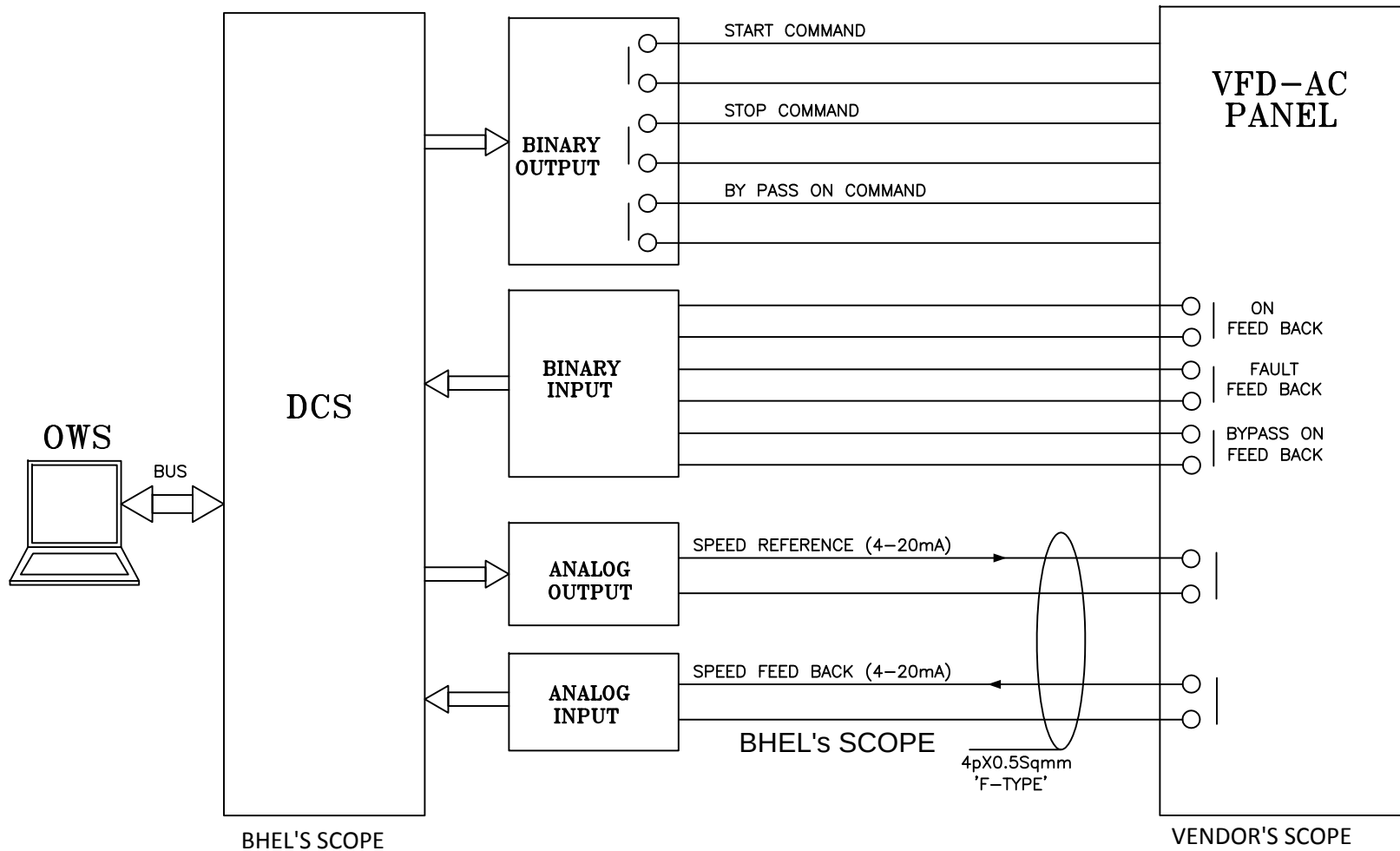


TITLE:

REFERENCE DRIVE INTERFACE SCHEME
FOR HVAC PACKAGE

DRG.NO.	
DATE	14.12.2016
REV.NO.	00
SHT 4	OF 15 of 102

DCS INTERFACE FOR CT FANs/AHUs VFD(VFD-AC)

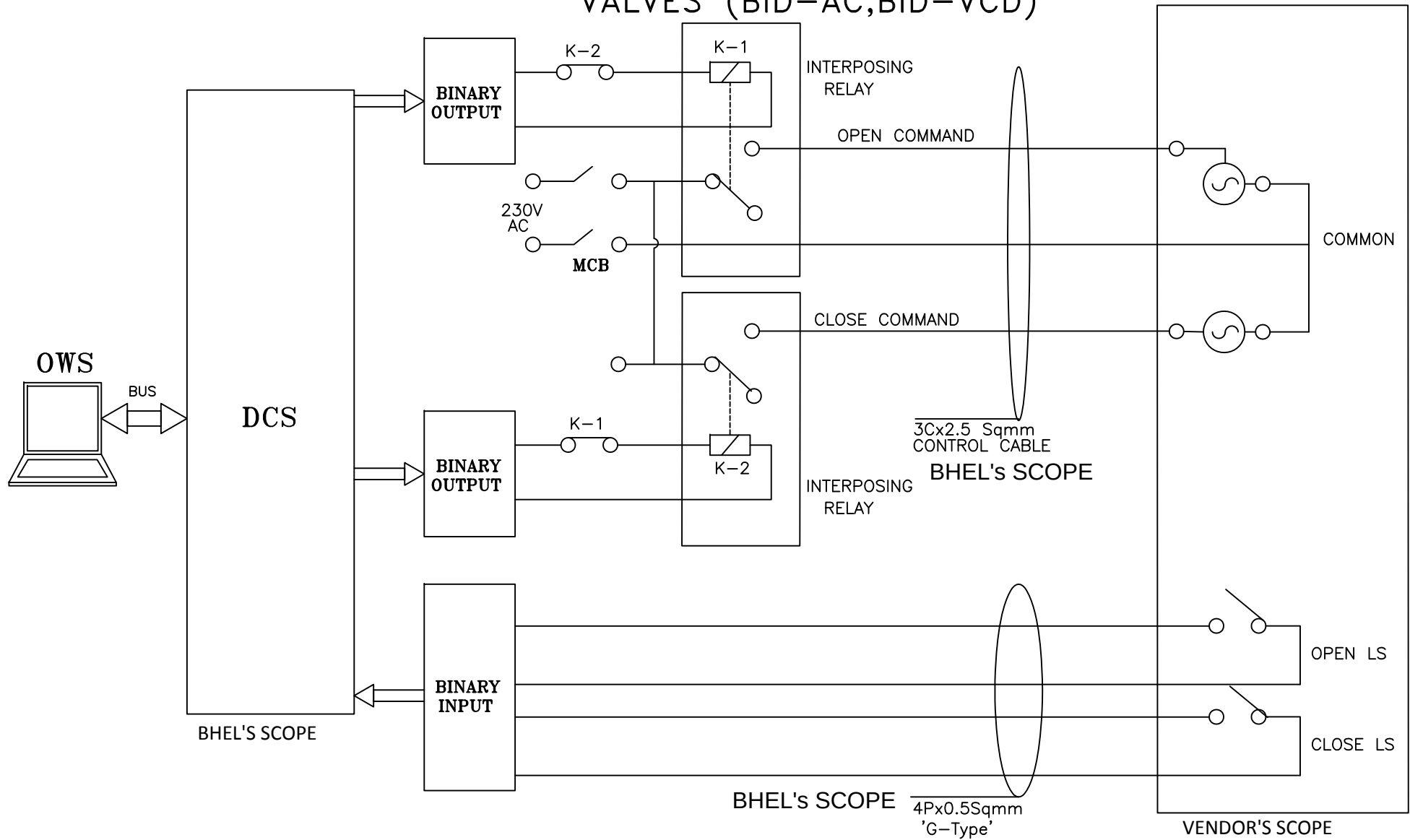


TITLE:

REFERENCE DRIVE INTERFACE SCHEME
FOR HVAC PACKAGE

DRG.NO.	
DATE	14.12.2016
REV.NO.	00
SHT 5	OF 16 of 102

DCS INTERFACE FOR MOTORIZED OPERATED VALVES (BID-AC,BID-VCD)



TITLE:

REFERENCE DRIVE INTERFACE SCHEME
FOR HVAC PACKAGE

DRG.NO.	
DATE	14.12.2016
REV.NO.	00
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FIELD & MEASURING INSTRUMENTS

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CHAPTER-3

FIELD AND MEASURING INSTRUMENTS

2.3.3 Field & Measuring Instruments (Primary & Secondary Instruments)

2.3.3.1 General requirements

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

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

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

For plug in type instruments, the plug & sockets shall be polarized to prevent wrong connections and have facility for secure coupling in plug-in position to prevent loose connections.

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

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

All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved. The enclosures of all electronic instruments shall conform to IP-65 unless otherwise specified (Explosion proof for NEC article 500, class 1, Division 1 area & flame proof) and an anticorrosive paint shall be applied to the field mounted enclosures / instruments. All the field instruments shall also be provided with SS tag nameplate and double compression type Nickel-plated brass cable gland. Gaskets, Fasteners, Counter and mating flange shall also be included wherever required with the field instruments.

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



**1X800 MW COAL BASED NORTH CHENNAI THERMAL
POWER PROJECT STAGE III**



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- a. Level switches / pressure switches / flow switches/any other process switches etc. for OLCS / Alarms / Interlocks / Protection. Pressure switches at inlet, outlet of individual pumps and discharge header of pumps for protection and auto start / stop & alarms.
- b. Level switches (Type as per Owner approval) for sump/tank level high/normal/ low/very low interlocks.
- c. Level Transmitters (Type as per Owner approval) for open sump/ tank/bunker/vessel/heaters.
- d. Stand pipes on both side of tank for all level instruments (LT, LS & LG).
- e. ~~Flow elements (Type as per Owner approval) with flow transmitter & Flow meter for flow measurement of process medium like Steam, Water, Air, Flue Gas, Fuel oil, open channel liquid, solid fuel, ash flow, DM water, Raw water, Instrument and Service air etc. as decided by owner.~~
- f. Pressure gauges and temp. Gauges at inlet and outlet of each heat exchanger and cooler.
- g. DPG, DPT & DPS across the filters/strainers.
- h. Tapping points/test points shall be provided.
- i. All primary Instruments, hardwares & JBs etc. used for measurement for HFO, LDO & Turbine Lube Oil system shall be flame proof (IEC-79.1, Part I). All primary Instruments, hardwares & JBs etc. used for measurement for Hydrogen shall be intrinsically safe and explosion proof as per NEC article 500, class 1, Division 1 area I.
- j. All Thermocouples & RTDs (Type as per Owner approval) shall be Duplex. Thermocouples shall be provided for Services with Temperature > 200 deg C.
- k. ~~All Field Instruments used in acid or alkaline atmosphere shall be with standard Anti corrosion coating i.e. the combination of Polyurethane and epoxy resin baked coating (ANSI/ISA 71.04).~~
- l. All primary instruments installed at "Minus level or Floor" shall be with protection class of IP 68.
- m. Transmitters (all type) for monitoring & controls purpose.
- n. Bidder shall provide electronics weighing in motion system as per IS-11547, hermitically sealed load cell of precision strain gauge type, 100% over load protection of cell and 250% overload protection for the construction; one calibrator attachment with two Weigher.
- o. All field mounted push button, selector switch etc. shall be as per IEC or NEMA 4X protection.



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POWER PROJECT STAGE III**



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- p. All limit switch shall be conform to IEC-60947-5-1 and shall have minimum 2SPDT/DPDT contacts.
- q. ~~At APH, temperature measuring device of different lengths forming grid shall be provided to have average temperature for variable flow of flue gas, secondary air and primary air. These temperatures may be connected to nearest remote I/O panel.~~
- r. ~~On both left and right sides of furnace, separate lines shall be laid and provided with furnace pressure transmitters having wide range than the furnace pressure transmitters used for modulating control.~~
- s. Temp. Transmitters are envisaged with RTD & Thermocouples for monitoring services / application only. However any RTD & Thermocouples are used for control, interlock & protection application, same shall be directly wired to DDCMIS/DCS using instrumentation & Extension cables respectively.
- t. ~~As for the water flow/ steam flow measurements, necessary flow elements/ transmitters are chosen in the process line and supplied such that their algebraic summation shall be mass balanced for calculating the system efficiency.~~
- u. Non-contact type electronic 2-wire position transmitters shall be provided for all inching type motorised valves and dampers.
- v. ~~For CW sump level, Turbine oil tank, Ash Silo, LDO/HFO tank, DM water tanks, CS tank, Acid and alkali applications, only noncontact type level transmitters like Acoustic, Ultrasonic, and Radar based (Type as per Owner approval) shall be provided by bidders as specified in Tender Specification and as approved by owner.~~
- w. ~~For Turbine oil, HFO/LDO applications & H2 Gas application, Zener protection on power supplies shall be included.~~
- x. ~~Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application. For HFO, LFO Applications, SS capillary with thin wafer element with ANSI RF flanged ends are to be provided. For hazardous area, explosions proof enclosure as described in NEC article 500 shall be provided.~~
- y. ~~Considering the type of application, wireless technology to bring signals to DDCMIS may be adopted by interfacing with OPC gateway to avoid cabling for smart level transmitters specified above at sr. no. xxi, in case used for monitoring only. However Wireless technology as adopted by Bidder shall be reliable and field proven in power plants and same shall be approved by Owner. Wirelss transmitters shall have the same minimum specification/ parameters as mentioned for wired transmitters.~~

- z. Gauges (all type) for local monitoring in field.
- aa. Each switching element including the limit and torque switches of valve actuators shall be provided with minimum two contacts i.e. 2SPDT OR DPDT.
- bb. All instruments should be supplied with valid calibration and test certificates provided by OEM.
- cc. Canopy/Enclosure shall be provided for field instruments like transmitters, switches & flow meters, etc and any other equipment to protect from direct sun light, lightning & rain.

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

2.3.3.2 Transmitters, Switches, Gauges and Panel Mounted Instruments

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

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

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

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

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

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

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

~~If one type of hand held type calibrator is not suitable for communicating with all types of transmitters then separate hand held calibrator will be provided.~~

~~Following minimum accessories shall be provided with each set:-~~

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

For flanged remote seal diaphragm:

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

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

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

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

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

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

S.No	Features	Essential / Minimum Requirements
7	Scale Details	Graduations in black lines on white dial, on white dial, 270 Deg. pointer deflection scale provided with glass cover. Smallest scale division shall be one (1) percent of full scale value or smaller. Pointer stop for all gauges.
8	Range Selection	Cover 125% of max. of scale
9	Accuracy	± One (1) percent or better
10	Instrument process connection	½" NPT Male (Back Entry)
11	Mounting Type	Local / 1/2 inch NPT Male (Back entry) mounted on local gauge board.
12	Protection Class	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)
13	Accessories	
	3 way needle valve / manifolds	For all gauges
	Self cleaning type	Pump and compressor discharge (Pulsation dampener / Snubbers (S316) lines
	Syphon	For all steam lines
	Protective separating	For fuel oil and corrosive liquid lines
14	Other Particulars	
	External Zero adjustment / Safety device	For all gauges
	Ranges 5 to 20 Kg/cm ²	Rubber blow out disc with open front construction.
	Ranges above 20 Kg/cm ²	Neoprene safety diaphragm at the back with solid front construction.
16	Over range protection	One Fifty (150) percent of full scale
17	Over Range Test	Test pr. For the assembly shall be 1.5 to the max. Design pr. At 38°C
18	Other Requirements	Movement mechanism shall be glycerine filled for oil services & vibration prone area. For Fuel oil & corrosive liquid lines diaphragm type sensors required. Armoured capillary of 10 M for Fuel oil & Corrosive liquid service. Contact type pressure gauges are not acceptable for interlock & protection. For condensate storage tank the pressure gauge in terms of 0-10000 mmwcl or suitable range having dial size of 300mm or bigger size shall be provided.
19	IBR Requirement	For high pressure service, Process tapping and root valves are as per IBR rules and regulations

2.3.3.3 Temperature Related Instruments

a) Temperature Transmitters (TT)

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

S.No	Features	Essential / Minimum Requirements
4	Ambient temperature error	0.1% per 10°C change
5	Input	Same transmitter shall be capable to handle Pt- 100 RTD, Thermocouples –K&R types (input type to be selectable at site through HART terminal)
6	Output	4-20 mA DC (2 wire system) HART compatible signals for analogue monitoring inputs to the distributed control system (DDCMIS), DCS & PLC.
7	Isolation	Min. 500 V AC
8	EMC compatibility	as per EN 61326
9	Operating ambient temperature	0 to 85 deg C (without indicator) 0 to 70 deg C (with indicator)
10	Protection class	NEMA 4 / IP66 or equivalent degree of protection for enclosure)/ (Explosion/Flameproof for NEC Class-1, Division 1 area)/flame proof (IEC-79.1, Part I). As applicable).
11	Material of accessories	SS316
12	Stability	± 0.1 % or ± 0.1 deg C of reading (whichever is great) for 2 years in case of RTD inputs and for 1 year in case of Thermocouples inputs.
13	Operating Voltage	16 – 48 V DC
14	Calibration	As per NIST monograph 125 for T/C & European Curve Alpha = 0.00385 for RTD.
15	Ref. Junction compensation	Provided
16	Span/zero adjustment	Locally adjustable, Non interacting
17	Auto calibration	Provided
18	Burn out protection upscale	Provided
19	Input - output isolation	Provided
20	Circuit ungrounded	Provided
21	Accessories	Mounting arrangements including Clamps etc.
22	Composite Accuracy	For head mounted and DIN-rail mounted type RTD =<0.4% of 0-250 deg C span For dual-input type: RTD =<0.25% of 0-250 deg C span
23	For head mounted and DIN-rail mounted type RTD =<0.4% of 0-250 deg C span For dual-input type: RTD =<0.25% of 0-250 deg C span	Temperature transmitters of this category shall be field mounting type & shall be capable of withstanding operating ambient temperature up to 70 deg C. These modules shall be connected to DDCMIS through field bus such as Profibus, Foundation Field bus etc. directly from the transmitter. Maximum Number of inputs per such temperature transmitter shall be eight. These shall be mounted in cabinets in non-AC areas. As an alternate, these signals from temperature transmitters can be connected to DDCMIS through standard remote I/O modules of the DCS, in which case, the temperature transmitter signals will be acquired through 4-20mA input modules in the remote I/O cabinet for connecting to DDCMIS through remote I/O bus.



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POWER PROJECT STAGE III**



EPC TENDER SPECIFICATION FOR BTG PACKAGE

Any RTD or Thermocouples shall be directly wired to DDCMIS/DCS/PLC for metal temperature application, bearing & winding temp application only.

The Temperature transmitter shall accept Universal dual inputs of all types of thermocouples & RTD, 0-5V input signals etc.

Temp. Transmitter shall be extremely stable against ambient temp variation, the accuracy figure shall be inclusive of effect due to ambient temperature variation.

~~For BFPs' differential temperature protection by 2 out of 3 logic, DTT shall be employed to deliver 4-20 mA output to DDCMIS using suction & discharge temperature measurements.~~

Temperature Transmitters shall not be used for CLCS, OLCS, interlock & protection services anywhere in the plant with RTD & Thermocouples. However RTD & Thermocouples are used for control, interlock & protection application, same shall be directly wired to DDCMIS/DCS/PLC using instrumentation & Extension cables respectively.

These transmitters shall be connected with duplex sensors and shall have bump less change over facility to second sensor in case first sensor fails .This change-over is to be alarmed.

~~Considering the monitoring application & distance involved for monitoring parameters wireless technology shall be adopted by interfacing with DDCMIS through OPC connectivity. However Wireless technology as adopted by Bidder shall be reliable and field proven in power plants and same shall be approved by Owner. Wireless transmitters shall have the same minimum specification/parameters as mentioned for wired transmitters.~~

b) Resistance Temperature Sensors (RTD) with Thermo wells

S.No	Features	Essential / Minimum Requirements
1	Applicable Standard	ASME PTC 19.3 - Latest Revision DIN EN 60751:1996, BS EN/IEC60751: 2008
2	Element	Platinum, R0=100 ohm 4-wire, Duplex for Process Temp. Measurement Platinum, R0=100 ohm 3-wire Duplex for Bearing & Winding Temp. Measurement
3	Sheath Material/ Insulation	316SS/Compacted Magnesium Oxide (Purity above 99.4%)
4	Sheath O D	8 MM
5	Gauge	18 AWG
6	Terminals	Spring loaded high temperature ceramic base with silver plated brass for high vibrating locations.
7	Calibration	As per DIN Standard – 43760/IEC 60751, Class A
8	Head	Hex Head, Die Cast Aluminium (Screwed) with galvanized SS chain
9	Response Time	6-10 Sec bare & 30 Sec. With protective sheath/thermo well
10	Accuracy	± 0.35 degree C or Class-A whichever is better.



**1X800 MW COAL BASED NORTH CHENNAI THERMAL
POWER PROJECT STAGE III**



EPC TENDER SPECIFICATION FOR BTG PACKAGE

S.No	Features	Essential / Minimum Requirements
11	Electrical connection	Gold plated Plug in type. Double entry – one unused entry with blind plug
12	Enclosure Class	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)
13	Response Time	Repeat and contradictory.
14	Accessories	i. Adjustable nipple-union-nipple with thermo well ii. Compression fittings/unions Flanges etc. (for flanged connections only) iii. SS 316 forged thermo well as per ASME PTC
	THERMOWELL	
15	Applicable Standard	ASME PTC 19.3 TW - 2010
16	Construction	Tapered drilled from Bar stock (Straight for Air & Gas systems)
17	Material	316 SS/F11/F22/F91 - water and steam Services depending upon process parameters. Inconel for air & flue gas services For furnace zone, impervious ceramic protecting tube of suitable material along with Incoloy supporting tubes and adjustable flanges. For Mill classifier outlet long life solid sintered tungsten carbide material or better of high abrasion resistance. Bidder shall provide calculation for thermo well as per ASME – PTC-19.3 2010. “All Thermo wells in high velocity steam service shall be checked for Strouhal’s frequency limit to arrive at a safer size and design of Thermo wells”.
18	Process Connection	(i) M 33 x 2 (ii) SS316 Flanged, for Air & Gas systems, with mating flanges, fasteners, gaskets etc.
19	Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
20	Immersion length	Within ± 10 mm of centre line of pipe and as per ASME – PTC-19.3 - 2010
21	Extension neck length	Minimum 100 mm above insulation of pipe and Minimum 160 mm when there is no insulation on pipe.
22	IBR Certification	For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations
23	Note : Extension /Compensating/paired cable exposed to atmosphere in the conventional method melts away due to high temperature or the head shall be more than 300 mm above the top of mill or due to coal burning. Hence The terminals of temperature sensors shall not be at the top of mills itself. The temperature sensors wires are to be laid up to JB though SS tube of required diameter and the head shall be placed nearer to the JB. In case, Duplex RTDs are not provided by bidder due to system/equipment limitation, two no. simplex RTD shall be provided instead of Duplex RTD. Both Simplex RTD shall be terminated at local JB/Termination Box.	



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POWER PROJECT STAGE III**



EPC TENDER SPECIFICATION FOR BTG PACKAGE

c) Thermocouples (T/C with T/W) With Thermo wells

S.No	Features	Essential / Minimum Requirements
1	Applicable standard	ASME PTC 19.3- Latest Revision ANSI-MC 96.1 – 1982, IEC 584-2
2	Element	Duplex
3	Sheath	8 MM OD
4	Sheath Material	316 SS
5	Spring Loaded	Yes
6	Nipple/Union	Yes
7	Packed connector	Compacted magnesium Oxide ungrounded
8	Type	i. Type K (Chromel - Alumel) ii. Type S/R (Platinum Rhodium-Platinum) iii. Type T (Cu-CuNi) with special limits to the standards
9	Gauge	16 AWG
10	Head	Die Cast Aluminium
11	Electrical connection	one unused entry with blind plug
12	Enclosure Class	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)
Thermo well		
13	Construction	Tapered Drilled from Bar stock (Straight for Air & Gas systems)
14	Material	316 SS/F11/F22/F91 - water and steam Services depending upon process parameters. - Inconel for air & flue gas services - For furnace zone, impervious ceramic protecting tube of suitable material along with Incoloy supporting tubes and adjustable flanges. - For Mill classifier outlet long life solid sintered tungsten carbide material or better of high abrasion resistance. Bidder shall provide calculation for thermo well as per ASME – PTC-19.3 2010. “All Thermo wells in high velocity steam service shall be checked for Strouhal’s frequency limit to arrive at a safer size and design of Thermo wells”.
15	Process Connection	SS316 Flanged, for Air & Gas systems, with mating flanges, gaskets, fasteners etc.
16	Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
Accuracy (Special Class as per IEC-751/ANSI-C-96.1)		
17	(For Type K T/C)	± 1.1 deg.C (for 0 to 277 deg.C) ± 0.4 percent (for 277 to 1280 deg.C) Class-A
18	For Type S & R T/C	± 0.6 deg.C or ± 0.1%
19	For Type T T/C	± 0.5 deg.C or ± 0.4%
20	Accessories	Bolts, nuts and gaskets for flanged connections.



**1X800 MW COAL BASED NORTH CHENNAI THERMAL
POWER PROJECT STAGE III**



EPC TENDER SPECIFICATION FOR BTG PACKAGE

S.No	Features	Essential / Minimum Requirements
	Response Time (Bare Thermocouple)	
21	For SH & RH Temp. Control	4-6 Sec.
22	All other applications	10 Sec.
23	Immersion length	Within + 10 mm of centre line of pipe and as per ASME – PTC-19.3 - 2010
24	Extension neck length	Minimum 100 mm above insulation of Pipe and minimum 160 mm when there is no insulation on pipe.
25	IBR Certification	For high pressure service, Steam Temp., Fuel oil temp. Measurement as per IBR rules and regulations.
26	Note Extension/Compensating cable exposed to atmosphere in the conventional method melts away due to high temperature or the head shall be more than 300 mm above the top of mill or due to coal burning. Hence The terminals of temperature sensors shall not be at the top of mills itself. The temperature sensors wires are to be laid up to JB though SS tube of required diameter and the head shall be placed nearer to the JB. CJC Boxes are not required, Thermocouple cables shall be directly terminated at Thermocouple I/P cards only. Bidder may also provide Triplex Thermocouples as per process requirements.	

~~Thermocouples provided for steam services like super heater / de super heater area, where the process pipe is inside the insulation of boiler penthouse, Thermo wells are inaccessible and terminal head and connecting cable cannot withstand high temperature, for such services thermocouples shall be provided with flexible extension SS316 Sheath of 10-15 meters.~~

d) ~~Metal Temperature Thermocouples (MTE)~~

S.No	Features	Essential / Minimum Requirements
1	Measuring Medium	Metal Temperature
2	Material of Thermocouple	Chromel Alumel Type K
3	Type of Thermocouple	Duplex with separate hot junctions, ungrounded
4	Insulation	Mineral Insulation Magnesium Oxide.
5	Thermocouple wire gauge	16 AWG
6	Protective sheath	SS 321
7	Protective sheath dia	8 mm O.D
8	Characteristics of Thermocouple	Special limits of error as in ANSI thermocouple MC 96.01.1975
9	Mounting accessories	½" BSP SS Sliding end connector, weld pad, clamps of heat resistant steel SS310
10	Cold end sealing	SS pot seal with color coded PTFE headed sleeve insulated flexible tails. Sealing compound Epoxy resin
11	Minimum bending radius	30 mm
12	Length of T/C	30 Mtr. (minimum)



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S.No	Features	Essential / Minimum Requirements
13	Enclosure Class	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)

e) Temperature Switches (TS)

S.No	Features	Essential / Minimum Requirements
	Type / Construction	
1	Switch	Industrial type inert gas filled with capillary and separable thermo well and contacts directly connected to Bourdon element/vapour pressure sensing, gas filled bellows type preferred.
2	Thermo well	Bar stock
a	Enclosure Class	IP 65 or better/ (Explosion/Flame proof for NEC Class 1/2, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable.
	Material	
3	Bulb	316 SS
4	Capillary	Armoured Stainless Steel
5	Bourdon	316 SS
6	Bourdon Movement	SS 316
7	Casing	Die-cast aluminium with stoved enamel black finish Epoxy coating shall be provided for corrosive atmosphere.
8	Setting and Differential	Adjustable
9	Accuracy	± One (1) percent of setting and differential
10	Repeatability	One half (1/2) percent of setting.
	Contacts	
11	Number	DPDT/2 SPDT
12	Type	Auto reset with internal Adjustable snap action micro switch
13	Rating	5 Amp, 240V AC / 0.2 Amp, 220V DC
14	Pipe Connection	M33 x 2
15	Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
16	Thermo well	To suit Temp. switch with same design criteria as specified for RTDs.
17	Electrical	Suitable for Plug in type. All the switches are internally connected and brought to the surface with Amphenol male/female connection. Cabling need not terminated inside the switch. Cable ends are to be soldered in connector and to be inserted for easy maintenance.
	Other Particulars	
18	Capillary length	As per requirement (min 10 meters)
19	Immersion Length	Within + ten (10) mm of centre line of pipe with adjustable nuts.
20	Extension neck length	Minimum 50 mm above insulation of pipe /As per approved hook up drawings



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S.No	Features	Essential / Minimum Requirements
21	Packing glands	Yes
22	IBR Certification	For high pressure service, Steam Temp, Fuel oil temp. measurement as per IBR rules and regulations
23	N.B	Switches designed for cross ambient operation shall be used in applications where the ambient temperature will approximate or exceed the switch set point.

f) Temperature Gauges (TG)

S.No	Features	Essential / Minimum Requirements
1	Applicable Standard	IS : 3602, BS:5235 ISA:RP:8.1 except as modified in this specification
	Type/Construction	
2	Thermometer	Industrial type, Gas in Filled type with separable thermo well
3	Thermo well	Bar stock
	Material	
4	Bulb	316 SS
5	Capillary	Armoured SS (Applicable for capillary Type)
6	Casing	SS 316/ Die-cast aluminium with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere
7	Dial Size	150mm with shatter proof glass
8	Scale Details	270 degree dial rotation/deflection. Graduations in black lines on white dial provided with glass cover. Smallest scale division shall be one (1) percent of full scale value or smaller .Pointer stop for all gauges
9	Accuracy	± One (1) percent or better
10	Response time	Maximum 15 seconds without thermo well and 30 seconds with thermo well
	Connection	
11	Pipe	M33 x 2
12	Thermo well	To suit instrument with same design criteria specified for RTDs.
13	Process Connection	M 33 x 2 (ii) SS316 Flanged, for Air & Gas systems, with mating flanges, fasteners, gaskets etc.
14	Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
15	Other Particulars	
16	Capillary length	5Meters/10 Meters as required
17	Immersion Length	Within + ten (10) mm of centre line of pipe with adjustable nuts.
18	Extension neck length	Minimum 50 mm above insulation of pipe /As per approved hook up drawings.
19	Stop at Maximum value	For all gauges of scale
20	Pointer	i) Externally adjustable



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S.No	Features	Essential / Minimum Requirements
		ii) In general, Contact type Temp. gauges are not acceptable for interlock & protection. iii) Contact type Temp. gauges are acceptable for interlock & protection in case of bearing temp. Only.
21	Over range protection	150 percent (%) of full scale
22	IBR Certification	For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations
23	Enclosure Class	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)

g) Test Thermo wells (TW)

S.No	Features	Essential / Minimum Requirements
1	Applicable Standard	ASME PTC 19.3 TW-2010
2	Type/Construction	Machined from Bar stock
3	Material	316 SS/F11/F22/F91
	Connection	
4	Pipe	M33 x 2
5	Test Instrument	To suit test instruments
6	Accessories	Plug with chain
7	IBR Certification	For high pressure service, Steam temperature Fuel oil temperature measurement as per IBR rules and regulations. Bidder shall provide calculation for thermo well as per ASME – PTC- 19.3 TW - 2010

Test wells shall be provided on main steam, reheat steam, extraction steam, feed water, condensate, spray water lines and other piping as required to meet ASME test requirements.

2.3.3.4 Level Instruments

a) Direct mounted level transmitter (LT)

Displacer type level transmitter shall not be used in the process anywhere in the plant.

b) Ultrasonic Level Transmitter (for Water sump/Tank level measurements)

S.No	Features	Essential / Minimum Requirements
1	Principle of Operation	Detection of reflected ultrasonic pulse
2	Measuring Ranges	Up to 30 meters (typical)
3	Signal Processing	Microprocessor Controlled Signal Processing
4	Operating Freq.	10 KHz to 50 KHz (typical)
5	Display	Head mounted alpha-numeric back lit LCD/LED
6	Calibration & Configuration	Accessible from front of panel & HART calibrator.
7	Diagnosis	On-line
8	Status	For power, Hi / Lo / V. Hi / V. Lo- level indication, fault etc.



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S.No	Features	Essential / Minimum Requirements
		operation.
5	Casing	IP-65.
6	Accessories (as required)	a) Air lock relay b) Hand wheel. c) Air filter regulator with gauge. d) Volume Booster. e) Limit Switches. f) Positioner with Input, Output and supply pressure gauges. g) Pilot Solenoid Valve (Double Coil type) h) Position Transmitter (4-20 mA DC linear output, LVDT or non-contact type).
7	Fail-safe operation	Stay put, open or close position on pneumatic / electrical power supply failure as per process safety criteria.
8	Repeatability	Better than 0.5% of full travel.
9	Hysteresis	Less than 1% of full travel.
10	Material	Internal part's material and material of accessories shall be SS316 only.
	In case of loss of mA signal. Manual adjustment shall be made through available manual knob and locked at required position for sufficient required process fluid flow.	

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

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

2.3.3.12 Junction Box

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



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

2.3.3.13 Interposing Relays (IPR)

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

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

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

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



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relay shall be of same make only and sockets shall have the plug in RC circuits/Varistors, required for EMI suppression.

2.3.3.14 Recorders (Chartless)

S.No.	Features	Essential/Minimum Requirements
1	Type	Micro-processor based, Digital TFT display type
2	No. of Channels	Six (6) Points & Forty Eight (48) point).(Simultaneous parameter display preferred)
3	Input Signal	Fully configurable multi range (Programmable) universal (input)
4	Recording method	Continuous with different colour, for each channel
5	Display colour	Desired display color using RGB value
6	Bar graph facility	To be provided
7	Digital indication	To be provided
8	Accuracy	+/- 0.1 % for reading for DCV Input And 0.1 Deg for TC/RTD input
9	Programmability	Front key board
10	Data Storage	hard disk/ Flash Memory
11	Data Retrieval	Compact 4 GB flash Memory card and USB port with 8 GB USB drive.
12	Scan rate	< 100 m second or less for individual channel. Selection of scan time for individual channel is required.
13	No. of Alarm relays with change over Contacts	6 Nos
14	Backup Battery	To be provided.
15	Communication	Ethernet connectivity for remote viewing in PC & file transfers to PC
16	Software to be supplied along With instrument	Software required for data archives from chartless recorder though Ethernet, remote viewing in PC through Ethernet, file transfer through Ethernet to PC.
17	External Storage media	Compact USB flash drive & Compact flash memory card with high capacity to be provided.
18	Math Function	General Arithmetic function, Summation for each channel and group of channels, Statistical operations like Average Maximum, Minimum etc.,
19	Ethernet Cable with Connectors	50 metres for each recorder
20	For virtual memory of chartless recorder	Provision of Modbus Protocol and its communication interface card in Chartless recorders for reading/writing of measurements/data from third party system/ electronic modules through digital communication. The recorder shall carry 48 or More channels of virtual measurements through data communication from third party system/ electronic modules
21	Color laser Multi function printer	1 No. A3 size color laser Multi Function printer for Print, Scan & Copy for complete set. 1 No. lap top computer with necessary CR application software to integrate with CR

2.3.3.33 Push buttons (PB)/ ILPBs for ON/OFF, OPEN/CLOSE, START/STOP

S.No.	Features	Essential/Minimum Requirements
1	Type	Momentary/Miniaturized Suitable for mosaic grid 24x48 Mm with 2 PB and 3 coloured LED
2	Contact Configuration	2 NO + 2 NC
3	Contact Material	Hard Silver Alloy
4	Contact Rating	500V / 10 A
5	Insulation Voltage	2 KV for 1 minute between terminals and earth
6	Lamp Rating :- a) Voltage b) Watt	240 V AC 2 Watt (approx.)
7	Colour	
	i. Red	ON/Start/Open ILPB, energized, running, Start, valve open LED/Lamp, OFF/Stop/Close PB, Emergency trip push buttons with red flap / hinged Transparent acrylic cover.
	ii. Green	OFF/Stop/Close ILPB, de-energized, stopped, valve closed LED/Lamp, ON/Start/Open PB
	iii. Light yellow	Abnormal, discrepancy LED/Lamp

2.3.3.34 Push Button for Control DESK

Momentary mosaic grid mounted 24x48 mm size, single PB 18x40 mm Colours for DESK RELEASE - Yellow, Desk Lamp test - Blue, Desk Acknowledgement – Green

2.3.3.35 Push Button for Sequence Start/Release

Momentary (Miniaturised) suitable for mosaic grid 24x48 mm3 PB + 5 LED

2.3.3.36 Push buttons for annunciation

S.No.	Features	Essential/Minimum Requirements
	Contacts	
1	Number & Type	As per requirement
2	Breaking capacity	1 Amp, 220V DC 10 Amp, 600V AC Different colours for Accept/Ack. - Green, reset Grey, Lamp test – Blue, System Test – Yellow & Audio Ack. - Black.

2.3.3.37 Hydrogen Gas System Instruments / Analysis

i) Hydrogen Gas Hygrometer

S.No.	Features	Essential/Minimum Requirements
A	Performance	

- l) At CW & ACW pump discharge headers flow transmitters shall be provided (Non Contact ultrasonic Type are preferable). In addition flow measurement shall also be provided for CW water used anywhere except condenser service.
- m) Flow transmitters for general applications shall be of the differential pressure type
- n) Flow switches for OLCS / Alarms / Interlocks / Protection.
- o) Lubricating oil Flow transmitter/meter with switch shall be provided for Bearing systems of APH, FD, PA, etc.,
- p) Sight glasses flapper indication type shall be provided on lube oil cooling water piping as required to ensure indication of fluid flow.
- q) On line Fuel flow & velocity measurement facility in each Pulverized Fuel (PF) pipe for each coal pulveriser shall be provided by bidder for accurate, absolute and simultaneous measurement of coal velocity, coal density, coal mass flow rate and air-to-fuel ratio. The equipments shall comprise of sensors working on micro wave technology.
- r) In addition to the conventional triple DP measurement techniques involving venturi/Aerofoil for secondary air flow measurement, One number Flow measurement system each on Left side and Right side shall be provided as redundant/checking measurement for secondary air flow which could be used in the optimization package.
- s) On line secondary air flow & velocity measurement facility in each on left side & right side shall be provided by bidder for accurate, absolute and simultaneous measurement of air velocity & flow rate. The equipments shall comprise of sensors working on tribo-electric (Correlation technique) technology.
- t) Any other flow element/meter required for system shall be finalised as per system requirement and as per approved drawings/documents by owner.

5. Process Connections

- a) The type of instrument source connection shall depend upon the process parameters and the tapping size. The source connection drawings shall be finalised during the engineering stage.
- b) Size of tapping point stub, number and size of root valves for different types of measurements are as follows:

S.No.	Quantity of root valves	Size of stub and root valve	Service Condition
Pressure and Differential Pressure Measurement			
(i)	2	25NB	$\geq 40 \text{ bar (g) OR } 425^{\circ}\text{C}$
(ii)	1	15NB	$< 40 \text{ bar (g) AND } 425^{\circ}\text{C}$
Level Measurement			
(a)	Level Gauge & Switch		
(i)	2	25NB	$\geq 40 \text{ bar(g) OR } 425^{\circ}\text{C}$
(ii)	1	25NB	$< 40 \text{ bar(g) AND } 425^{\circ}\text{C}$
(b)	Level transmitter (displacement type)		
(i)	2	40NB	$>40 \text{ bar(g) OR } 425^{\circ}\text{C}$
(ii)	1	40NB	$<40 \text{ bar(g) AND } 425^{\circ}\text{C}$
(c)	Stand pipe for level measuring instrument		
(i)	2	80 NB	$\geq 40 \text{ bar(g) OR } 425^{\circ}\text{C}$
(ii)	1	80 NB	$< 40 \text{ bar(g) AND } 425^{\circ}\text{C}$
Flow Measurement			
(i)	2	25NB	$\geq 40 \text{ bar(g) OR } 425^{\circ}\text{C}$
(ii)	1	25NB	$< 40 \text{ bar(g) AND } 425^{\circ}\text{C}$
Sampling system measurement (Steam and Water Service)			
(i)	2	25 NB	$\geq 40 \text{ bar(g) OR } 425^{\circ}\text{C}$
(ii)	1	25 NB	$< 40 \text{ bar(g) AND } 425^{\circ}\text{C}$



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S.No.	Features	Essential/Minimum Requirements
11	Max. Flow speed	6 m/sec
12	Temperature Range	-20°C----+55°C
13	Air pressure Range	800---1100 hPa
14	Humidity range	20----90% RH
15	Storage Conditions	Temperature : -25°C to 60°C Air pressure : 800---1100 hPa Humidity: 20---90% RH
16	Field Interface	4-20 mA safety related maximum voltage Um=250V
17	Supply voltage (Detector Terminals)	18-----28VDC SELV / PELV Integral fuse 100mAT Safety- related maximum voltage Um=250V
18	Calibration Interface	Ex-Protection class, intrinsically – safe EEx ib IIC; Only for connection to a certified intrinsically safe circuit; maximum values; Ui=13.8 V; Pi=432 mW Li and Ci negligibly small
19	Switch contacts	Alarm 1 (Pre- alarm) Alarm2 (main alarm, latching) Fault All are NC contacts (failsafe), max. 28VDC SELV/ PELV, with integral fuse (200mAT)
20	Reset input	18---28VDC, potential free
21	Max. cable length	200m
22	Extrinsic safety of equipment	II3(2) G EEx nA de(ib) IIC T4 PTB 05 ATEX 1047

b) Humidity & Temperature Sensor with LCD display for Unit Control room

At Unit control room, minimum three numbers shall be installed.

S.No.	Features	Essential/Minimum Requirements
Humidity Sensor		
1	Measurement range	0-100%r.h.
2	Range of use	0-100%r.h.
3	Measurement accuracy at 23° C 0-100% r.h.	+2%
4	Temperature dependency	<0.05% r.h./ ° C
5	Output signal, linear (terminal I1)	DC4-20mA = 0-100%r.h.
Temperature Sensor		
1	Range of use	0-50° C & -35 to 35° C
2	Sensing element	Pt1000 class A
3	Measurement accuracy at 15-35° C	+0.5K



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S.No.	Features	Essential/Minimum Requirements
4	Output signal, linear (terminal I2)	DC4-20mA = 0-50° C & -35 to 35° C
	General Sensor Data	
1	Power supply	
2	Operating voltage	AC 24V +20%
	Degree of Protection & Safety Class	
1	Degree of protection of housing	
a	With enclosed cable gland	IP 65 to IEC 529
b	Safety class	III to EN 60 730
	Environmental Condition	
1	Temperature (housing with electronics)	-40 to 70° C
2	Humidity	5 to 95% r.h. (non condensing)
1	Location	In each AHU room, return air line and each Control room, cubicle room, meeting room, training room, & conference room etc.

AIR CURTAIN (TO BE PROVIDED AT EACH ENTRANCE DOOR OF CONTROL ROOM)

I) Industrial Grade and fully automatically controlled (with On/Off control with door switch, Heat On/ Off control with room thermostat and Fan speed control with two phase thermostat),
Air Curtains shall be designed in accordance to ISO 27327

II) Self-supporting casing construction along with filter at inlet supply of air shall be provided.

III) Air curtain shall be with Low noise.

The following instruments to be taken care in the AC & ventilation package in addition to requirement of air curtains(at the entrance of main doors) for both Main Control room & BOP control room :-

- 1) Main Control room- 8 Nos. Temperature and 4 Nos. Humidity monitoring system.
- 2) MRS Control Room- 4 Nos. Temperature and 2 Nos. Humidity monitoring system.
- 3) ESP Control Room- 4 Nos. Temperature and 2 Nos. Humidity monitoring system.
- 4) HVAC Local Control Room - 4 Nos. Temperature and 2 Nos. Humidity monitoring system
- 5) Service building- 4 Nos. Temperature and 2 Nos. Humidity monitoring system.
- 6) SWAS Room- 4 Nos. Temperature and 2 Nos. Humidity monitoring system.
- 7) CPU Control Room- 4 Nos. Temperature and 2 Nos. Humidity monitoring system.
- 8) C&I Lab- 4 Nos. Temperature and 2 Nos. Humidity monitoring system.

LOCAL PANEL



SPECIFICATION FOR LOCAL PANELS

SPECIFICATION NO.: PE-SS -999- 145 -054A	
VOLUME	II B
SECTION	D
REV. NO. 03	DATE : 16-09-2013
SHEET	1 OF 6

1.0 SCOPE

This specification covers the Design, Manufacture, Inspection and Testing at the manufacturer's works, proper packing for transportation and delivery to site, supervision, erection, and commissioning at site of Local Panels required for control and monitoring of the Auxiliary Plant & Equipment.

2.0 CODES AND STANDARDS

2.1 All the equipments specified herein shall comply with the requirements of the latest issue of the relevant National and International standards.

2.2 As a minimum requirement, the following standards shall be complied with:

- a) IS-6005 : 1998 : Code of practice for phosphating of iron and steel.
- b) IS-5 : 2007 : Colors for ready mixed paints and enamels.
- c) IS-1248:2003 : Direct Acting Indicating Analog Elec Measuring Instruments.
- d) IS/IEC 60947:Part 1:2004 : Low Voltage switchgear & control gear: Part-I (General Rules)
- e) IS-8828:1996 : Circuit breaker for household and similar installations.
- f) IS-13947 (Part-I):1993 : Low Voltage switchgear & control gear : Part-I (General Rules)
- g) ISA-18.1:1979 : Annunciator Sequences and Specification
- h) NFPA-496:2003 : Purged & Pressurised Enclosure for Electrical Equipment in Hazardous Locations.

3.0 TECHNICAL REQUIREMENTS

3.1 Panel Construction

3.1.1 The local panels shall house the secondary instruments, annunciation system, Single loop controller, Control switches / push buttons, indicating lamps/LED cluster, relays, timers and other devices required for operation and monitoring of the equipment locally.

3.1.2 The panels shall be of free standing type either welded construction on angle iron (minimum section of 50 x 50 x 4 mm) structure or folded construction by sheet metal formation depending upon the equipments to be mounted on it. The panels shall be robustly built and stiffeners as necessary shall be provided.

3.1.3 The panel shall be suitably reinforced to ensure adequate support for all instruments mounted thereon. All welds on exposed panel surfaces shall be ground smooth.

3.1.4 The salient features of construction shall be:

Sheet material: Cold rolled sheet steel

Frame thickness: Not less than 3.0mm

Enclosure thickness: Not less than 2.5 mm for load bearing sections (Mounted with instruments)
1.6 mm for doors and Not less than 2.0 mm for others

Panel Height: As Required

Gland plate thickness: 3.0mm

Base channel: ISMC 100 with anti-vibration mounting & foundation bolts.

3.1.5 The panel shall be provided with rear doors with integral lockable handle. The door when locked shall be held at minimum three places. The door width shall not be more than 550mm. The doors shall be provided with suitable stiffeners to prevent buckling. The handle shall be on the right side of the door. The door shall be removable type with concealed hinges to facilitate maintenance work. Suitable pocket inside the door shall be provided for keeping the drawings / documents. Double door shall be provided with suitable glass windows, as per the requirement.

3.1.6 Suitable neoprene gasket shall be provided on all doors and removable covers. Suitable ventilation system along with louvers shall be provided at bottom and top of the doors covered with removable wire mesh.



SPECIFICATION FOR LOCAL PANELS

SPECIFICATION NO.: PE-SS -999- 145 -054A	
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- 3.1.7 The class of protection shall be in accordance with IP-42 unless otherwise specified in the data sheet – A (No. PES-145-54A-DS1-0).
- 3.1.8 All steel surfaces shall be cleaned by sand / pellet blasting, treated for pickling, degreasing and phosphating etc. by seven tank method. The panel shall have a high quality finish and appearance. The panel shall be painted with two coats of primer followed by two coats of epoxy / synthetic enamel based final paint of color shade and finish as given in data sheet-A (No. PES-145A-DS1-0). Minimum thickness of the paint shall be 85 microns for external paint and 70 microns for internal paint.
- 3.1.9 The cable glands of the required size and type as given in data sheet-A (No. PES-145A-DS1-0) shall be supplied alongwith the Panel.
- 3.1.10 All operable and indicating devices shall be mounted on the front of the panel while aux. Relays / timers MCBs etc. required for realization of control logics shall be mounted on a mounting plate inside the panel. Auxiliary relays and timers etc. shall be grouped according to the control function. No operable or indicating devices shall be mounted below 750 mm and above 1800 mm (w.r.t. finished ground level). The devices shall be located in such a way so as to ensure easy access for operation / maintenance.
- 3.1.11 Single / dual control power supply feeders of voltage class as specified in data sheet-A (No. PES-145A-DS1-0) shall be provided by the purchaser. In case redundant power supply feeders are provided then auto changeover unit shall be mounted on the panel are in the panel supplier's scope. Where DC control power supply is specified an additional 240V, 50 Hz AC supply feeder for powering of space heater and lighting shall be provided by the purchaser. Suitable arrangement shall be provided inside the panel to receive and terminate the power supply feeder(s). For this purpose MCBs of suitable current rating shall be provided by the vendor. A supervisory relay along with a pilot lamp to indicate control supply 'ON' shall be provided on the panel. Any other power supply required for the operation of the devices mounted in the panel shall be arranged by the vendor.
- 3.1.12 The internal wiring shall be carried out with 1100 volt grade PVC insulated copper multi strand wire / flexible of 1.5mm² size. AC & DC wires shall be kept separate from each other. Separate coloured wires to be used for AC and DC circuits. All wires shall be properly numbered and identified with ferrules as per the Control scheme / wiring diagram. Wires shall be routed and run through PVC troughs.
- 3.1.13 Terminal blocks shall be clip on type, 1100 volts grade. Separate terminal blocks shall be used for AC & DC circuits. The terminals shall be suitable for terminating 0.5 mm² to 2.5mm² external cables. The TB points in terminal block shall be cage clamp type / screw type. The terminal for ammeters shall be provided with removable links for shorting CTs. Each terminal strip shall be provided with identification strip. The terminal shall not be mounted below 250 mm height from finished floor. The panel shall have ten (20) percent spare terminal.
- 3.1.14 The interior of each panel shall be suitably illuminated through fluorescent lamps / tube lights with shrouded cover of minimum 15W operable on 240V 50 Hz AC power supply through panel door switch. A 15 Amp. 3-pin Power receptacle shall be provided.
- 3.1.15 Suitable space heaters operable on 240 Volts 50 Hz AC power system shall be provided at the panel bottom. These shall be designed to maintain the panel temperature five (5) deg. C above the ambient temperature during maintenance shutdown. Suitable isolating and control devices comprising of MCB, thermostat etc. shall be provided for the space heater.
- 3.1.16 The panel shall be provided with a copper earth bus of 25 x 6 mm size running throughout the width of the panel. It shall be terminated internally with 10 mm bolts at extreme ends for connection to; main station earth. The panel mounted equipments / devices shall be connected to earth bus through green coloured PVC insulated stranded copper conductor of 2.5 mm² size.
- 3.1.17 Local Panel shall be provided with main name plate of 150 mm x 40 mm size having inscription of 20 mm height. The individual devices on the panels shall be as provided with separate name plate with inscription of 3 mm height. The instrument / devices shall be provided with stick on label plates inside the panel. The material of the main and individual labels shall be three (3) ply 3 mm thick Traffolyte



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Sheet / 2 mm Anodised Aluminium Plate. The inscription shall be with white letters on black background on traffolyte sheet. The labels shall be fixed by self tapping non-rusting screws.

3.1.18 Vendor shall furnish electric load and heat load list (in case panel is to be placed in ac environment) of each panel.

3.2 Hazardous Area Panel Requirement

3.2.1 The Local Panel located in hazardous area shall be pressurized as per NFPA-496 requirements to render it non-hazardous. Alarms shall be provided for local and remote annunciation when pressurisation falls below 2.5 mm of water column. Protection shall be of type Z of NFPA-496. It shall not be possible to switch ON the power of purged section unless it is purged as per the recommendation of NFPA-496. Vendor must provide a protective device on the panel to protect the panel from over pressurisation.

3.2.2 Vendor shall supply pressurisation kit consisting of valves, restriction orifices, dual filter regulation, pressure gauges, pressure switches, rotameter etc. Pressurisation kit shall be surface mounting on a metal board and located outside the local panel. Pressurisation kit shall further consist of solenoid valve flow switch, timer blow off safety device etc., so as to make purging fully automatic. However final start shall be manual. Panel protection against over pressure to be provided as per NFPA-496.

3.2.3 Pressurised local control panel pressurization kit assembly design shall provide minimum leakage flow through the Local Control Panel. Panel venting shall be as per NFPA-496.

3.2.4 All components in the local panel like indicating instruments, push buttons switches, lamps etc., which are required to be energized without panel pressurization or before completion of purge cycle shall be explosion proof as per NEMA-7 & suitable for area classification.

3.2.5 All push buttons etc. requiring frequent operation during machine running shall have good positive sealing. Weatherproof housing or cover to be provided wherever necessary. Vendor shall provide pressurisation bypass switch outside explosion proof enclosure of pressurized panel with lamp indication. This shall be used only during maintenance. All hinges, screws, other non-painted metallic parts shall be of stainless steel material.

3.2.6 Provision to switch off manually all types of power shall be provided in the panel. In addition, it shall also be possible to switch off power circuits / components which are powered from motor control centre or control room manually in case of pressurization failure. All such cables from MCC and main control room shall be terminated in explosion proof boxes (NEMA-7).

3.3 Control & Monitoring devices

3.3.1 Instruments like Indicators, recorders, single loop controllers etc. as applicable and specified elsewhere for the plant / equipment shall be supplied and mounted on the panel.

3.3.2 Alarm Annunciator System

It shall be solid state discrete facia type having a sequence of ISA-S18.1A or as specified, opaque facia windows of 70 mm x 50 mm size, having two (2) lamps per window, and hooter of 10W, and provision for repeat group alarm at remote. The annunciator shall be provided with ten (10) percent spare windows or minimum two (2) windows along with electronics.

3.3.3 Relays

The relays shall be electromagnetic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable. There shall be ten (10) percent spare contacts.

3.3.4 Timers

The timers shall be electronic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However, minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable.



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3.3.5 Control / Selector Switches

Switches shall be Rotary Cam type with minimum of 5 Amps AC & 2 Amp DC continuous current rating. Selector switches shall be stay put type while control switches shall be spring-return-to-neutral type. Contact configuration and rating shall be as per the control function requirement. The switches shall be lockable type wherever specified. Each switch shall be provided with engraved plates indicating the switch position / functions.

3.3.6 Push Buttons / Indicating Lights

The push buttons shall be momentary action self-resetting type, however stop P.B. for unidirectional drives shall be provided with manual reset facility. Its contact configuration & rating shall be as required for the control function but minimum 2 NO + 2 NC of 5 Amp. AC rating. It shall have round coloured projecting tab and engraved escutcheon plate / inscription plate. Colour coding of push buttons shall be as under:

RED	Motor OFF / Valve CLOSE	YELLOW	Alarm acknowledge	Left Hand Side
GREEN	Motor ON / Valve OPEN	BLACK	Lamp test	Right Hand Side

Indicating lights shall be suitable for direct connections across specified power supplies. It shall be fitted with built in resistance to prevent circuit tripping on shorting of lamp filament. It shall be fitted with LED cluster type lamp replaceable from front.

GREEN	Motor OFF / Valve CLOSED condition	AMBER	Motor tripped	Left Hand Side
RED	Motor ON / Valve OPEN condition	WHITE	Normal / healthy	Right Hand Side

3.3.7 Ammeters

Ammeter shall be 96 x 96 mm size, 90 deg. deflection, 1.5% accuracy, 1 Amp. CT operated or with 4-20mA input and Flush mounting type as called for in the data sheet-A (No. PES-145-54A-DS1-0). Ammeters for motors shall have six (6) times folded scale at upper end to enable motor starting current indication

3.3.8 Miniature Circuit Breaker (MCB)

These shall be instantaneous magnetic trip type for short circuit in addition to current time inverse delayed thermal trip feature for over current protection. The housing of MCB shall be made of non-ignitable, high impact material. It shall have minimum short circuit rating of 9 KA for AC Voltages and 4 KA for DC Voltages.

3.3.9 Makes of various instruments / devices shall be as given below

1.	Alarm Annunciators	:	Procon / IIC
2.	Ammeters	:	AEP / IMP
3.	Control / Selector Switches	:	Alsthom / Kaycee / Siemens / L&T
4.	Push Buttons / Indicating Lamps	:	Siemens / L&T / Teknic / Alsthom
5.	Auxiliary Relays	:	Jyoti / Siemens / L&T / OEN
6.	Timers	:	L&T / Alsthom / Bhartiya Cutler Hammer
7.	MCBs	:	S&S Power Engg. / Indo Asian / MDS
8.	Terminal Blocks	:	Jyoti / Elmex

4.0 TESTING AND INSPECTION

4.1 The bidder shall adopt suitable quality assurance program to ensure that the equipments offered will meet the specification requirements in full.

4.2 BHEL's standard Quality Plan for LCP is enclosed with the specification. The bidder shall furnish his acceptance to BHEL's QP and submit the signed and stamped copy of QP along with the offer.



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4.3 The vendor shall conduct the following tests as a minimum requirement:

4.3.1 Routine Tests

1. High Voltage (H.V.)
2. Insulation Resistance (I.R.)
3. Functional

4.3.2 Type Tests

1. Enclosure Class Test



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5.0 SPARES AND CONSUMABLES

5.1 Commissioning Spares and consumables

The bidder shall supply all commissioning spares and consumables 'as required' during Start-up, as part of the main equipment supply.

5.2. Mandatory Spares

The bidder shall offer alongwith main offer, the Mandatory Spares as specified elsewhere in the specification. The Mandatory Spares offered shall be of the same make and type as the main equipment.

5.3. Recommended Spares

The bidder shall furnish a list of Recommended Spares indicating the normal service expectancy period and frequency of replacement; quantities recommended for 3 years operation alongwith unit rate against each item to enable BHEL/BHEL's Customer to place a separate order later, if required.

6.0 DRAWINGS AND DOCUMENTS

6.1 The bidder shall furnish the following documents in required number of copies along with the bid :

1. Data Sheet no. PES-145A-DS1-0
2. General Arrangement Drawing.
3. Catalogue and technical information for instruments and devices.
4. Quality Plan.

6.2 The vendor shall furnish the following documents in required number as agreed after the award of contract:

1. Data Shee No. PES-145A-DS2-0
2. GA Drawing indicating layout of instruments, construction details, foundation details, cable gland plate alongwith cable glands and all details mentioned in this specification.
3. Control Schematic Diagram along with grouping of different terminals for various functions.
4. Catalogue and technical information for instruments and devices with selected options clearly marked.
5. O&M Manuals.
6. "As Built" Drawing.
7. CDs.

7.0 MARKING AND PACKING

7.1 Panel with all instruments / devices mounted on it shall be suitably packed & protected for the entire period of despatch, storage and erection against impact, abrasion, corrossion, incidental damage due to vermin, sunlight, high temperature, rain moisture, humidity, dust, sea-water spray (where applicable) as well as rough handling and delays in Transit and storage in open.

8.0 APPLICABLE DATA SHEET FORMS

This document shall be read with one or more of the following data sheet forms :

- Data sheet A&B for Local Panels	:	Data sheet no. PES-145A-DS1-0
- Data sheet C for Local Panels	:	Data sheet no. PES-145A-DS2-0



DATA SHEET FOR LOCAL PANELS

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TAG No. Qty.....

Data Sheet No.: PES-145A-DS1-0

Data Sheet A & B

DATA SHEET-A FOR LOCAL PANEL
(TO BE FILLED BY PURCHASER)

DATA SHEET-B
(TO BE FILLED-UP BY
BIDDER)

GENERAL

MANUFACTURER

CONSTRUCTION

☐ FOLDED ☐ WELDED
(As per requirement EDN)

ENCLOSURE SHEET THICKNESS

FRONT

☐ 2.0 mm

OTHER

☐ 2.0 mm

DOOR

☐ 1.6 mm

HEIGHT

☐ 2365 mm for stand alone panels. ☐ Other

OTHER

☐ Load bearing sheet front shall have 3mm thickness

TECHNICAL

INPUT POWER SUPPLY *

(ANY OTHER POWER REQUIREMENT
TO BE DERIVED FROM THIS SUPPLY ONLY)

☐ 240V 50 Hz AC ☐ 220V DC
☐ 415V 3 PHASE 3W ☐ 415V 3 PHASE 4W

NO. OF FEEDERS

☐ ONE ☐ TWO

STARTER WITH MCC

(CHECK WITH MAUX/ELEC)

☐ REQUIRED ☐ NOT REQUIRED

IPR POSITION

☐ MCC ☐ RELAY PANEL

CONTACT RATING OF RELAY

☐ 5 Amp, 230 V AC ☐ 0.25 Amp, 220V DC

CONTROL SUPPLY

☐ 110V AC ☐ 220V AC
☐ 220V DC ☐ Other.
(As per requirement)

ALARM ANNUNCIATOR WINDOW

(EXCLUDING SPARES)

____ NOS. (AS REQUIRED)

TEMP SCANNER

(IF REQUIRED –NO. OF CHANNELS TO BE
SPECIFIED UNDER SEC-C)

☐ REQUIRED ☐ NOT REQUIRED

PAINT TYPE

☐ EPOXY ENAMEL
☐ EPOXY POWDER COATED

MIMIC (TYPE OF MIMIC- MATERAIL, THICKNESS
TO BE SPECIFIED DURING DETAILED ENGG.)

☐ REQUIRED ☐ NOT REQUIRED

PANEL COLOUR (EXTERNAL)

☐ LIGHT GREY (Shade 631 IS-5)
☐ OPALINE GREEN (Shade 275) .

FINISH (EXTERNAL)

☐ MATT
☐ GLOSSY ☐ SEMI GLOSSY

PANEL COLOUR (INTERNAL)

☐ WHITE ☐ CREAM
☐ OFF WHITE

FINISH (INTERNAL)

☐ MATT
☐ GLOSSY ☐ SEMI GLOSSY

CLASS OF PROTECTION

☐ IP-42 (FOR INDOOR SERVICE)
☐ IP-55 (FOR OUTDOOR SERVICE) ☐ ANY
OTHER

CONTROL HARDWARE

☐ RELAY BASED

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TAG No. Qty.....			Data Sheet No.: PES-145A-DS1-0		
Data Sheet A & B					
DATA SHEET-A FOR LOCAL PANEL (TO BE FILLED BY PURCHASER)				DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
	FOUNDATION ARRANGEMENT		☐ FOUNDATION BOLTS ☐ ANCHOR FASTENERS		
	WEIGHT OF PANEL (Kg.)		(Vendor to specify)		
	PANEL TYPE		☐ PRESSURISED ☐ UNPRESSURISED As per Requirement		
	CABLE GLAND		☐ DOUBLE COMPRESSION		
	AMMETER (TYPE OF INPUT) *		☐ 1 Amp CT ☐ 4-20 mA		
	SCOPE OF SUPERVISION FOR ERECTION & COMMISSIONING		☐ APPLICABLE ☐ NA		
	* TO BE CO-ORDINATED WITH PEM ELECTRICAL				
NAME DESIGNATION SIGNATURE DATE	PREPARED BY	CHECKED BY	APPROVED BY	COMPANY SEAL NAME: SIGNATURE: DATE:	
	AANCHAL CHOUDHARY	SACHIN SRIVASTAVA	MA MANSOORI		
	SR.ENGR	DY.MNGR	D. GM		
	16.09.2013	16.09.2013	16.09.2013		



DATA SHEET FOR LOCAL PANELS

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TAG No. Qty.....

Data Sheet No.: PES-145A-DS1-0

Data Sheet C

DATA SHEET-C FOR LOCAL PANEL
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)

GENERAL	MANUFACTURER				
	CONSTRUCTION		☐ FOLDED ☐ WELDED (As per requirement EDN)		
	ENCLOSURE SHEET THICKNESS	FRONT			
		OTHER			
		DOOR			
		HEIGHT			
OTHER					
TECHNICAL	INPUT POWER SUPPLY				
	NO. OF FEEDERS				
	CONTACT RATING OF RELAY				
	TEMP SCANNER				
	CONTROL SUPPLY				
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)				
	PAINT TYPE				
	PANEL COLOUR (EXTERNAL)				
	FINISH (EXTERNAL)				
	TYPE OF MIMIC				
	MATERIAL OF MIMC				
	THICKNESS OF MIMIC				
	PANEL COLOUR (INTERNAL)				
	FINISH (INTERNAL)				
	CLASS OF PROTECTION				
	CONTROL HARDWARE				
	FOUNDATION ARRANGEMENT				
	WEIGHT OF PANEL (Kg.)				
	PANEL TYPE				
	CABLE GLAND				
	AMMETER (TYPE OF INPUT)				
SCOPE OF SUPERVISION					
NAME SIGNATURE DATE	PREPARED BY	CHECKED BY	APPROVED BY	COMPANY SEAL NAME: SIGNATURE: DATE:	
	AANCHAL CHOUDHARY	SACHIN SRIVASTYAVA	MA MANSOORI		
	16.09.2013	16.09.2013	16.09.2013		

Interposing relay panels for the system shall be supplied for mounting interposing relays & terminating all cables originating from the DO cards in case of solenoid valves, and other required services etc. IPR panels shall be placed in CER and LCR.

Interposing relay shall be mounted in respective SWGR / MCC / integral starter required for commands signals of HT / LT unidirectional drives and bidirectional drives, breakers, isolators & bus couplers etc. from DDCMIS / DCS or any control system. Terminal blocks shall be located inside the cabinets on support wings fabricated of metal plates. Similarly suitable lockers (min. 8 nos in each control room) shall be provided in BOP package / BTG offsite control rooms shall be provide by bidder.

The plug socket shall be mounted on hinged plates to provide an access to the rear pins of the plugs. General features of termination cabinets and accessories shall conform to the general design and construction specification of panels. Terminal blocks shall be Rail mounted Terminal blocks (Screw less cage clamp type) with markers.

2.3.6.5 Constructional Features of Panels, Consoles, Control Desk, Cubicles & Enclosures

All panels, cubicles, consoles, SOV panels and enclosures furnished as per this specification shall be of free standing type and shall be constructed of specified gauge of steel plates. The panel sheet thickness shall be not less than 2mm unless otherwise specified herein.

The panels, consoles / desks shall be reinforced as required to ensure true surfaces and adequate support for instruments mounted thereon. All instrument cut outs, mounting studs, and support brackets shall be accurately located. All welds on the exposed panel surfaces shall be ground smooth. Finished panel surfaces shall be free from waves, bellies, or other imperfections. Unless specified, otherwise, panel doors shall be 4 points hinged and shall have turned back edges and additional bracing where required to ensure rigidity. Door hinges shall be of the concealed type. Door latches shall be of the three-point type to ensure tight closing. Door locks shall be furnished which will allow actuation of all locks by a single master key. All panels shall have removable lifting eyebolts for safe lifting from top during storage and installation handling.

Cabinet doors shall be hinged and shall have turned back edges and additional bracing where required ensuring rigidity. Hinges shall be of concealed type. Door latches shall be of three / four-point type to assure tight closing. Detachable lifting eyes or angles shall be furnished at the top of each separately shipped section and all necessary provisions shall be made to facilitate handling without damage. Front and rear doors shall be provided with locking arrangements with a master key for all cabinets. If width of a cabinet is equal or more than 800 mm, double doors shall be provided.

All panels shall be mounted on vibration dampers, which are secured to channels mounted on the floor. The channels shall be field welded to steel plates set into the concrete flooring. The steel plates shall be located such as to approximate the outline of panel bases. The exact mounting details shall be as approved by the owner during detailed engineering stage. All panels shall be provided with adequate ventilation and packaging density of components shall be restricted so as to limit the

temperature rise above ambient to 10°C under the worst conditions. All panels shall have auto on/off switch for internal lighting. All the power supply circuit for control panels shall be provided with auto changeover circuitry.

In each panel / cabinet, a 24 VDC Voltmeter digital type shall be provided to check the Field Interrogation voltage.

Exhaust Fans with louvers & filters shall be provided on door's (front & Rear) upper side to remove hot air in all consoles, control desk and panels.

~~Fire / Smoke detectors shall be provided inside the Control room mounted system / control cabinets.~~

UPS, 24V DC & non UPS's Feeder failure / healthy indication shall be provided in each cabinet & remote indication shall be hooked up to DDCMIS / DCS / annunciation & suitably grouped.

All the panels shall be equipped with Antivibration pad of min. 15 mm size. Cable gland plate thickness shall be 3 mm.

Doors shall be provided with neoprene / polyurethane gasket only.

All the cable entries shall be at the bottom of electronic cubicles / control panels. Protection class of panels shall be as specified at Vol. II, chapter 2.

a) Operator Control Desk

In CCR, Operator work station consoles / desk shall be of granite top of curved nature with powder coated frame. OWS consoles shall be provided with the facility for locating the CPU, document etc. with all required utilities.

Unit In charge desk / consoles shall be of granite top of curved nature with powder coated frame. OWS consoles shall be provided with the facility for locating the CPU, document etc. with all required utilities.

Station In charge desk / consoles shall be of granite top of curved nature with powder coated frame. OWS consoles shall be provided with the facility for locating the CPU, document etc. with all required utilities.

Engineer work station and all other consoles / desk shall be ergonomically designed industrial grade type with swivel chairs for use at the various Programming stations and all other plant locations. All the equipment like Programmers stations, PC's, various peripherals & similar devices shall be complete with desks and they shall be of industrial grade stands and other mounting accessories and the same shall be completely erected & commissioned by the bidder. Details for other operating and engineering stations shall be as below:

1. Operator Control desk shall be free standing table top type with doors at the back and

shall be constructed of 3 mm thick CRCA steel plates. It shall have concealed cable & wire way management system. The top surface of control desk shall be 30mm thick with the top 12mm of acrylic solid surface and the remaining 18mm of laminated medium density fibre board. Control desk shall consist of vertical, horizontal and base supports with their coverings for work surface, keyboard trays, Mouse pads, Monitor shelf and concealed cable and wire way management, perforated trays with covers in both horizontal & vertical directions.

2. To achieve durable & water resistant finish, a sheet of "plastic PVC membrane" on the surface of control desks shall be provided. Final paint finish with proper smoothening is to be ensured. Final finish of CD should be in line with relevant International standards. For more durability, the membrane sheet of the Control desk should extend 200 mm more into the underside of the desk. The cabling / wiring between OWS & CPU's, power supply cables etc. shall be aesthetically routed and concealed from view.
3. All the control desk shall be equipped with Anti vibration pad of min. 15 mm size. Cable gland plate thickness shall be 3 mm.
4. Doors shall be provided with neoprene / polyurethane gasket only.

b) Surface Preparation and Painting

All panel exterior steel surfaces shall be ground smooth, and painted as specified below: Suitable filler shall be applied to all pits, blemishes and voids in the surfaces. The filler shall be sand blasted so that surfaces are level and flat, corners are smooth and even. Exposed raw metal edges shall be ground burr free. The entire panel surface shall be sand blasted to remove rust and scale and all other residue due to the fabrication operation. Oil grease and salts etc. shall be removed from the panels by one or more solvent cleaning methods. Alternatively 7 tank process shall be followed.

Two spray coats of inhibitive epoxy primer surface shall be applied to all exterior and interior surfaces, each coat of primer surface shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish colour (Catalysed epoxy finish) shall be applied to all surfaces of dry film thickness 2.0 mil. The finish colours for exterior and interior surfaces shall conform to the following shades:

- a. Exterior - RAL 7032 / RAL 7035.
- b. Interior - Glossy white two coats / RAL 7035 with fire resistant paint

One uniform colour shade as finalized shall be applicable for complete plant. Paint films, which show sags, checks, blisters teardrops, fat edges or other painting imperfections, shall not be acceptable and if any such defects appear, they shall be repaired by and at the expenses of the Bidder.

c) Panel Wiring

Interconnecting wiring shall be provided between all electrical devices mounted in the panels, and between the devices and terminal blocks if the devices are to be connected to equipment outside the panels by cabling and through pre-fabricated plug in cables. All alarm contacts located within a panel shall be wired to terminal blocks. Thermocouple and other special circuits shall be field wires direct to instrument terminal blocks without the use of panel wiring.

All control and instrument wiring used within the panels shall conform to NEC and NEMA standards and shall be factory installed and tested at the works of a qualified manufacturer. All interior wiring shall be installed neatly and carefully, and shall be terminated at suitable terminal blocks. Sufficient clearance shall be provided for all control and instrumentation leads, and all incoming and outgoing leads shall be connected to terminal blocks suitably located for connecting external circuits.

All panel wiring shall have appropriate ferruling for clear identification. Interior wiring shall be so arranged that the external connections can be made with only one wire per terminal point. Any common connections shall be made internal side of the terminal blocks. Common connections shall be limited to two wires per terminal. Instrumentation cable shield wires shall be connected to separate terminal at the terminal block. Signal circuit shields shall be grounded separately.

All internal wiring (except low level instrument wiring) shall be National Electric Code Type SIS, Plyometric / Elastomeric insulated, tinned copper stranded conductor, switchboard wire, or owner approved equal.

Panel wiring shall have a flame resistant insulation with adequately sized 650 / 1100 V grade tinned copper stranded conductor based on current carrying capacities as etc. forth by the National Electric Code. Wire sizes shall be as specified herein and suitable for intended applications.

Wiring to door mounted devices shall be provided with (49 strand minimum) adequate loop lengths of hinge wire so that multiple door openings will not cause fatigue braking of the conductor.

Wiring shall be arranged to enable instruments or devices to be removed and / or serviced without unduly disturbing the wiring. No wire shall be routed cross the face or rear of any device in a manner, which will impede the opening of covers or obstruct access to leads, terminals or devices.

Panel wires shall be identified with wire number and each termination by means of action craft products split sleeve or Borden Chemical Co. indelible tubing markers or owner approved equal. Corrections and modifications of all panel wiring shall be Bidder's sole

responsibility. Any corrections / modifications required at site for successful commissioning shall be done by the Bidder without any additional costs. Terminal lugs furnished must be of the compression, insulated sleeve, half ring tongue type. Open ended terminal lugs will not be accepted. Wires shall not be looped around the terminal screws or studs. Wires shall not be tapped or spliced between terminal points.

Panels, cabinets, consoles / desks will be provided with removable, gasketed cable gland plates and cable glands, for all floor slots used for cable entrance. Split type grommets shall be used for prefab cables.

Internal wiring in factory prewired electronic systems cabinets may be installed according to the Bidder's standard as to wire size, insulation, and method of termination on internal equipment except that insulation for all wiring power supply wiring, and interconnecting cables between devices shall pass the following tests.

- 1) Flammability test IEEE 383 / 1974
- 2) When tested under UITPP test method or ASTM 2893 / 77 light transmittance of 80%.
- 3) When tested under IEC 754-1 maximum acid gas generation shall be 2% by weight
- 4) Oxygen index not less than 30 as per ASTM D 2863.

All terminations for intra panel wiring inter panel cabling and connecting the Bidders panels, PB stations, control stations etc. shall be with cage clamp Screwed less connections. Soldered connections are not acceptable. All field side or external input connections shall also preferably of Cage clamp / Spring Clamp / Screwed less connection.

Conductor clamping shall also confirm to Standard IEC – 60947-1 & IEC-60947-7-1. Identification of conductors may be done by insulation colour coding identified on drawings or by printed wiring lists. Terminal blocks for connection of external circuits in to factory prewired electronic system cabinets shall meet all the requirements as described elsewhere in the specification. For all multicore cables, the outer sheath shall satisfy the properties identified above. However, for panel wiring, the wiring insulation shall also satisfy the properties identified above. The internal wiring shall be done in coloured wiring.

Following Wire size shall be utilized for internal wiring:

S.No	Nature of signals	Wire size
1	Current (4-20 mA), Low voltage signals (AI / AO & DI signals)	0.75 sq.mm
2	DO signals, Ammeter / voltmeter circuit, control switches, indicator, recorder	1.5 sq.mm
3	Internal Illumination	2.5 sq.mm

S.No	Nature of signals	Wire size
4	Size of Power supply cables shall be as below:- i. 1 to 16 Amp. ii. 17 to 20 Amp. iii. 21 to 32 Amp. iv. 33 to 40 Amp. v. 41 to 60 Amp. vi. Power earth	2.5 sq. mm 4 sq. mm 6 sq. mm 10 sq. mm. 16 sq. mm 4 sq. mm

d) Instruments Mounting

Instruments and relays mounted on the panels shall be easily accessible for repair and replacement without disturbing other equipment their connected wiring. No special tools shall be needed for the purpose.

e) Panel Illumination

Panels shall be provided with LED based illuminating lamps with door switch and six (6) point 6 / 16A, 240V AC universal type power sockets with switch for maintenance purposes. These switches shall be with quick make and break mechanism. 100 % spare LED lamps shall be provided with each panel, these are in additional to mandatory spares.

f) Fuse Blocks

Where fuse blocks rated 30 amp. 250 Volts are required by the specifications or the manufacturer's design, they shall be modular type with Bakelite frame and reinforced retaining clips. Blocks shall be class H.2 pole, screw terminal fuse blocks. Blocks for other current and voltage ratings shall be similar in construction.

g) Fuses & MCB

All fuses shall be fast acting semiconductor types for AC supply and compatible to the UPS fuses. For all DC Powered devices, similarly the fuses shall be fast acting compatible to

DCDB fuse provisions. All the AC power supplies shall be provided with the protection of Fast acting semiconductor fuses & 2 P thermomagnetic type MCB. Make of Fuses shall be GE or Siemens. For all the DC power supply circuits, electronic type DC MCB shall be used only. Make of DC MCB shall be Siemens, Phoenix contacts, Murr, Weidmuller, or Lutze. 50 % spare fuses shall be provided with each panel, these are in additional to mandatory spares.

h) Moulded Case Circuit Breakers

Moulded case circuit breakers used in equipment covered under these specifications shall have not less than 5000 amp. Interrupting capacity at 220 Volts DC 10,000 Amp. Symmetrical interrupting capacity at 240 Volts AC. MCCB shall be provided at each main feeder line like ACDB & DCDB main feeders, PLC main feeder, control panels, UPS circuits etc.

i) Grounding

All panels and cabinets shall be provided with a continuous bare copper ground bus of minimum 6 mm x 25 / 50 mm cross section. The ground bus shall be bolted to the panel structure and effectively ground the entire structure. Each Ground bus shall have provision at each end for connection of ground leaks (6 mm x 50 mm GI Flats) by suitable bolting. All system cabinets shall be brought to a common system ground by the bidder. Electronic earthing resistance shall be < 0.5 ohms.

Each circuit requiring grounding shall be individually and directly connected to the panel ground bus by ring tongue type compression lugs. For electronic system cabinets the system ground bus shall be insulated from the cabinet enclosure and shall be separately connected to the system ground. All system cabinets shall be brought to a common system ground by the bidder.

The Bidder shall furnish his recommendations regarding grounding requirements for all equipment / systems and shall specifically indicate the deviations if any from the above requirements as a part of his proposal.

j) Terminal Blocks

For all inputs to the system emanating from the field or other systems, the bidder shall furnish terminals suitable for correct size of field cables.

All outputs going to MCC / SWGR terminal blocks, shall be rated 600 volts minimum and shall have strap screw less terminals suitable for connection of wires with ring tongue type lugs. Standard terminal blocks shall be screw less cage clamps type. Terminal blocks shall be approximately sized for larger wire size of higher voltage insulated incoming conductors as necessary. All the TBs used shall be 6.6 polyamide to withstand corrosion and the metallic portion shall be coated against rust / corrosion. All metal parts should be nonferrous in nature.

Terminal blocks shall be provided with white marking strips and re permitted by the safety codes and standards shall be without covers.

Fuses shall not be mounted on terminal blocks. Neither step type terminal blocks nor angle mounting of terminal blocks will be acceptable.

At least 20 per cent spare unused fully wired terminals shall be provided on each terminal block for circuit modifications and for termination of all conductors in a multi-conductor control cable with each panel, enclosure, cubicle, SOV Boxes etc.

k) Name Plates and Labels

Name plates of adequate size shall be provided for each panel on front and rear of the panel. Instruments / other accessories mounted inside the panels shall have identification marking clearly visible from inside.

Devices to be mounted on the panels shall also be labelled on the panels shall also be labelled on the outside of the panel. Name plates shall be of polyamide sheets with black letters on white background. Name plates shall be attached to the boards by means of stainless steel pan head screws. Fuses provided for protection of various boxes shall be accessible for replacement. Fuse boxes shall be provided with circuit label and fuse rated current and voltage.

l) Markings / Labels

All markers / labels shall be made of halogen & silicon free polyamide material with inflammability class V2 as per UL 94, ensuring scratch proof printing with the use of environment friendly solvent free ink & latest BLUEMARK UV technology so as to comply the WIPE RESISTANCE according to DIN EN 61010-1 / VDE 0411-1.

2.3.6.6 Local Instrument Racks & Enclosure

Transmitters and switches located in the field shall be grouped together and shall be installed in the enclosure (closed transmitter racks) in case of outdoor area such as Boiler area etc. And in open type Rack in case of covered area. Racks shall be factory prefabricated & painted and complete with internal tubing, manifold valve, isolation valves, integral junction boxes with outside access door, illumination etc. Racks used for furnace, flue gas and air application shall be provided with intermittent & continuous air purging.

i) Closed Type Instruments / Transmitter Racks

- a)** Required number of Instruments / transmitter racks shall be furnished to house transmitters, switches and converters by grouping them suitably, area wise / function-wise.
- b)** The transmitter enclosure shall be constructed of 3 mm thick steel plate. The enclosures shall preferably be of modular construction and with two end plate assembly bolted to the frame.
- c)** The enclosure shall approximately be 1200 millimetres wide, 1000 millimetres deep and 2200 millimetres high to allow easy access to the internals. Racks shall be reinforced as required to ensure true surfaces and to provide adequate support for instruments and equipment mounted therein. Double interlocking doors with three point locking arrangement shall be provided and shall be arranged for maximum possible access to the interior. Centre posts or any member which would reduce access shall not be provided.

- b) Since nowadays the reliability and availability of control system is enhanced due to the redundancy path, backup panel with mosaic and vertical type (not L type) is to be provided with as minimum as possible for safe guarding the main equipments BTG and auxiliaries.
- c) Hence in addition to the LVS and OWS, a limited operation from backup unit control vertical panel with mosaic is envisaged for emergency operation and to provide safe shut down of plant/equipments. The backup Unit control vertical panel with mosaic shall be housed Conventional Push-button (ILPB) stations, Console inserts (SG & TG), Trip Push Buttons, Ammeters, CCTV for Furnace Flame, chartless recorders & digital display units for Boiler, Turbine & Generator Process/electrical parameters. Also bidder to refer details in Chapter 6.
- d) Back up panel system shall be designed for handling the situation in clause 2.3.2.17 for failure of HMI.
- e) For electrical layout, complete backup panel with mosaic shall have to be provided for complete on/off operations with necessary meters, DDU's, synchroscope etc. as specified elsewhere in specification.

2.3.2.11.1 Unit Control And Monitoring Philosophy

The main equipments namely SG & Auxiliaries, TG & auxiliaries , Power cycle / LP piping, Equipments cooling area system and Circulating water system CW etc for this project is envisaged to be controlled from the operator workstations (OWS) mounted on the Unit control Desk (UCD) in association with Large Video Screens (LVS) and backup panels in the Unit Control Room (UCR) under all regimes of operation i.e. start up, shutdown, load maneuvering, load throw off & emergency handling. All the information required for safe and efficient operation of the plant shall be displayed on OWS MONITORS at high speed and accuracy in specially designed displays suitable for Power plant operation .The quantity of OWS stations and LVS are shown in the configuration diagram and elsewhere in the specification.

It may be noted that the plant operation in all regimes even in case of emergency operation is envisaged through LVS and OWS MONITOR only. However Hardwired PB Stations / TPL switches and supervisory/monitoring instruments are envisaged for utmost emergency or the contingency and in case non availability of both i.e. operators' workstations & LVS so as to bring the unit or equipment to safe shutdown without damaging plant/equipment.

Control panel cum desk with HW annunciation windows, ILPBs, Ammeters, PBs, voltmeters, indicators, mimic, recorders etc. shall be provided as Control System Philosophy.

2.3.2.12 Protection, class of cabinets / panels, enclosures etc.

- a) All panels, desks cabinets, consoles & enclosures furnished at least comply with the requirements of protection classes as indicated below.

Ambient Temperature (outside cabinets)	Atmosphere & Pressure	Relative Humidity (RH)	Required Protection Class
Outdoor Locations			
55 degree C max.	Dirty Air @ Atmospheric Pressure	100 % Max.	IP 66***
4 degree C min.	Dirty Air @ Atmospheric Pressure	5 % Min.	IP 66***
Indoor Locations			
55 degree C max.	Air @ Atmospheric Pressure	95 % Max.	IP 54**
4 degree C min.	Air @ Atmospheric Pressure	5 % Min.	IP 54**
Air Conditioned Areas			
24±5 degree C (normal)	Air @ Atmospheric Pressure	95 % Max.	IP 32
50 degree C max.*	Air @ Atmospheric Pressure	5 % Min.	IP 32
* During air conditioning failure. ** For non-ventilated enclosures. For ventilated enclosures, protection class shall be IP 42. *** With a suitable canopy at the top to prevent ingress of dripping water.			

- b) Distribution boxes, junction boxes, cold junction compensation boxes, terminal boxes and all other field mounted equipment to be furnished as per this specification shall have weather protection conforming to IP 65.
- c) The design of panels, cabinets, enclosures and packaging density of components mounted therein shall be such that the temperature rise does not exceed 10 deg. C above the ambient under the worst conditions.
- d) The panels housing electronic hardware shall be provided with flame and smoke detectors by bidder.
- e) Enclosures for peripheral equipments like printers, etc. shall take care of noise and shall ensure minimum possible noise disturb to the working personnel.
- f) For Hazardous areas the protection class shall be in accordance with the requirements of the relevant NEC code for the location.
- g) ~~Workstations, OWS, EWS, Servers, Network Switches, Printers, and other peripherals, maximum temperature limit shall be 40 deg. C. For LVS the same shall be around 30 deg. C.~~
- h) For remote I/O cabinets mounted in non-AC areas, panel redundant AC shall be provided.
- i) Specific requirements due to corrosive applications and corrosive environment at project site shall also be considered by bidder.
- j) Delivery of all electronic panels from the manufacturer's works are subject to readiness of respective work fronts or readiness of fully covered stores.

Guards, barriers and access doors, covers of plates shall be marked to indicate the hazard, which may occur upon removal of such devices. Danger or caution signs shall be used to warn of specific hazards such as voltage or current. The marking shall be permanently affixed to the equipment.

2.3.2.13 System Documentation

Master document/drawing list along with dates within 3 months shall be submitted by bidder after award of contract for each package for approval of owner. The Bidder shall provide drawings, system overview & description, hardware/software details, Technical literature, functional & hardware schemes, bill of material, parts list, Inter connection diagrams, data sheets, erection / installation / commissioning procedures, Instruction/operating manuals, etc. for each of the C&I system/sub-systems/equipment, supplied under this package. The documentation shall include complete details of the C&I systems/sub-systems/equipment to enable review & approval by owner during detailed engineering stage and to provide information to plant personnel for Operation & Maintenance (including quick diagnostics & trouble shooting) of these C&I systems/sub-Systems/equipments at site. Following minimum documents shall be submitted by bidder during detailed engineering for review and approval:

DATA / DETAILS TO BE FURNISHED		
S.No	Description	Category
1	C&I System Design Basis Report incorporating Control philosophy / Operation philosophy / Design philosophy / Redundancy philosophy.	A
2	Codes and application standard followed for the project.	A
3	Process & Instrumentation Diagrams (PID) indicating local gauges, Transmitters, analysers for (alarm, control etc.)	A
4	Engineering documents for DDCMIS / DCS based control systems: a. Bill of Quantity for DDCMIS / DCS based system b. I / O Assignment for DDCMIS / DCS based control system including nest loading. c. Instrument Schedule with set points d. I / O List e. Drive List / Solenoid Valve List f. Annunciation List g. SOE list. h. Process mimics / graphics indicating Analog and digital parameters i. List of logs with point assignment j. Time Synchronisation System k. Historical Storage and Retrieval (HSR) system details. l. List of Displays m. Plant Performance Calculation & Optimisation package Details n. Controller partitioning Diagram o. Data sheet for HART management system p. Drive Control Philosophy & MCC Interface diagrams	A

QUALITY ASSURANCE PLAN

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									P	W	V	
1.0	INCOMING Sheet Steel (CRCA & HR)	1. Chemical Composition	MA	Chemical analysis	Sample	IS:1079 IS:513	IS:1079 IS:513	Test Certificate	3	---	2	
		2. Bend Test	CR	Mech. test	Sample	IS:1079 IS:513	IS:1079 IS:513	Log Book	2	---	---	
		3. Surface finish	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---	
		4. Waviness	MA	Visual	100%	Factory Standard	No Waviness	Log Book	2	---	---	
		5. Thickness	MA	Measurement	100%	BHEL Spec.	BHEL Spec.	Log Book	2	---	---	
		6. Mill marking	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	1	
2.0	Flats / Angles / Channels	1. Dimensions	MA	Measurement	Sample	IS:2062	IS:2062	Log Book	2	---	---	
		2. Surface Defects	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---	
		3. Straightness	MA	Measurement	100%	Factory Std.	Factory Std.	Log Book	2	---	---	
		4. Mill marking	MA	Visual	100%	IS:2062	IS:2062	Log Book	2	---	1	
3.0	Cables / Wires	1. Visual / Surface defects	MA	Visual	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---	
		2. IR and HV	MA	Electrical	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---	

LEGEND: * CR - Critical characteristics
MA - Major characteristics
MI - Minor characteristics

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									P	W	V	
		3. Conductor a) Resistance b) Size c) Sheet colour	MA MA MA	Electrical Measurement Visual	100% 100% 100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---	
		4. Type / Routine Test Certificates	MA	Verification	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	3	---	2	
4.0	Electrical Components like Annunciator Transformers Lamps Switches PBs Contactors Relays Timers Space Heaters Thermostat Indicating meters etc.	1. Verification at make and Type 2. Verification of Test Certificates 3. Operation / Functional check 4. I.R. 5. H.V. 6. Calibration 7. Pick up / Drop off Voltage	CR CR CR MA MA MA MA	Visual Scrutiny of Type / Routine T.Cs. Electrical Electrical Electrical Electrical	Sample 100% Sample+ 100% 100% 100% 100% 100%	BHEL Spec. and BOM Relevant IS Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue	BHEL Spec. and BOM Relevant IS Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue	Log Book Log Book Log Book Log Book Log Book Log Book Log Book	2 2 2 2 2 2 2	--- --- --- --- --- --- ---	--- --- --- --- --- --- ---	+ for relay & contactors only @ for all components except relays & contactors. 1

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									P	W	V		
5.0	Misc. Components like Gaskets, Terminal Blocks etc.	1. Verification of Type / Make	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---		
		2. Surface defects	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---		
		3. IR / HV on Terminal Blocks	MA	Electrical	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---		
6.0	IN PROCESS Blanking / Bending / Forming	1. Dimensions	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---		
		2. Surface defects after bending	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	---		
7.0	Nibbling / Punching	1. Cutout Sizes	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---		
		2. Deburring	MA	Visual	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---		
8.0	ASSEMBLY Frame Assembly & Sheet fixing	1. Dimensions	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2		
		2. Alignment	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2		
		3. Welding Quality	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2		
		4. Surface defects	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2		
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									P	W	V	
9.0	Pre-treatment and Painting	1. Pretreatment Process	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		2. Process parameters like bath temp. concentration etc.	MA	Measurement	Periodic	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		3. Dipping / Removal Time	MA	Measurement	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		4. Surface quality after every dip	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		5. Primer after phosphating	MA	Visual, Thickness	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		6. Putty Application & Rubbing after primer	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		7. Paint first coat	MA	Visual, Thickness	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		8. Putty Application and Rubbing after first coat of paint	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		9. Paint second coat	MA	Visual, Thickness, Scratch test Colour adhesion	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	

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									P	W	V	
10.	Panel Wiring	1. Wiring Layout	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		2. Wiring Termination (Crimped Lugs)	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		3. Ferrule numbers	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		4. Colour of wiring	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1	
		5. Size of Conductor	MA	Measurement	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1	
11.	Component Mounting	1. Correct components	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	
		2. Fixing	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	
12.	FINAL Final Inspection	1. Workmanship	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.
		2. Component layout (neatness, accessibility & safety) Mounting / Proper fixing of all components	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		3. Components identification Marking / Name plates	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	

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									P	W	V	
		5. Dimensions	MA	Measurement	100%	BHEL approved drg. / Spec., BOM	BHEL approved drg. / Spec., BOM	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.
		6. Door functioning	MA	Functional	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		7. Paint Shade	CR	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		8. Paint Thickness	CR	Measurement	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		9. Workmanship of Gaskets	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	
		10. Wiring Layout	MA	Visual	100%	BHEL approved drg.	BHEL approved drg.	Inspection Report	2	1	1	
		11. Wire Termination	MA	Pulling manually	Sample	-----	Firm termination	Inspection Report	2	1	1	
		12. Continuity	MA	Electrical	100%	-----	Continuity OK	Inspection Report	2	1	1	

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									P	W	V	
13.	TYPE TEST	Degree of Protection	CR	Mech. Protection	Sample	BHEL approved spec., drg relevant IS-13947 Part-1, IS-2148.	BHEL approved spec., drg relevant IS-13947 Part-1, IS-2148.	Type Test Certificate	3	---	1	
14	ROUTINE TEST	IR before & after HV Test	CR	Electrical	100%	BHEL approved spec., drg., BOM & relevant IS.	BHEL approved spec., drg., BOM & relevant IS.	Test Report	2	1	1	
15	FUNCTIONAL TEST	1. Control Logic Operation	CR	Electrical	100%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1	
		2. Instrument Calibration	CR	Electrical	10%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1	
		3. Temperature rise	CR	Electrical	100%	BHEL approved spec/drg. & relevant IS.	BHEL approved spec/drg & relevant IS.	Inspection Report	2	1	1	

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2.5.3.6 Calibration of Instruments

The Bidder shall carry out the calibration of instruments as indicated below by submitting the test procedure and quality assurance plan for the Owner's approval. Bidder shall also prepare detailed checklist/calibration sheets for each of the systems/equipment clearly indicating the step-by-step procedures to be carried out for calibration pre commissioning, loop checking, powering and commissioning.

The calibration of all instruments shall be checked and calibration records prepared for the Owner's use. If the instruments require recalibration, Bidder shall recalibrate the instruments and revise the calibration records and submit to the Owner.

2.5.3.7 Tests to be performed for Field Instruments

S.No	Tests to be performed
1.	Pressure Gauges
	Calibration Hydro test (1.5 times max. pr.)
2.	Pressure switches
	Calibration test / Hydro test / Contact rating test / Accuracy test / Repeatability
3.	Differential Pressure Gauges
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
4.	Differential Pressure Switches
	Calibration test / Hydro test / Contact rating test / Leak test / Accuracy test / Repeatability test.
5.	Thermometers
	Calibration / Material test / Accuracy test / Bore concentricity : $\pm 5\%$ of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
6.	Temperature switch
	Calibration / Material test / Accuracy test / Bore concentricity: 1.5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.) / Contact rating test.
7.	Resistance temperature detector assembly.
	Calibration / Material test / Bore concentricity test / Insulation test ($\leq 500 \text{ M}\Omega$ at 500V DC) As per ISA, Hydro test for TW. Bore concentricity: $\pm 5\%$ of wall thickness, Accuracy test.
8.	Thermocouple assembly
	Calibration / Material test, Insulation test ($\geq 500 \Omega$ at 500 V, DC) as per ISA, Hydro static test (1.5 times max. pr.), Bore concentricity: $\pm 5\%$ of wall thickness.
9.	Thermo wells
	Material test / Bore concentricity: $\pm 5\%$ of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
10.	Level Gauges

S.No	Tests to be performed
	Hydrostatic test / Material test / Seat leakage test / Ball check test.
11.	Level switches (Magnetic)
	Material test / Contact rating test / Hydro test / Calibration test.
12.	Flow Switch
	Material test / Hydro static test (1.5 times max. pr.) / function test.
13.	Flow glasses
	Material test / Hydrostatic test (1.5 times max. pr.) / function test.
14.	Variable area flow meters
	Calibration test / Material test / Hydrostatic test (1.5 times max. pr.)
15.	Flow element
	100% Radiography test / Hydro test / Calibration test, IBR Certificate.
	Calibration test for flow element shall be witnessed by Owner.
16.	Control valves / Pneumatic block valve / Pressure regulating valve – Refer chapter 10.
17.	Position transmitters
	Calibration / hysteresis and Accuracy test
18.	Electro Pneumatic Convertors
	Calibration test / Accuracy test
19.	Solenoid valves
	Hydro test / Seat leakage test / CV test / Coil insulation test
20.	Air filter regulators
	Calibration test / Accuracy test
21.	Junction Boxes
	Test for degree of protection / Material test
22.	Tests for terminal blocks
	Test for moulding for flame resistant, Non-hygroscopic and Decarbonised / Insulation test between terminals / Insulation between terminal block and frame.
23.	Thermocouple extension cable
	Thermo-e.m.f characteristic / Continuity test / Measurement on capacitance, inductance and loop resistance / Insulation resistance / High voltage test as per latest IS / Tensile and elongation test / Oxygen index test / Any other test applicable.
24.	Mass flow meter
	Performance test / Calibration test / Hydrostatic test.
25.	Boiler Level Gauge
	Hydrostatic test / Material test / Seat leakage test / IBR Certificate
26.	pH / Conductivity measurement / Silica / Dissolved oxygen analysers:
	Calibration test, Accuracy test
27.	Sample cooler :

S.No	Tests to be performed
	Hydro test, IBR Certificate
28.	Sampling racks :
	Hydro test, IBR Certificate for tubes and fittings.
29.	SO₂ / NO_x analyser / SPM analyser:
	Calibration test, accuracy test
30.	Interposing relay
	Functional test, temperature rise test, H.V test, Insulation test
31.	Transmitter Racks :
	Hydro test, air leak test for piping / tubing and fittings. IBR certification as required for tubing / piping and fittings.
32.	Pressure Transmitter
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
33.	Differential pressure transmitter
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
34.	Temperature Transmitter
	Calibration test / Accuracy test / Ambient temperature error test
35	Pneumatic Block Valves
	a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 Deg.C) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 Deg.C) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test
36.	Pressure Regulating Valve
	a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 Deg.C) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 Deg.C) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test
37.	Local Panels :
	Visual inspection, wiring & continuity check, H.V. and I.R. tests on panels, checking of bill of materials, functional tests.
38	Wiring Termination & Accessories

S.No	Tests to be performed
	Routine test: Conductor resistance test / High voltage test / Impulse dielectric test / insulation test / Humidity test / Temperature rise test on power circuits / short time current test on power circuits.
	Type test: Annealing test / Test for insulation and sheath / Flame retardency test - a) Oxygen index, b) Flammability / Test for acid gas generation / test for water absorption / wet dielectric test
39	Marshalling / System cabinets
	Verification of degree of protection / Electrical tests as detailed under wiring Termination & accessories / Type test and routine test as per relevant Indian standards.
	Notes:
	1. Test Certificates in addition to inspection at manufacturers works shall be furnished for all the instruments for Owner's review. 2. Above Test to be witnessed shall be finalized by Owner. 3. In addition to above test, test as per approved QAP shall also be witnessed by owner

i) Testing Types

The BIDDER shall furnish the Type test reports of all type tests as per relevant standards and codes. As well as other specifics test indicated in the specification. A list of such test are given for various equipment in table titled, Type Test Requirement for C&I System and under the item special requirement for solid state requirements/systems. For the balance equipments/instruments type test may be conducted as per manufacturer standards or if required by relevant standards.

- 1) Out of these test listed, the bidder / sub vendor / manufacturer is required to conduct certain type test specifically for this contract (and witnessed by employer or his authorized representative). Even if the same have been conducted earlier as clearly indicated subsequently such tests.
- 2) For the rest, submission of type test, results, and certificates shall be acceptable provided following points
 - a) The same have been carried out by the bidder/ sub vendor on exactly the same model/rating of equipment. (For control valves this shall be same size, type & design).
 - b) There has been no change in the components from the offered equipments and tested equipments.
 - c) The test has been carried out as per the latest standards along with amendments as on the date of bid opening.
- 3) In case the approved equipment is different from the one on which the type test had been conducted earlier or any of the above grounds, then the tests have to be repeated and the cost of such tests shall be borne by the bidder/sub-vendor within the quoted price and no extra cost will be payable by the owner on this account.

As mentioned against certain items, the test certificates for some of the items shall be reviewed and approved by the main bidder or his authorized representative and balanced have to be approved by the employer. The schedule of conduction of type test/submission of reports shall be submitted and finalized during preaward discussion.

For the type test to be conducted, bidder shall submit detailed test procedure for approval by owner. This shall clearly specify test setup, instruments to be used, procedure, and acceptance norms (wherever applicable). , recording of different parameters, intervals of recording precaution to be taken etc. for the test to be carried out.

ii) Special Requirements for Solid State Equipments /Systems

The minimum type test report, over and above the requirements of above clause which are to be submitted for each of the major C&I systems like DDCMIS, DCS etc. shall be as indicated below:

Surge Withstand Capability (SWC) for solid state equipments/equipments

1. All solid state systems/equipments shall be able to withstand the electrical noise and the surges as encountered in actual service conditions and inherent in the power plant. All the solid states systems /equipments shall be provided with all required protection that needs the surge withstand capability as defined in ANSI 37.90.1/IEEE 472. Hence, all front end cards which receive external signals like analog input and output modules, Binary input and output modules etc. including power supply, data highway, data links shall be provided with protection that meets the surge withstand capability as defined in ANSI 37.90.1/IEEE 472. Complete details of the features incorporated in the electronic system to meet this requirement the relevant test carried out, the test certificates, etc. shall be submitted along with the proposal. As an alternative to the above, suitable class of EN 61000-4-12 which is equivalent to ANSI 37.90.1/IEEE 472 may also be adapted for SWC test.
2. The dry heat test as per IEC-68-2-2 or equivalent
3. Damp heat test as per IEC 68-2-3 or equivalent
4. Vibration test as per IEC 68-2-6 or equivalent
5. Electrostatic Discharge test as per EN 61000-4-2 or equivalent
6. Radio frequency immunity test as per EN 61000-4-6 or equivalent
7. Electromagnetic Field Immunity test as per EN 61000-4-3 or equivalent

Test listed at Item no 5, 6, 7 above are applicable for electronic cards only as defined under item no. 1 Above

iii) Type Test Requirements for C&I Systems

S.No	Item	Test Requirement	Standard	Test to be specifically conducted	Owners approval required on test certificate

S.No	Item	Test Requirement	Standard	Test to be specifically conducted	Owners approval required on test certificate
1	Electrical metering instruments	As per standards	IS 1248	No	Yes
2	Thermocouple	Degree of Protection Test	IS - 13947	No	No.
3	Junction Box	Degree of Protection Test	IS - 13947	Yes	Yes
4	RTD	As per standards	IEC-60751	No	No
5	Electronic Transmitter	As per standards	BS 6447 / IEC 60770	No	Yes
6	E / P convertor	As per standards	Manufacturing standard	No	Yes
7	Instrumentation cable (Twisted and shielded) (Refer Vol. II, Chapter 8)				
8	Battery	As per standard	IS 10918	Yes	YES
9.	Voltage stabiliser	Over load test	Approved procedure	No	YES
		Temp. rise test without redundant fans	Approved procedure	No	YES
		Input voltage variation test	Approved procedure	No	YES
10	DDCMIS				
	CLCS system	Model Test	Approved procedure	No	No
	BMS & MFT	Safety requirement	VDE0116, SEC 8.7	No	YES
11	Conductivity type level switch	Degree of protection test	IS 13947	No	No
12	Local gauges	Degree of protection test	IS 13947	No	No
13	Process actuated switches	Degree of protection test	IS 13947	No	No
14	Control valves	CV test	ISA 75.02	No	YES
15	LIE / LIR	Degree of	IS 13947	YES	YES
16	Flue gas O2 analyser, other Flue	Degree of protection test	IS 13947	No	YES
17	Flow nozzles & Orifice plates	calibration	ASMEPTC BS 1042	YES	YES

Note:

VENDOR LIST

PEM REGISTERED VENDOR

Package Code	Package Name	Vendor Name	Vendor Address
145-45000-A	INSTRUMENT FITTINGS	VIKAS INDUSTRIAL PRODUCTS	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA-UTTAR PRADESH-INDIA Phone- +91-9810122070 Pincode : 201301 Email : naveensingh@vsnl.com
145-45000-A	INSTRUMENT FITTINGS	PRECISION ENGINEERING INDUSTRIES	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI-MAHARASHTRA-INDIA Phone- 022 42631700 Pincode : 400 062 Email : peiks@vsnl.com
145-45000-A	INSTRUMENT FITTINGS	HP VALVES & FITTINGS INDIA PVT. LTD.	S. Harichandran/P.S. Pandi B-11, Mugappair Industrial Estate, CHENNAI-Tamilnadu-INDIA Phone- 044 26252537 Pincode : 600037 Email : sales@hpvalvesindia.com
145-45000-A	INSTRUMENT FITTINGS	Perfect Instrumentation Control (India) Pvt. Ltd.	MD Hussain Shaikh/Shahanawaz Khan Gala No. 168, Loheki Chwal,216/ 218, Maulana Azad Rd. Nagpada Junction Mumbai-Maharashtra-INDIA Phone- 91-9324383121 Pincode : 400008 Email : shahanawaz.khan@perfectinstrumentation.com
145-45000-A	INSTRUMENT FITTINGS	PANAM ENGINEERS	Mr. Santosh Shukla 203, Jaisingh Business,Parsiwada, Sahar road,Andheri(East), Mumbai,-Maharashtra,-India, Phone- 9892179529, Pincode : 400099, Email : santosh@panamengineers.com,
145-45000-A	INSTRUMENT FITTINGS	Comfit & Valve Pvt. Ltd.	Mr. Jeetu Jain/Mr. Vinay Sosa Survey No. 23/1, Part 2, Ahmedabad-Mehsana Highway Laxmipura, Nandasan-Gujarat-INDIA Phone- 02764-267036/37 Pincode : 382705 Email : marketing@com-fit.com
145-45000-A	INSTRUMENT FITTINGS	AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI-DELHI-INDIA Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com
145-45000-A	INSTRUMENT FITTINGS	Arya Crafts & Engineering Pvt. Ltd.	Mr.Sanjay Brahman/Mr.Shyam Vazirani 102, Vora Industrial Estate No.4 Navghar, Vasai Road (E) Dist.Thane, Mumbai-Maharashtra-INDIA Phone- +91-250-2392246 Pincode : 401210 Email : arya@aryaengg.com

145-45000-A	INSTRUMENT FITTINGS	Fluid Controls Pvt. Ltd.	Sophie Y. Moochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI- MAHARASHTRA-INDIA Phone- (022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com
145-45000-A	INSTRUMENT FITTINGS	FLUIDFIT ENGINEERS PVT. LTD.	Mr. Abbas Bhola Potia Building No. 2, Office No. 3,292, Bellasis Road,Mumbai Central (East) Mumbai-Maharashtra-India Phone- 9920044113 Pincode : 400008 Email : ab@fluidfitengg.com
145-38000-A	INSTRUMENTS PIPE FITTINGS	Fluid Controls Pvt. Ltd.	Sophie Y. Moochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI- MAHARASHTRA-INDIA Phone- (022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com
145-38000-A	INSTRUMENTS PIPE FITTINGS	AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI-DELHI- INDIA Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com
145-38000-A	INSTRUMENTS PIPE FITTINGS	PRECISION ENGINEERING INDUSTRIES	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI-MAHARASHTRA- INDIA Phone- 022 42631700 Pincode : 400 062 Email : peiks@vsnl.com
145-38000-A	INSTRUMENTS PIPE FITTINGS	VIKAS INDUSTRIAL PRODUCTS	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA-UTTAR PRADESH-INDIA Phone- +91- 9810122070 Pincode : 201301 Email : naveensingh@vsnl.com
145-32000-A	INSTRUMENTS TUBE FITTINGS	VIKAS INDUSTRIAL PRODUCTS	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA-UTTAR PRADESH-INDIA Phone- +91- 9810122070 Pincode : 201301 Email : naveensingh@vsnl.com
145-32000-A	INSTRUMENTS TUBE FITTINGS	PRECISION ENGINEERING INDUSTRIES	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI-MAHARASHTRA- INDIA Phone- 022 42631700 Pincode : 400 062 Email : peiks@vsnl.com
145-32000-A	INSTRUMENTS TUBE FITTINGS	AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI-DELHI- INDIA Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com

145-32000-A	INSTRUMENTS TUBE FITTINGS	Fluid Controls Pvt. Ltd.	Sophie Y. Moochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI-MAHARASHTRA-INDIA Phone- (022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com
145-25000-A	JUNCTION BOX	FLEXPRO ELECTRICALS PVT. LTD.	Mr. Dineshbhai Zaveri C-1/ 27&37, GIDC, Kabilpore, Navsari-Gujarat-India Phone- 02637-265140,265003 Pincode : 396424 Email : flexpro@flexproltd.com
145-25000-A	JUNCTION BOX	AJMERA INDUSTRIAL & ENGINEERING WORKS	JIGNESH MAHENDRA AJMERA DENA BANK BLDG.,SHREE NAGESH INDL. ESTATE,STATION ROAD, MUMBAI-MAHARASHTRA-INDIA Phone- 022 67973578 Pincode : 400 088 Email : ajmera@ajmera.net, jmajmera@yahoo.com
145-25000-A	JUNCTION BOX	K.S.INSTRUMENTS PVT.LTD.	S Raghavan No. 72, 3rd Main, 1st Stage Industrial Suburb, Yeshwanthpur Bangalore-Karnataka-India Phone- 9880385770 Pincode : 560022 Email : sales1@ksinstruments.net
145-25000-A	JUNCTION BOX	SUCHITRA INDUSTRIES	NO-2,OPP-27 AECS LAYOUT 2ND STG REJAMAHALVILAS EXTN 2ND STG BANGALORE - Phone- Pincode : Email : suchitra.industriesblr@gmail.com
145-25000-A	JUNCTION BOX	Shrenik & Company,	Mr. Mitesh Shah/Mr. Pulin Shah 39 A/3 ,Panchratna Industrial Estate, Sarkhej-Bavla Road Ahmedabad-Gujarat-India Phone- 9825024921 Pincode : 382213 Email : sales@pustron.com, pulin@sumip.com
145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.- MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI- Maharashtra-INDIA Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com
145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	GAUGE BOURDON INDIA PVT. LTD.	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai,-Maharashtra,-India, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com,

145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	H.GURU INDUSTRIES	Mr. G. D. Hazra/Mr. P. K. Mitra 10 B, HO-CHI-MINH SARANI, KOLKATA-WEST BENGAL-INDIA Phone- 033 2282 2463 / 1637 Pincode : 700071 Email : mguru@vsnl.net
145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	32,INDUSTRIAL SUBURB YESWANTHAPUR BANGALORE-KARNATAKA-www.hgurusouth.com Phone- 080-23370300, Pincode : 560022 Email : info@hgurusouth.com
145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	FORBES MARSHALL (HYD) LTD.	MR SAILESH PATALAY/MR. M K SRINIVASAN PLOT NO.A-19/2, & T-4/2, IDA, NACHARAM, HYDERABAD-TELANGANA-INDIA Phone- 9849913704 Pincode : 500 076 Email : mksrinivasan@forbesmarshall.com
145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	BOSE PANDA INSTRUMENTS PVT.LTD.	Mr. Partha Bose 44, Saheed Hemanta Kumar Bose, Sarani, Kolkata-West Bengal-India Phone- +91 33 2548 7220 Pincode : 700074 Email : parthabosebpi@gmail.com; bosepanda@vsnl.net
145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	PRECISION MASS PRODUCTS PVT. LTD.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol-Gujarat,-INDIA Phone- 9999464663 Pincode : 382729 Email : sales@precisionmass.com
145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	A.N. INSTRUMENTS PVT. LTD.	MARKETING DIVISION, 5th FLOOR, 59-B, CHOWRINGHEE ROAD, KOLKATA-WEST BENGAL-INDIA Phone- 24757784,22472509 Pincode : 700020 Email : anidel@bol.net.in
145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	PRECISION MASS PRODUCTS PVT. LTD.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol-Gujarat,-INDIA Phone- 9999464663 Pincode : 382729 Email : sales@precisionmass.com
145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Barksdale GmbH, Germany	Michael Weileder Dorn Assenheimer, Strasse 27 Reichelsheim--Germany Phone- +91-9999107840 Pincode : D-61203 Email : msingh@barksdale.de
145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	DRESSER INDUSTRIES INC.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol-Gujarat-India Phone- 02764-233682 Pincode : 382729 Email : Nishit.patel@ashcroftindia.com

145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	INDFOS (INDIA) LIMITED	MR.L.C.VENKATRANGAN/MR.B.KANNAN New No.17, II Floor, Adwave Towers, Dr.Sevalia Shivaji Salai, T.Nagar Chennai-TamilNadu-INDIA Phone- +91 44 24353407 Pincode : 600017 Email : delhi@indfos.com
145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	GENERAL INSTRUMENTS CONSORTIUM	Mr. Amarendra Kulkarni 194/195, Gopi Tank Road, Off. Pandurang Naik Marg, Mahim Mumbai-Maharashtra-India Phone- 9323195251 Pincode : 400016 Email : amarendra@general-gauges.com
145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Kaustubha Udyog,	S.No. 36/1/1, Sinhgad Road, Vadgaon Khurd, Near Lokmat Press, Pune,-Maharashtra,-India, Phone- 020-24393577, Pincode : Email : pressure@vsnl.com,
145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	INDFOS INDUSTRIES LIMITED	B-20-21, INDUSTRIAL AREA, MEERUT ROAD, GHAZIABAD-UP-INDIA Phone- 0120-2712016 Pincode : Email : mktg@indfos.com
145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	SWITZER PROCESS INSTRUMENTS PVT. LTD.	B Kannan/V S Jayaprakash 9, SOUTH BOAG ROAD, II FLOOR, PB NO-1423, T.NAGAR, CHENNAI-TAMIL NADU-INDIA Phone- 044-24340999 / 24344 Pincode : 600017 Email : marketing@switzerinstrument.com
145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	SOR INC.	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA-KANSAS-USA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdhesh@sherman-india.com,
145-14000-A	TRANSMITTERS	Honeywell Automation India Limited	Mr. Ritwij Kulkarni 917, INTERNATIONAL TRADE TOWER, NEHRU PLACE, NEW DELHI-DELHI-INDIA Phone- 9890200584 Pincode : 110019 Email : rajesh.chaudhary@honeywell.com
145-14000-A	TRANSMITTERS	V. AUTOMAT & INSTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI-DELHI-INDIA Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com
145-14000-A	TRANSMITTERS	TOSHNIWAL INDUSTRIES PVT. LTD.,	Industrial Estate, Makhupura, Ajmer,-Rajasthan,-India, Phone- 9352009000, Pincode : 305002, Email : info@tipl.com,
145-14000-A	TRANSMITTERS	YOKOGAWA INDIA LIMITED,	PLOT NO.96, ELECTRONICS CITY COMPLEX, HOSUR ROAD, BANGALORE,-KARNATAKA,-INDIA, Phone- 080-41586000, Pincode : Email : uday.shankar@in.yokogawa.com,

145-14000-A	TRANSMITTERS	SIEMENS LIMITED	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai-Maharashtra-INDIA Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com
145-14000-A	TRANSMITTERS	EMERSON PROCESS MANAGEMENT (INDIA) PVT.LTD.	Mr. Amit Paithankar/Vikram Raj Singh 206-210,BALARAMA BUILDING 2ND FLR. BANDRA EAST MUMBAI-MAHARASHTRA-INDIA Phone- 9619121500 Pincode : 400051 Email : vikramraj.singh@emerson.com
145-14000-A	TRANSMITTERS	SMART INSTRUMENTS LTD, BRAZIL	Agents: Digital Electronic Ltd. 74/11 'C' Cross Road MIDC Andheri (East) MUMBAI-MAHARASHTRA-INDIA Phone- 28208477 Pincode : 400093 Email : corp@delbby.rpgms.ems.vsnl.net.in
145-14000-A	TRANSMITTERS	SBEM PVT. LTD.	MR.N.K. BEDARKAR/MR. VISHWANATH KARANDIK 39, ELECTRONIC CO.OP. ESTATE, PUNE SATARA ROAD PUNE,-MAHARASHTRA-INDIA Phone- 912041030100 Pincode : 411009 Email : newdelhi@sbem.co.in
145-14000-A	TRANSMITTERS	Pune Techtrol Pvt. Ltd.	N.P.Khatan/Sudhakar Badiger S-18, MIDC Bhosari, Pune-Maharashtra-INDIA Phone- 9850560042 Pincode : 411 026 Email : ho@punetechtrol.com
145-14000-A	TRANSMITTERS	PANAM ENGINEERS	Mr. Santosh Shukla 203, Jaisingh Business,Parsiwada, Sahar road,Andheri(East), Mumbai,-Maharashtra,-India, Phone- 9892179529, Pincode : 400099, Email : santosh@panamengineers.com,
145-14000-A	TRANSMITTERS	NIVO CONTROLS PVT. LTD.	Mr. Praveen Toshniwal 104-115, Electronic Complex, Indore-M.P.-India Phone- 0731-4081305 Pincode : 452010 Email : sales@nivocontrols.com
145-14000-A	TRANSMITTERS	Moore Industries International Inc.	Leonard.W. Moore/ Matt Moren 16650 Schoenborn St. North Hills-CALIFORNIA-USA Phone- +1 818 830 5548 Pincode : 91343 Email : mmoren@miinet.com
145-14000-A	TRANSMITTERS	ABB LIMITED	MR. RAJIV GOVIL 14, MATHURA ROAD, FARIDABAD-HARYANA-INDIA Phone- 09971085678 Pincode : 121003 Email : vipin.swami@in.abb.com
145-14000-A	TRANSMITTERS	Endress + Hauser (India) Pvt. Ltd.,	Mr. Prakash Vaghela 215-216, DLF Tower 'A', Jasola District Centre, New Delhi,-New Delhi,-India, Phone- 9717593001, Pincode : 110025, Email : prakash.vaghela@in.endress.com,

SI No.	Package Name	Vendor Name	LOCATION
1	LOCAL CONTROL PANELS	C and S ELECTRIC LTD.	New Delhi
		PYROTECH ELECTRONICS PVT. LTD.	Udaipur
		PROCON INSTRUMENTATION PVT. LTD.	Chennai
		INDUSTRIAL CONTROLS & APPLIANCES PVT LTD	Mumbai
2	ANALYSERS (ALL TYPES)	ABB INDUSTRIES AG	SWITZERLAND.
		ROSEMOUNT ANALYTICAL INC	IRVINE
		ENDRESS + HAUSER INDIA PVT. LTD.	MUMBAI
		HACH LANGE S.A.R.L CH-1222,	VESENAZ
		SWAN Analytische Instrumente AG, CH-8340	Hinwii
		METTLER-TOLEDO INDIA PVT. LTD.,	MUMBAI
		THERMO ORION INC	BEVERLY
3	UPS	EMERSON NETWORK POWER,	AMBERNATH
		EMERSON NETWORK POWER	PUNE
		HITACHI-HIREL,	GANDHINAGAR
		KELTRON,	TRIVANDRUM
		CONSUL NEOWATT POWER SOLUTIONS,	PUNE
5	MOTORISED ACTUATOR	ROTARK	UK
		AUMA	Bengaluru
		WEIR BDK VALVES	Hubli
		LIMITORQUE	Faridabad
6	AIR FILTER REGULATOR	PLACKA	Chennai
		SHAVO-NORGREN	Mumbai
		SCHRADER SCHORILL DUNCAN LTD.	Mumbai
		FAIRCHILD	USA
		SMC PNEUMATICS	Noida
7	SOLENOID VALVE	ASCO	USA
		ROTEX	Vadodra
		SCHRADER	Pune
		AVCON	Mumbai
		HERION-NORGREN	Germany
		IMI-NORGREN	Germany
		JAFFERSON	Argentina

Notes :-

1) The above sub-vendor list is tentative & reference only. However sub-vendor list is subject to BHEL/end user approval without any commercial/delivery implication.

2) New subvendor, if proposed by vendor during contract stage shall be subject to BHEL/end user approval without any commercial implication.

MANDATORY SPARES

|

1X800MW NORTH CHENNAI SUPERCRITICAL THERMAL POWER PROJECT
STAGE III IN THE EXISTING PREMISES OF NCTPS

ANNEXURE IV
MANDATORY SPARES

III. MANDATORY SPARES (C & I):

S No	Name/ Description of Spares	Unit	Qty
	The quantity of following spares includes a minimum of 20 % spares for replacement of each type of lamps, PBs, ILPBs, fuse, MCB, MCCB used in the equipment/system offered by him even if this is not detailed below.		
i)	~~Measuring Instruments - Indicators, Recorders, Electrical Metering and Skid Mounted Instruments~~	Lot	1
1	10% of the number of indicators, recorders and meters offered from each model for the project or a minimum of one number per model, whichever is more. These instruments shall be supplied with three sets of blank scales.		
2	For skid mounted instruments (if any) - 10% of total number of instruments for each model and type for the project or a minimum of one number for each model and type, whichever is more.		
ii)	Temperature Elements and Thermowells	Lot	1
1	10% spare thermocouple/RTD elements,	%	10%

1X800MW NORTH CHENNAI SUPERCRITICAL THERMAL POWER PROJECT
STAGE III IN THE EXISTING PREMISES OF NCTPS

ANNEXURE IV
MANDATORY SPARES

S No	Name/ Description of Spares	Unit	Qty
	suitable for replacement for each type and length of element furnished with thermocouple/RTD assemblies, or a minimum of one number of each type & length, whichever is more.		
2	10% thermo wells for each type of temperature sensors or a minimum of one for each type, whichever is more	%	10%
3	Temperature Transmitters and Electronic Transmitters (For Pressure, DP, Temp, Flow, Level), Temperature, Pressure, Flow & Level Switch, safety switches, Gauges, meters, Transducer or any other instrument etc.		
	10% of total number of instruments/transducers offered for each model and type for the project or a minimum of one number, whichever is more.	Lot.	1
iii)	Flue Gas Analyzers & CEMS	Lot	1

1X800MW NORTH CHENNAI SUPERCRITICAL THERMAL POWER PROJECT
STAGE III IN THE EXISTING PREMISES OF NCTPS

ANNEXURE IV
MANDATORY SPARES

S No	Name/ Description of Spares	Unit	Qty
	type		
12	Analyzers spares like transmitter lens and receiver lens, protection windows for transmitter & receiver, integral pressure and temperature sensors, signal processing unit, electronic modules 1 No. of each type for each type of flue gas analyzer.		
iv)	Distributed Control System and Other Electronic Systems/ Sub-Systems/ VMS / MIS / LAN / Simulator / WAN / CAAQMS and any other system as supplied as per Tender Specification etc.	Lot	1
1	Electronic modules - 10% of number for each type or minimum of 2 number for each type whichever is high.	%	10
2	Auto/Manual stations, set-point/bias stations etc.: - 10% of the number of stations offered for the project from each type or a minimum of 2 number from each model, whichever is more.		
3	Twenty percent spare replacement for each type of control logic power supply fuses, MCB, MCCB, at each current rating required for the project.	%	20
4	Ten (10) percent or 2 no. (Whichever is more) Electronic cards of each type used for Servers supplied with any control system.		

1X800MW NORTH CHENNAI SUPERCRITICAL THERMAL POWER PROJECT
STAGE III IN THE EXISTING PREMISES OF NCTPS

ANNEXURE IV
MANDATORY SPARES

S No	Name/ Description of Spares	Unit	Qty
5	10% of electric to pneumatic converters of each type utilized with automatic control system using pneumatic drives or a minimum of one of each type, whichever is more.		
6	Plug-in type keyboard - 10 nos. of each type/model and mouse - 20 nos. of each type/model.	No.	10
7	Two Nos control OWS and Two Nos. utility/Engineering OWS of each type with complete accessories & monitors.	No.	4
8	10 boxes of DVD/CD along with Five no. DVD/CD drive unit of each type.	No.	10
9	Process I/O Cards - 10% of the number of cards offered for the project from each category/model or at least 2 No. of each type/model (Whichever is more)		
10	200 mts. each set of data highway cable with adequate connectors of each type.	Sets	1
11	Five nos. hard disc drive unit of each type as offered for each system complete	No.	5
12	10% or 5 nos (whichever is more) of prefab cable connectors of each type.	No.	5
13	Ten (10) percent or five no. (Whichever is more) of cubicle power supply power supply modules of each type and rating.	No.	5
14	Ten (10) percent of the total quantity of each type of interposing/coupling relays.	Sets	1

1X800MW NORTH CHENNAI SUPERCRITICAL THERMAL POWER PROJECT
STAGE III IN THE EXISTING PREMISES OF NCTPS

ANNEXURE IV
MANDATORY SPARES

S No	Name/ Description of Spares	Unit	Qty
15	Ethernet Switches, & other communication hardware etc :- 10% of the number of hardware offered for the project from each type or a minimum of 2 number from each model, whichever is more.	No.	2
16	10% or Five no. (Whichever is more) of each type of Sensors with special cables, Power supply modules, Relay, Interface Module, and electronic modules used for vibration monitoring system.	Sets	1
17	Ten (10) percent or 3 no. of each type printer toners (whichever is more) for all printers of the total quantity of each type.	No.	3
18	2 nos. of each type 132 columns DMP printer head of the total quantity of each type.	No.	2
19	2 nos. of each type Drum for A3 sized scanner cum copies, printer 3 nos. 24" LED monitor, 1 no. 29" LED monitor and 5 nos. 22" LED monitors.	No.	2
20	Twenty (20) percent or 2 no. (Whichever is more) RJ 45 connector with box of each type.	No.	2
21	Ten (10) percent or 2 no. (Whichever is more) Hooters, Buzzers, Cooling fans of each type.	%	10
22	Interface cables 2 sets of each type/model	Sets	1
23	Power supply modules (AC to DC convertors) 10% or Five	No.	5

1X800MW NORTH CHENNAI SUPERCRITICAL THERMAL POWER PROJECT
STAGE III IN THE EXISTING PREMISES OF NCTPS

ANNEXURE IV
MANDATORY SPARES

S No	Name/ Description of Spares	Unit	Qty
	no. (Whichever is more) of each type/model		
v)	Steam and Water Analysis System (SWAS)	Sets	1
1	Ten spare high pressure reducing elements for sample flow.		
2	Four spare ion exchange columns with resin as utilized with Cation conductivity analyzers.		
3	Two nos. spare conductivity cells of each type as utilized with conductivity monitors.		
4	Two nos. spare pH flow-through type cells of each type used with pH monitors.		
5	All chemical reagents required for 12 months continuous operation of all analyzers from date of taking over.		
6	All chemical reagents required for 12months operation at the colorimetric silica analyzers from the date of taking over.		
7	One (1) no. of Electronic Modules for each type of Analyzer.		
8	Two (2) no. of each type of pressure gauge, solenoid valves, temperature gauge, Back Pressure regulating valves, 3 way grab valves, needle valves, isolation valves, PRV, flow switch, flow indicator and temperature switch, erection hardware's, valves in SWAS.		
9	Three (3) No of each type Primary coolers/secondary		

1X800MW NORTH CHENNAI SUPERCRITICAL THERMAL POWER PROJECT
STAGE III IN THE EXISTING PREMISES OF NCTPS

ANNEXURE IV
MANDATORY SPARES

S No	Name/ Description of Spares	Unit	Qty
	coolers.		
vi)	Relay Based Control Panels	Sets	1
1	10% LEDs for indicating lights shall be furnished.		
2	Three times, the one hundred percent (300% of installed) spare replacement control circuit fuses/MCB/MCCB of each current rating required shall be furnished.		
3	20% spare replacement relays modules & contactors of each type.		
vii)	Alarm Annunciation System	Sets	1
1	20% spares of each type installed shall be provided for logic modules, group card modules, power supply modules, Hooters and any other electronic module.		
2	5% spares of each size shall be provided for un-engraved window boxes complete with LED etc.		
3	20% of installed LEDs for annunciation facia windows and LEDs box assemblies offered for the project shall be provided as mandatory spares.		
4	One (1) spare annunciator hooter of each type.		
viii)	Erection hardware	Sets	1
1	Ten (10) percent of each type & Size installed instrument valve, manifold		

1X800MW NORTH CHENNAI SUPERCRITICAL THERMAL POWER PROJECT
STAGE III IN THE EXISTING PREMISES OF NCTPS

ANNEXURE IV
MANDATORY SPARES

S No	Name/ Description of Spares	Unit	Qty
	for each type, rating, model number and size of devices supplied for the project.		
2	Ten (10) percent of total number of condensate pots or four numbers whichever is higher of each type & Size installed.		
3	Ten (10) percent of each type & Size installed Fittings		
iv)	LVS	Sets	1
1	20% spare LEDs of each type & size		
2	50% spare or min 6 nos. LVS Filters		
3	3 nos. or 20% whichever is more Electronic cards of each type for LVS		
4	2 set of interfacing cables of each type & size.		
5	3 nos. or 20% whichever is more power supply modules of each type for LVS		
6	3 nos. or 20% whichever is more Cooling modules of each type		
7	2 nos. LVS controllers of each type for LVS		
x)	Master Slave Clock system	Sets	1
	As per Manufacturer's Recommendation for Three Years Continuous Operation or minimum quantities indicated (whichever is more). One no. Electronic cards (each type & model), One no. signal conditioner card (each type & model), Cubicle power supply power supply modules - Ten (10) percent or 2 nos (whichever		

1X800MW NORTH CHENNAI SUPERCRITICAL THERMAL POWER PROJECT
STAGE III IN THE EXISTING PREMISES OF NCTPS

ANNEXURE IV
MANDATORY SPARES

S No	Name/ Description of Spares	Unit	Qty
	AAQMS (Ambient Air Quality Monitoring System) system. However following Minimum mandatory spares shall be considered by bidder:-		
1	Electronic Module/Mother Board /Signal Processing Unit for each type of Analyzer.		
2	Power supply module of each type for each Type of Analyzer.		
3	UV Lamp with adopter with SO2 analyzer.		
4	Light source and detector unit for SPM, and NOX/SOX analyzer.		
5	Pump for SPM Analyzer		
6	2 no. each type of conference hall mike & speakers.		
xiii)	HMS	Sets	1
	As per Manufacturer's Recommendation for Three Years Continuous Operation and One no. Electronic cards, of each type used for Hart Management system.		
xiv)	Mandatory Spares for Control valves, Power Cylinder, Control Dampers, Actuators and Accessories		
a	Following spares shall be furnished for control valves, Power Cylinder, Control Dampers as applicable.	Lot	1
1	One set of spare control valve stem packing for each control valve.		
2	Two moulded rubber		

1X800MW NORTH CHENNAI SUPERCRITICAL THERMAL POWER PROJECT
STAGE III IN THE EXISTING PREMISES OF NCTPS

ANNEXURE IV
MANDATORY SPARES

S No	Name/ Description of Spares	Unit	Qty
	diaphragms for each control valve.		
3	One sets of each of O-rings and rubber gaskets for each control valve.		
4	100 percent qty. of lubricants for gaskets for each control valve on one year consumption basis.		
5	2 sets of limit switches and 1 set of valve positioner for each control valve.		
6	20 percent of position transmitter (4-20mA) for total qty. of control valve.		
7	One (1) set of valve trims (such as plug, stem, seat ring / cage, guide bushing, stem lock pin, packing retaining ring, etc.) for each control valve.		
8	One completes actuator of each type or min 10% for each type and size whichever is more.		
9	20 percent of Solenoid valves or min 2 no. of each type for total qty. of control valves.		
10	20% of I to P converters, Pressure regulators.		
b	Mandatory spares for each type of critical applications special control valves	lot	1
1	Soft Goods Kit Valve 1 Set		
2	Metal seat 1		
3	Seat Ring 1		
4	Spindle 1		
5	Actuator Soft Goods kit 1 Set		
6	Feedback transmitter unit 2 NOS.		
7	Electronic Position		

1X800MW NORTH CHENNAI SUPERCRITICAL THERMAL POWER PROJECT
STAGE III IN THE EXISTING PREMISES OF NCTPS

ANNEXURE IV
MANDATORY SPARES

S No	Name/ Description of Spares	Unit	Qty
	Detection System		
	Following mandatory spares along with their individual price required for maintaining boiler tube leak detection system to supply along with the package.		
1	2nos. acoustic transducer with rear connector sealed to IP-65		
2	2 nos. flexible high temperatures lead, 3metre long for acoustic transducer.		
3	2 nos. acoustic s field amplifier / processor mounted in a die cast aluminum or polycarbonate box sealed to IP-65 with mounting brackets, pairs.		
4	1 no. A/D Convertor cards/field signal interface module for 32 or more channels.		
5	1 no. Alarm relay output card.		
6	Consumables like batteries, fuses etc. for two years operation of boiler tube leak detection system		
xvi)	Mandatory spares not covered above	Lot	1

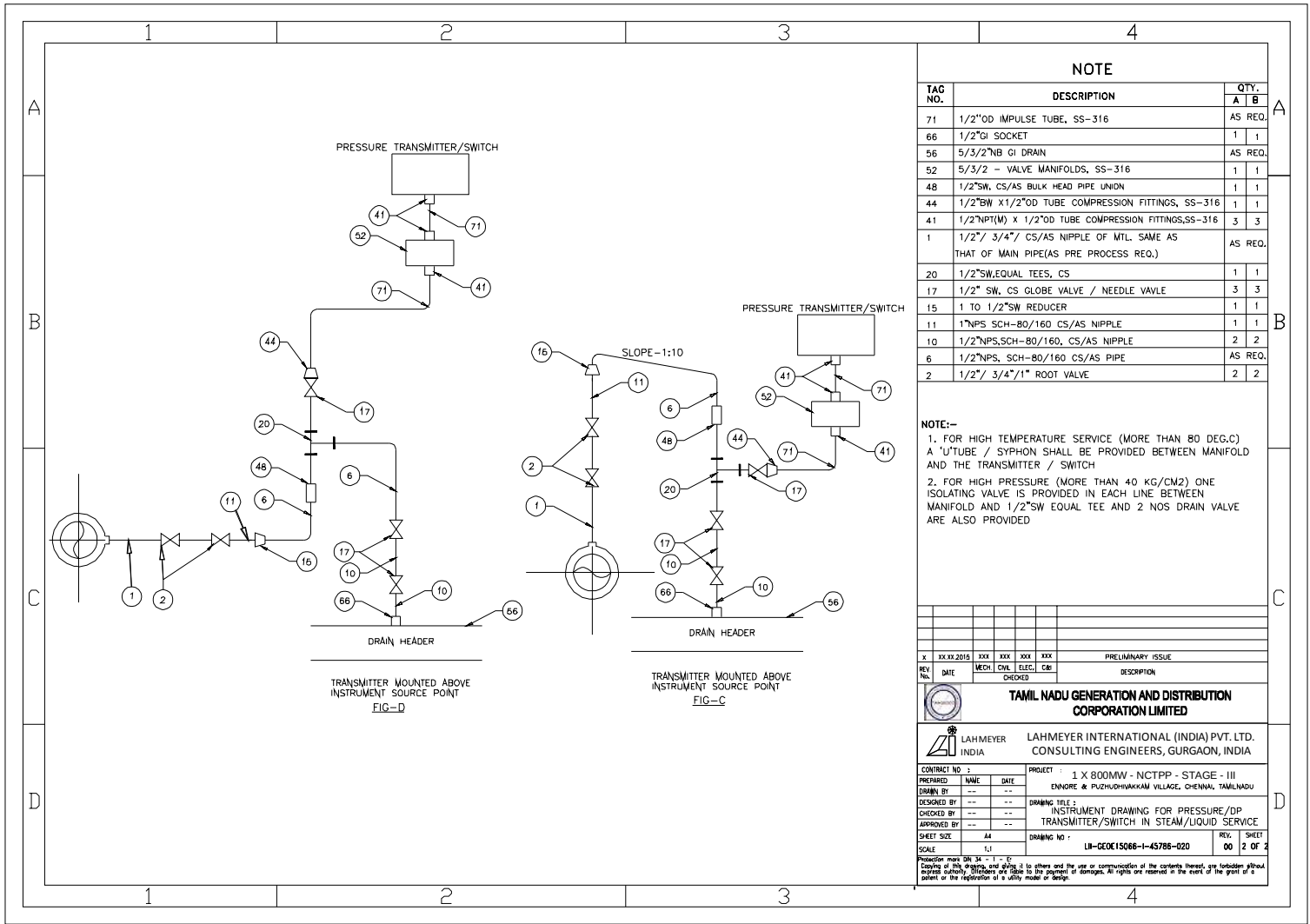
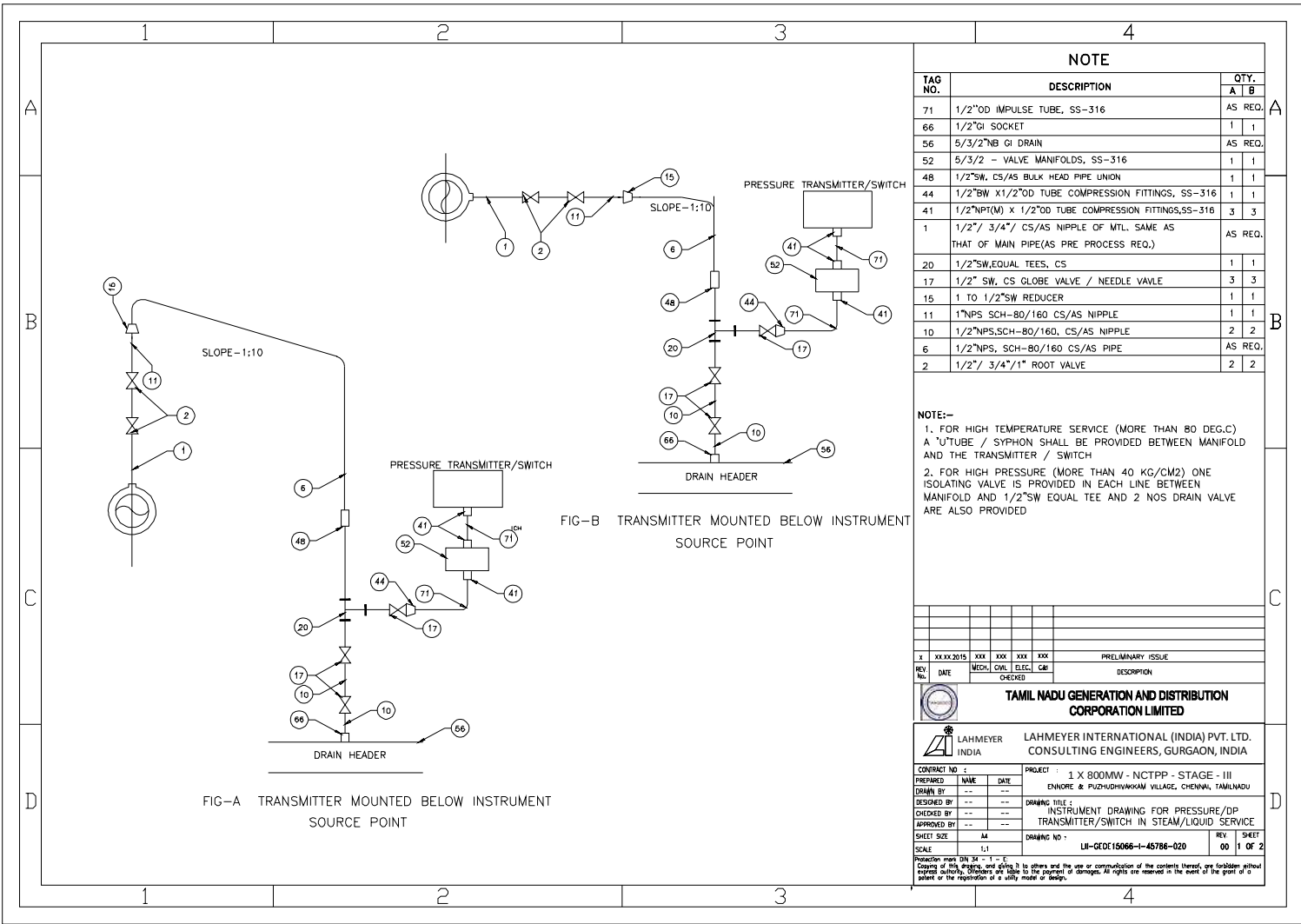
1X800MW NORTH CHENNAI SUPERCRITICAL THERMAL POWER PROJECT
STAGE III IN THE EXISTING PREMISES OF NCTPS

ANNEXURE IV
MANDATORY SPARES

S No	Name/ Description of Spares	Unit	Qty
	Bidder to supply 10% or 1 no. (whichever is more) of each type of sensor/instrument, analyzers /special instruments/Electronic card, instrumentation/mechanical fittings etc. for any other electronic system, feeder control cabinets, hydra step (EWLI), Vibration Monitoring System, CCTV, C&I Lab Instruments, On line Carbon in Ash analyzer system, On line Coal mass flow/speed measurement system, On line secondary air flow measurement system Mass Flow meter, Solid flow meter, 3 D Acoustic type level transmitters, Nucleonic & non nucleonic density transmitter etc.		
~~xvii)~~	~~Other Related Control and Instrumentation Systems/Equipments~~		
	~~Other SG related sub-systems~~		
1	Flame Monitoring System	Lot.	1
(i)	Complete Flame Scanner Assembly including scanner head assembly, scanner housing, and fiber optic cables.		20% or 4 nos. whichever is more.
(ii)	Flame Scanner Lens.		100%
(iii)	Electronic cards for scanners		10% or 2 nos. of each type whichever is more.

INSTRUMENT INSTALLATION DRAWING

|



A

B

C

D

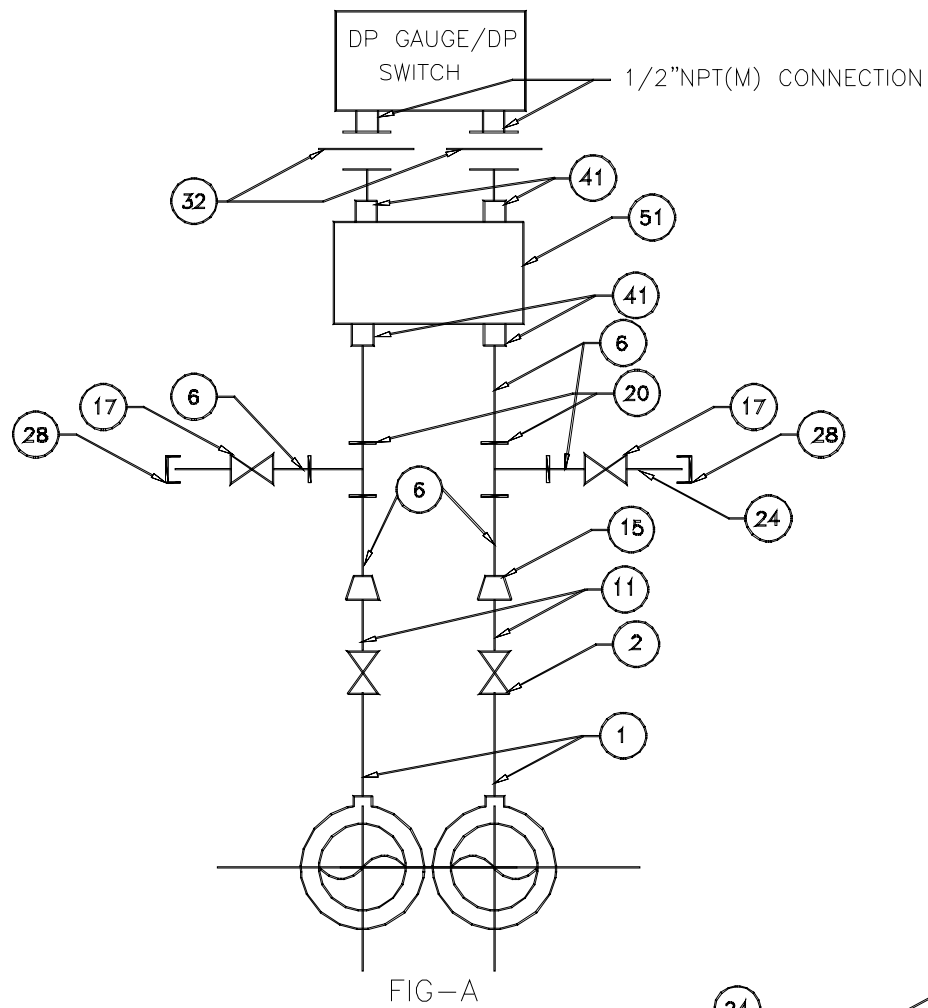


FIG-A

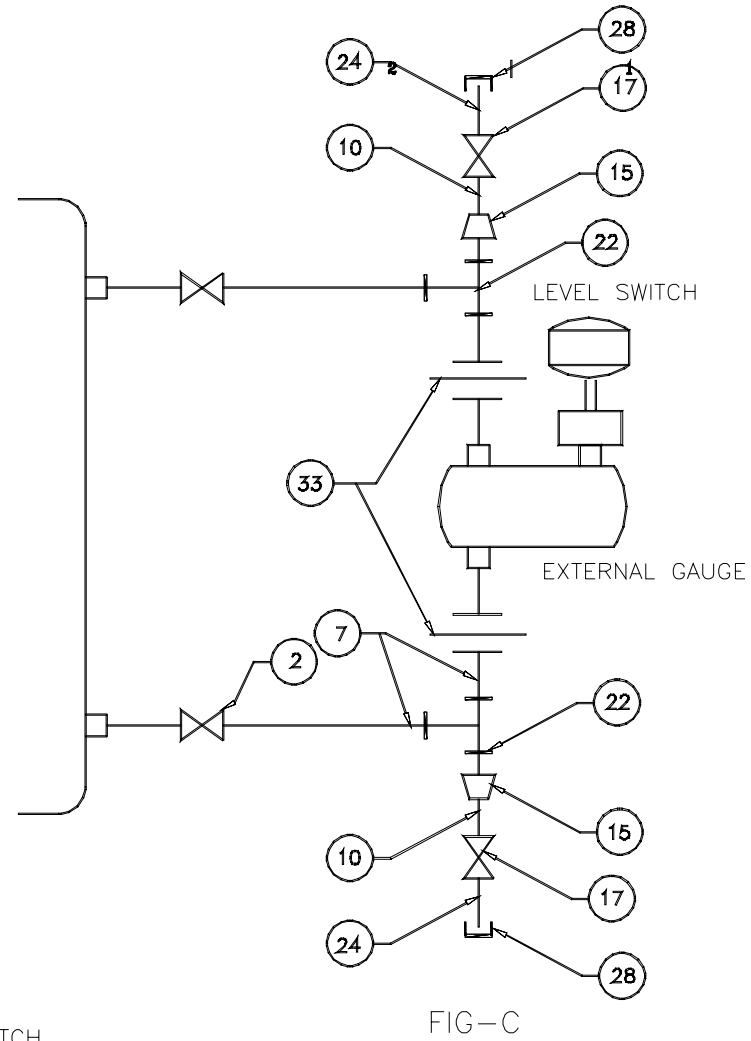


FIG-C

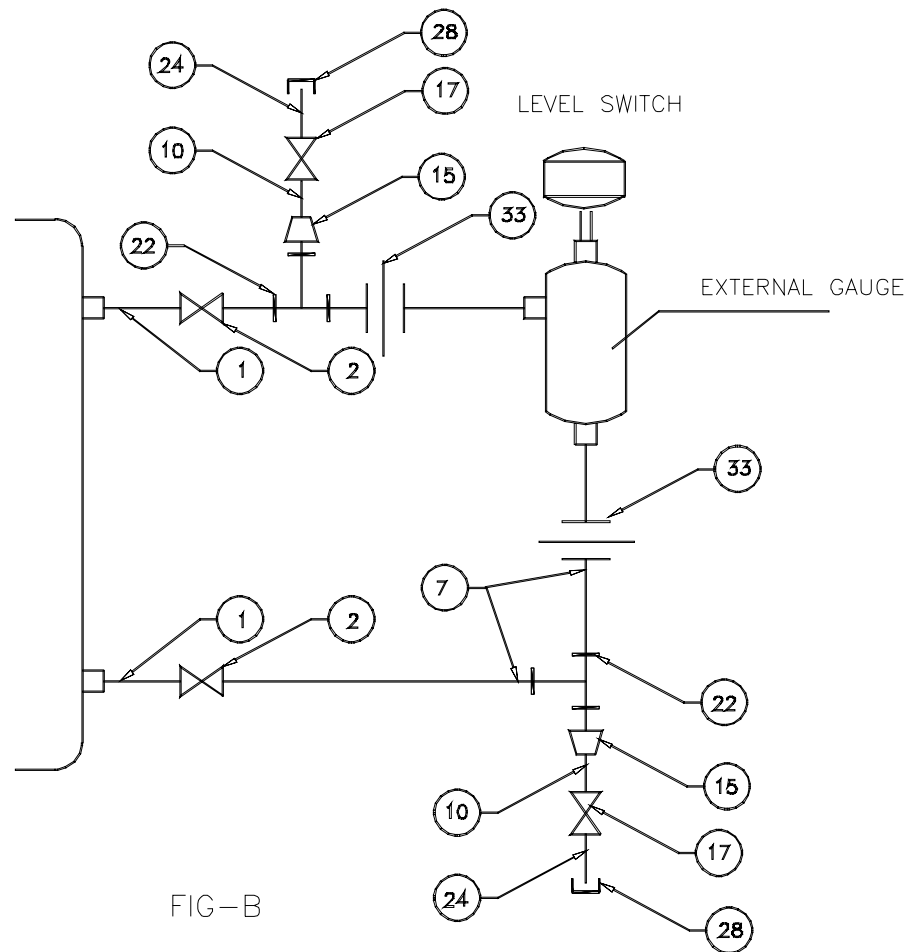


FIG-B

NOTE

TAG NO.	DESCRIPTION	QTY.		
		A	B	C
78	1/2"NPT(F)X1/2"NPT(M) SNUBBER/ PULSATION DAMPER	1	-	-
38	3-WAY GAUGE VALVE WITH 1/2" NB SW	1	-	-
32	1/2"NPS, 3 PIECE PIPE UNION WITH 1/2"NPT(F) SCREWED	1	-	-
28	1/2"NPT (f) CS CAP	1	2	2
24	1/2"NPS, SCH-80/160 X 1/2"NPT(M) CS/AS NIPPLE	1	2	2
20	1/2"SW EQUAL TEE, CS/AS	1	-	-
17	1/2"SW CS/AS GLOBE VALVE	1	2	2
1	1/2"/ 3/4"/ CS/AS NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PRE PROCESS REQ.)	AS REQ.		
15	1"TO 1/2"SW REDUCER	1	2	2
11	1"NPS SCH-80/160 CS/AS PIPE	1	-	-
6	1/2"NPS. SCH-80/160 CS/AS PIPE	AS REQ.		
2	1/2"/3/4"/1"ROOT VALVE - SW GLOBE VALVE	2	2	2
33	1"SW EQUAL PIPE UNION	-	2	2
22	1"SW EQUAL TEE CS/AS	-	1	2
10	1/2"NPS, SCH 80/160 CS/AS NIPPLE	-	2	2
7	1"NPS, SCH 80/160 CS / AS PIPE	AS REQ.		
33	1"SW EQUAL PIPE UNION	2	2	2

NOTE:-

WITH VALVE SIZE 1/2"SW NIPPLE PIECE IS NOT REQUIRED

X	XX.XX.2015	XXX	XXX	XXX	XXX	PRELIMINARY ISSUE			
REV. No.	DATE	MECH.	CIVIL	ELEC.	C&I	DESCRIPTION			
						CHECKED			



TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LIMITED



LAHMEYER INDIA

LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS, GURGAON, INDIA

CONTRACT NO :			PROJECT :		
PREPARED	NAME	DATE	1 X 800MW - NCTPP - STAGE - III		
DRAWN BY	--	--	ENNORE & PUZHUVAKKAM VILLAGE, CHENNAI, TAMILNADU		
DESIGNED BY	--	--	DRAWING TITLE :		
CHECKED BY	--	--	INSTRUMENT DRAWING FOR DP GAUGE/		
APPROVED BY	--	--	SWITCH & LEVEL SWITCH		
SHEET SIZE	A4		DRAWING NO :		REV.
SCALE	1:1		LII-GEOE15066-I-45786-013		00
					SHEET
					1 OF 1

Protection mark DIN 34 - 1 - E:
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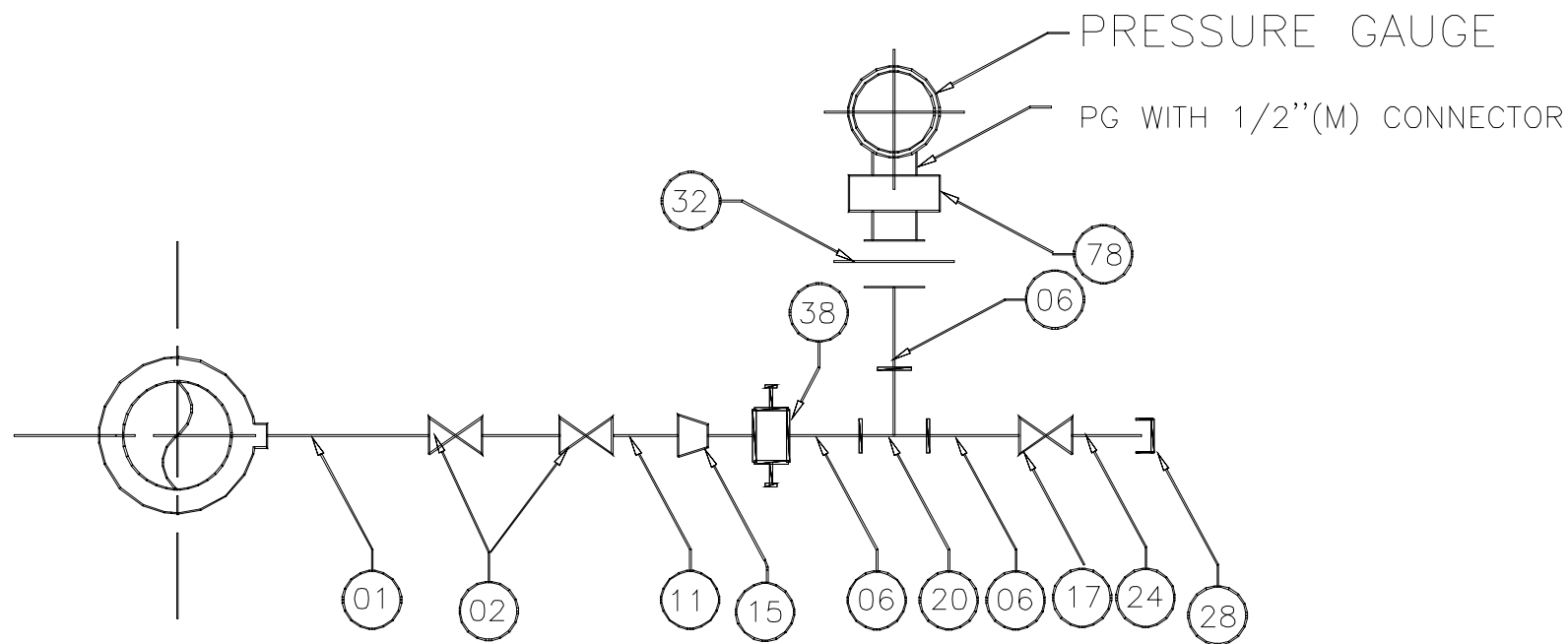


FIG-A STEAM/LIQUID SERVICE

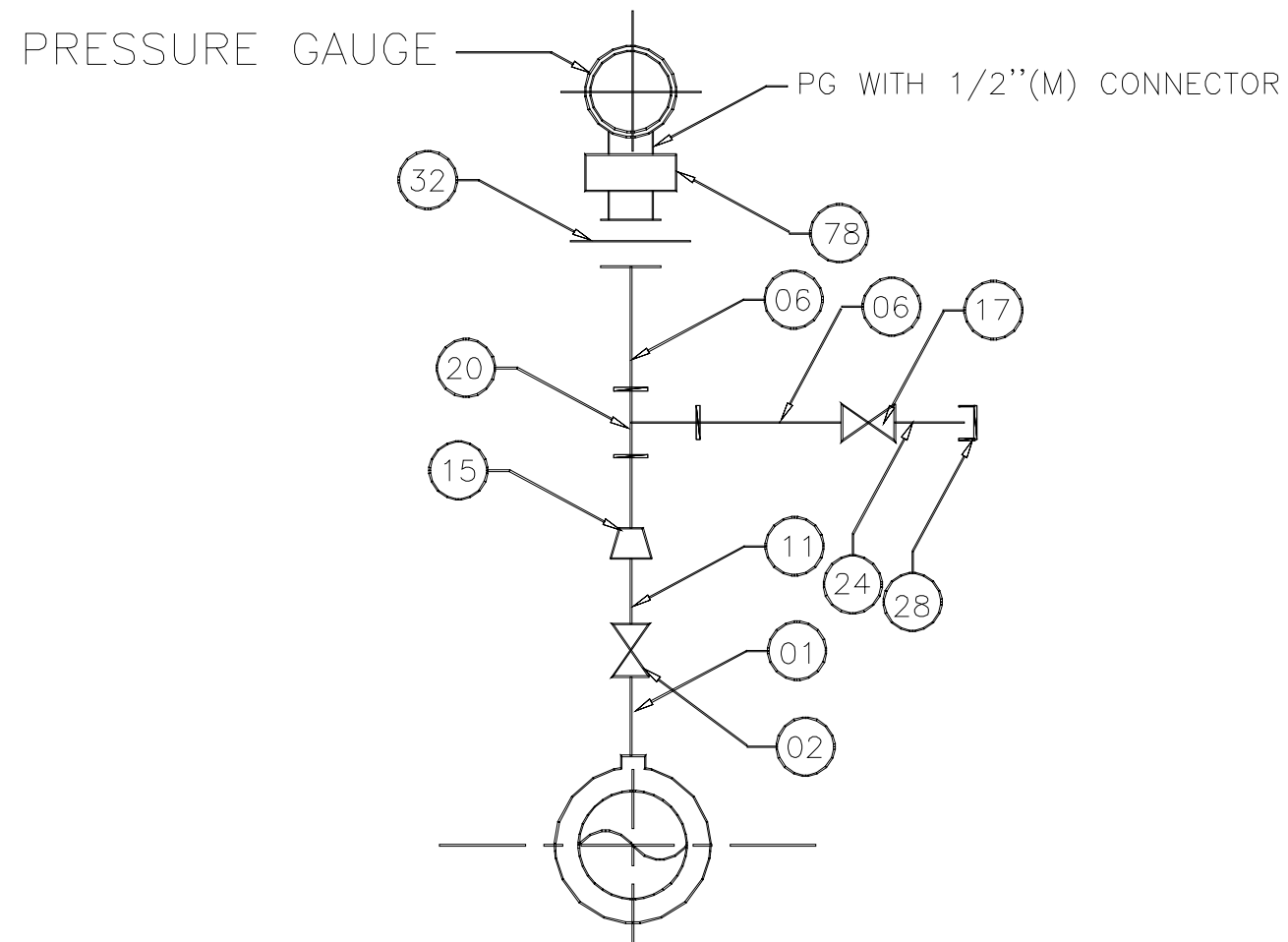


FIG-B AIR SERVICE

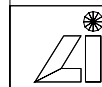
NOTE

TAG NO.	DESCRIPTION	QTY.	
		A	B
78	1/2"NPT(F)X1/2"NPT(M) SNUBBER/ PULSATION DAMPER	1	1
38	3-WAY GAUGE VALVE WITH 1/2" NB SW	1	-
32	1/2"NPS, 3 PIECE PIPE UNION WITH 1/2"NPT(F) SCREWED	1	1
28	1/2"NPT (f) CS CAP	1	1
24	1/2"NPS, SCH-80/160 X 1/2"NPT(M) CS/AS NIPPLE	1	1
20	1/2"SW EQUAL TEE, CS/AS	2	1
17	1/2"SW CS/AS GLOBE VALVE	1	1
1	1/2"/ 3/4"/ CS/AS NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PRE PROCESS REQ.)	AS REQ.	
15	1"TO 1/2"SW REDUCER	1	1
11	1"NPS SCH-80/160 CS/AS PIPE	1	1
6	1/2"NPS. SCH-80/160 CS/AS PIPE	AS REQ.	
2	1/2"/3/4"/1"ROOT VALVE - SW GLOBE VALVE	2	1

X	XX.XX.2015	XXX	XXX	XXX	XXX	PRELIMINARY ISSUE	
REV. No.	DATE	MECH.	CIVIL	ELEC.	C&I	DESCRIPTION	
		CHECKED					



TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LIMITED



LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.

CONSULTING ENGINEERS, GURGAON, INDIA

CONTRACT NO :			PROJECT : 1 X 800MW - NCTPP - STAGE - III ENNORE & PUZHUDHIVAKKAM VILLAGE, CHENNAI, TAMILNADU				
PREPARED	NAME	DATE					
DRAWN BY	--	--					
DESIGNED BY	--	--					
CHECKED BY	--	--					
APPROVED BY	--	--	DRAWING TITLE : INSTRUMENT DRAWING FOR PRESSURE GAUGE FOR STEAM/LIQUID/AIR SERVICE				
SHEET SIZE	A4		DRAWING NO : LII-GEOE15066-I-45786-004			REV.	SHEET
SCALE	1:1					00	1 OF 1

Protection mark DIN 34 - 1 - E:
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1x800 TANGEDCO NORTH CHENNAI TPP

**AIR CONDITIONING SYSTEM
TECHNICAL SPECIFICATION
(MH PORTION)**

SPECIFICATION No: PE-TS-423-553-A001

SECTION : I

SUB-SECTION : C-5

REV. 01

DATE: NOV 2017

SECTION: I

**SUB-SECTION: C-5
TECHNICAL SPECIFICATION (MATERIAL HANDLING PORTION)**



**TECHNICAL SPECIFICATION
ELECTRIC HOISTS & CHAIN PULLEY BLOCKS
1X800 MW NORTH CHENNAI TPP STAGE III**



Material Handling Equipments



**TECHNICAL SPECIFICATION
ELECTRIC HOISTS & CHAIN PULLEY BLOCKS
1X800 MW NORTH CHENNAI TPP STAGE III**



1.0 ELECTRIC HOIST AND MANUAL HOIST (CHAIN PULLEY BLOCK)

Required number of electric hoist / manual hoist of adequate capacity, to meet the erection and maintenance requirements are to be provided for the various areas.

Manual hoists (hand operated) shall be designed to duty class 2 as per IS 3832 and electric wire rope hoist shall be designed as per IS: 3938 (latest).

The stipulations of all statutory codes like Indian Electricity Act, Indian Electricity Rules, Factory Acts, Local Municipality act etc. shall however prevail over the specification requirements, in case any conflict arises between this specification and the statutory codes.

Maintenance tools and tackles shall be as per data sheet attached.

DESIGN CRITERIA

For items weighing 500 kg and above, hoists and trolleys along with monorails shall be provided throughout the plant where crane cannot be utilized. For items weighing less than 1000 kg, manual hoists shall be provided. For items weighing 1000 kg and more, electric hoists (lift & travel) shall be provided. In case the lifting height is more than 10m, electric hoist (lift & travel) shall be provided irrespective of the weight. All hoists shall be provided with trolleys.

Capacity of electric and manual (Chain pulley block) hoists shall be decided keeping 25% margin over equipment to be handled.

For hand operated hoists, the hoists shall be suitable for operation from floor level. Hand chain shall be provided for long travel of trolley and the Hoisting mechanism. The operator shall be able to control the movement of the electrical/ manual hoist with the help of floor operated pendant

MINIMUM LIFTING REQUIREMENT

S.N.	AREA DESCRIPTION	QTY (nos)	CAPACITY(T)	TYPE
1	LIST TO BE MENTIONED AS APPLICABLE			
2				
3				

Note:

1. Area, type, capacity mentioned are minimum requirement and shall be finalised during detail engineering without any commercial implication
2. Travel and Lift are layout dependent and shall be finalised during detail engineering without any commercial implication
3. Additional electric/manual hoist required during detail engineering shall be provided as per design criteria given above without any commercial implication.

2.0 SCOPE OF SUPPLIES

Equipment and services to be furnished by the bidder for the ELECTRIC HOIST/ MANUAL HOIST with accessories as per the details given in the technical specification and data sheet A. Any equipment / accessories not specified in the specification but required to make the ELECTRIC HOIST/ MANUAL HOIST complete and efficient operation shall also be under the bidder's scope of work.

Compliance with this specification shall not relieve the bidder of the responsibility of furnishing material and workmanship to meet the specified working/duty conditions.



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- 2.1.0 Electric hoist shall include but not be limited to the following: -
- a. Hoisting and CT drive arrangement
 - b. All electrical equipment including cables (as per electrical scope matrix) and panels.
 - c. PVC insulated shrouded bus bar DSL
 - d. Earthing arrangement.
 - e. Initial fill of lubricant.
 - f. Painting of electric hoist and accessories.
 - g. Maintenance Tools & Tackles (as per attached list at SI No-11 below)
 - h. Erection & Commissioning spares
 - i. Isolating switch in enclosure at operating floor for disconnecting supply to DSL while maintaining the electric hoist.
- 2.2.0 Erection and Commissioning spares (ELECTRIC HOIST)
The Bidder shall also supply erection & commissioning spares along with his main equipment as per his experience, for replacement of damaged or unserviceable parts during the execution of the project at site, to avoid delay in the project schedule. This shall form part of the main equipment supply. The Purchaser shall retain the unutilized commissioning spares. The initial fill of lubricants, oil etc. shall also be supplied by the bidder.
- 2.3.0 Services to be provided by the bidder
Packing, forwarding and transportation to site, storage and handling at site.
- 2.4.0 Erection and Commissioning
- 2.5.0 Functional test (Overload testing, load testing at rated speed, travel and hoisting motion checks as per relevant Indian standards)
- 2.6.0 Obtaining clearance and acceptance certificate from the concerned competent authority after site test as applicable. Necessary fees/expenditure as required shall be borne by the supplier.

3.0 Inspection and Testing

As per enclosed reference quality plan and as per IS 3938 (latest revision). Prime inspection agency shall be Consultant/ End Customer. Equipment supplied shall be strictly in accordance with nomenclature & technical specification. Any additional testing requirement/CHP (Customer Hold Point) at any stage of inspection deemed necessary by Consultant/ End Customer during detailed engineering shall be carried out without any commercial or technical implication.

4.0 Works Excluded

Supply of ISMB monorail.

5.0 PAINTING SPECIFICATION

As per painting details specified elsewhere in specification.

6.0 PACKING

In general packing shall be wooden box packing.

7.0 TESTING AT VENDOR'S WORKS

Hoist along with its drives, controls and other accessories shall be demonstrated for the rated capacity against the rated speed of motions and for the service conditions specified as specified in QAP and as per IS 3938 for electric hoist and IS 3832 for manual hoist.

The bidder shall have the full responsibility for the safe and efficient operation of the hoist with associated accessories as a single unit.

If the shop performance tests indicate the failure of any of the components to achieve the guaranteed



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performance, the deficiency shall be made good at bidder's cost.

Demonstration tests shall be carried out each time after the rectification /modification is carried out.

8.0 MAKE OF SUB - VENDOR ITEMS

Makes of bought out items will be as per list specified in the specification. No other make will be acceptable, until and unless specifically got it approved by the purchaser/ end client. (Refer annexure-I)

9.0 TESTING AT SITE

A) ELECTRIC HOIST:

As required for statutory clearance for operating at site i.e., overload test, load test and other tests as per IS 3938.

Test for Operation -After the supply has been connected, tests shall be carried out to prove the following:

- a) The satisfactory operation of each controller, switch, contactor, relay and other control devices and in particular the correct operation of all limit switches under the most unfavorable conditions;
- b) The correctness of all circuits and interlocks and sequence of operation; and
- c) The satisfactory operation of all protective devices.

Overload Test -After test but before the hoist is put into service, it shall be tested with overload relays appropriately set, to lift and sustain a test load of 125 percent of the working load. During the overload test, the hoist shall sustain the load under full control. The specified speeds need not be attained but the hoist shall show itself capable of dealing with the overload without difficulty.

B) MANUAL HOIST:

As required for statutory clearance for operating at site with following minimum test i.e., overload and load test.

10.0 TECHNICAL DATA SHEET:

A) Technical data sheet-A for ELECTRIC HOIST:

Sl.no	DESCRIPTION	TECHNICAL PARTICULARS
1.0	Type	Steel wire electric hoist with electrically operated trolley
2.0	Scope (Qty., Capacity, Lift, Travel Length)	Refer the separate Annexure A.
3.0	Type of service	Indoor
4.0	Overload test	125% of SWL
5.0	Design Ambient temperature	50° C
6.0	General Design	As per IS: 3938 / 1983 or latest, Class-II duty
7.0	Operating speed	
7.1	Hoisting speed/ Creep speed (thru' VVVF drive)	3 Mtr per min/ creep speed 10% of main speed.
7.2	Trolley speed	6 Mtrs per min
8.0	Type of transmission	Through Electric motor and gear box.
9.0	Wire Rope	



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9.1	Construction / core	6 x 36 or 6 x 37 construction, steel core
9.2	Code	IS:2266
9.3	Number of falls	Min. 4
9.4	Factor of safety	Not less than 5
10.0	Load Hook and block	NORMALISED HOOK ONLY
10.1	Type of load hook	Plain shank trapezoidal section with safety latch.
10.2	Load hook Code	IS: 15560
10.3	Load hook Material	Alloy steel/carbon steel as per IS:15560
10.4	Hook suspension	Thrust bearing
10.5	Material of block suspension	Fabricated from steel plate, Material: IS: 2062
11.0	Gearing	
11.1	Type	Spur / Helical, hardened and tempered with machine cut teeth
11.2	Gear material	Forged steel as per IS 3938
11.3	Lubrication	Oil splash/ grease lubricated
11.4	Bearing type	Antifriction Ball / Roller
12.0	Trolley drive	
12.1	Wheel	Single flange taper thread
12.2	Wheel conform to (Std. / code)	IS: 3938
12.3	Wheel material	Heat treated carbon steel/ low alloy steel, graded cast iron.
12.4	Bearing type	Antifriction Ball / Roller
12.5	Trolley type	Rolled structural steel with side plates extended beyond wheel flanges to protect wheels.
12.6	Hardness	Max hardness 200 BHN
13.0	SHEAVE	
13.1	Material	Cast steel or mild steel.
13.2	Bearing type	Antifriction Ball / Roller.
14.0	BRAKE (HOIST)	
14.1	Type	DC EM brakes disc type (fail to safety).
14.2	Capacity	As per IS 3938.
14.3	Number	One number for each motor.
15.0	BRAKE (TROLLEY)	



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15.1	Type	DC EM brakes disc type (fail to safety).	
15.2	Capacity	As per IS 3938.	
15.3	Number	One number for each motor	
16.0	ROPE DRUM		
16.1	Material	Cast steel or mild steel.	
16.2	Flange / Flangeless	Flanged	
16.3	Type of groove	As per manufacturers standard to suit the layout requirement.(Shall be decided during detail engineering)	
17.0	TYPE OF DSL		
17.1	CT travel	PVC shrouded Cu conductor bus bar	
18.0	MOTORS		
18.1	Type	Sq. Cage induction, TEFC, S4 duty, 60% CDF.	
18.2	Number of start	300starts / hr, Motors shall be suitable for direct on-line (DOL) starting	
18.3	Voltage , Phase and Frequency	415V $\pm$ 10%, 3 phase, 50 Hz	
18.4	Class of insulation	Class "F" and temperature rise limited to class B.	
18.5	Type of enclosure	TEFC	
18.6	Degree of protection provided for enclosure	IP-55	
18.7	Margin	10% over maximum continuous load demand of driven equipment under entire operating range including voltage and frequency variation.	
19.0	LIMIT SWITCHES	Hoisting	Trolley
19.1	Type	Snap action, self actuating type	One (1) no. two way limit switch
20.0	Control panel	* Fabricated from CRCA sheet steel not less than 2 mm thick * Degree of protection shall be IP 54. * Power on indicating lamps shall be provided * Panel illumination lamps operated by door switch. * 2 nos earthing terminals on panel. * 20 % spares terminals (clip on type) shall be provided. * Power and control terminals (clip on type) shall be on separate channels. * Gland plate thickness shall be minimum 3mm. * Gland plate shall be double brass compression type.	
20.1	Qty	1 No.	
21.0	Pendent Push buttons	Up /down / forward / Reverse push buttons. Indicative marking for easy operation shall be provided.	
22.0	Power cables	Copper material, minimum size : 6 mm sq ,FRLS insulated, multi strand Copper PVC sheathed armoured	



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		cable(for fixed cable) and EPR insulated CSP sheathed cable (for flexible cable)
23.0	Control cable	Control cables shall have stranded copper conductor, Minimum size 2.5 mm sq. FRLS—insulated, multi strand Copper PVC sheathed armoured cable(for fixed cable) and EPR insulated CSP sheathed cable (for flexible cable) Minimum size 1.5 mm sq.
24.0	Control Voltage	110 V

B) MANUAL HOIST (CHAIN PULLEY BLOCK):

DATA SHEET-A

- 1.00.00 Type : Chain pulley block with/ without travelling trolley
- 2.00.00 Area : **As per requirement**
- 3.00.00 Design : IS: 3832, IS: 2429, IS 15560, IS 210, IS 4367, IS 6216, IS: 4460. (All standards shall be of latest revision)
- 4.00.00 Duty Class as per IS:3832 : Class –II
- 5.00.00 Hoisting Mechanism
- a) Type : Hand operated gear transmission
- b) Type of gear : Spur / Helical
- c) Load Chain :
i) Type : Link type
ii) Material : Alloy steel grade 80 as per IS: 6216
iii) Conforms to (Std./Code) : IS: 6216
- d) Hand Chain :
i) Type : Link type
ii) Material : Mild steel (grade 30) as per IS 2429 Part II
- e) Load Hook & Hook Block :
i) Type of load hook : Plain shank- Trapezoidal section
ii) Load hooks conform to : IS: 15560
/ Material
iii) Type of hook suspension : Swivelling
iv) Type of make of bearing : Thrust ball bearing of hook suspension
- f) Gears/pinion :
i) Type : Spur/ Helical
ii) Material : Alloy steel / Carbon Steel
iii) Type of bearing used : Antifriction ball bearing / Roller
- g) Sprockets



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- i) Type of bearings used : Antifriction ball bearing / Roller
- h) Method of lubrications Used
 - i) Bearings : Grease
 - ii) Gearing & Pinions : Grease
 - iii) Sprockets : Grease
- i) Brakes
 - i) Type : Ratchet and pawl arrangement along with screw and friction disc type
- 6.00.0 Trolley & Bridge Drive
 - a) Trolley
 - i) Type : Geared (Manually operated)
 - ii) Material of frame : Rolled structural steel (IS:2062 Grade A or B)
 - b) Drive Chain
 - i) Type : Link type
 - ii) Material : Steel Gr.30
 - c) Trolley Wheel
 - i) Number of pairs of wheel : Two/four
in each trolley/bridge
 - ii) Flange : Single flanged
 - iii) Wheel material : As per IS 3832
 - iv) Type of bearings need : Antifriction
 - d) Gears
 - i) Type : Spur / helical
 - ii) Material : Alloy/ Carbon steel/ High graded cast iron (Material confirming to IS 3832)
 - iii) Type of bearings used : Antifriction
 - e) Method of lubrication for
 - i) Bearings : Grease
 - ii) Sprockets : Grease
 - f) Load chain wheel (Load chain wheel shall be part of hoisting mechanism)
 - i) Material : SG iron/ Steel casting/IS 3832
 - g) Hand chain wheel
 - i) Material : SG iron/ Steel casting/Grey iron Casting./IS 3832

11.0 Maintenance Tools and Tackles

One (1) complete unused new set of special purpose tools, tackles and accessories along with detailed instructions and maintenance manual shall be supplied. Tools shall be of suitable sizes for maintenance of electric hoist of each type and capacity. Each tool and wrench shall be stamped so as to be identified easy for its use. The tools shall be supplied in steel toolbox and with a copy of instruction manual. The items supplied shall be of the best quality, specially protected against rusting. The following shall be provided as minimum requirement:

S-No.	Description	Qty.
1	Complete set of ring spanners (Indicate the sizes offered)	1 Set
2	Complete set of screwdrivers (Indicate the sizes)	1 Set
3.	Adjustable Spanner	1 No.



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4.	Insulated plier	1 No.
5.	Grease gun	1 No.
6.	Oil gun	1 No.
7.	Line tester	1 No.

Note: -The tools shall be supplied in one tool box .Bidder shall ensure that the tools & tackles mentioned in above list are sufficient to handle all sizes/capacities of hoists & in case any other /additional tool is required for handling/maintenance any size/capacity of hoist the same shall be included in this list.

12.0 DRAWING/DOCUMENT SUBMISSION

The successful bidder shall submit the following drawings / documents during detail engineering for customer's approval /information:

A) ELECTRIC HOIST

SI. No.	BHEL DRG.NO	DRAWING TITLE
1	PE-V0-423-553-A100	Manufacturing Quality Plan with Sub vendor list
2	PE-V0-423-553-A101	GA Drawing for Electric Hoist, DSL arrangement and painting details
3	PE-V0-423-553-A102	Schematic Circuit Diagram
4	PE-V0-423-553-A103p	Mechanism Sizing Calculation
5	PE-V0-423-553-A104	Detailed BOM/BOQ for crane
6	PE-V0-423-553-A105	O & M Manual
7	PE-V0-423-553-A107	Erection procedure

B) MANUAL HOIST (CHAIN PULLEY BLOCK):

SI. No.	BHEL DRG.NO	DRAWING TITLE
1	PE-V0-423-553-A200	Manufacturing Quality Plan
2	PE-V0-423-553-A201	GA Drawing for Chain Pulley Block with detail BOM with painting details
3	PE-V0-423-553-A202	O & M Manual

Notes:

1. The above drawing list is tentative and shall be finalized with the successful bidder after placement of order.
2. Drawings shall be prepared in Auto-Cad latest edition. Required no. of hard and soft copies (editable) of the drawings shall be furnished as per requirement specified elsewhere in the specification.
3. All the drawings and documents including general arrangement drawing, data sheet, calculation etc. to be furnished to the customer during detailed engineering stage shall include / indicate the following details for clarity w.r.t. Inspection, construction, erection and maintenance etc.:-
 - a) All drawings and documents shall indicate the list of all reference drawings including general arrangement.
 - b) All drawings shall include / show plan, elevation, side view, cross - section, skin section, blow - up view; all major self-manufactured and bought out items shall be labeled and included in BOQ / BOM in tabular form.



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- c) Painting schedule shall also be made as a part of general arrangement drawing of each equipment / items indicating at least 3 trade names.
- d) All the drawings required to be furnished to customer during detailed engineering stage shall include technical parameters, details of paints and lubrication, hardness and BOQ / BOM in tabular form indicating all major components including bought out items and their quantity, material of construction indicating its applicable code / standard, weight, make etc.
- e) Drawings/ documents to be submitted for purchasers review/ approval shall be under Revision A, B, C... etc. while drawings /documents to be submitted thereafter for customer's approval after purchaser's approval shall be under R-0, 1, 2, 3 etc.

13.0 MANDATORY SPARES: No Mandatory Spares are applicable for Electric Hoist and Chain Pulley Blocks.

14.0 MAKES: Following makes of Electric hoists & Chain Pulley Blocks are acceptable:

CHAIN PULLEY BLOCK	TUOBRO FURGUSON (INDIA) PVT LTD	Approved
	TRACTEL TIRFOR INDIA PVT. LTD.	Approved
	HERCULES HOISTS LTD.	Approved

ELECTRIC HOIST	Alpha Services	Submit Credentials
	Grip Engineers Pvt. Ltd.,	Submit Credentials
	ARMSEL MHE PVT. LTD	Submit Credentials
	Mangla Hoists Pvt Ltd	Submit Credentials
	CONSOLIDATED HOISTS PVT LTD	Approved
	LIFTING EQUIPMENTS and ACCESSORIES	Submit Credentials
	REVA INDUSTRIES LTD.	Approved
	TUOBRO FURGUSON (INDIA) PVT LTD	Approved
	EDDY CRANES PVT. LTD.	Approved
	CENTURY CRANE ENGINEERS PVT. LTD.	Submit Credentials
	HERCULES HOISTS LTD.	Approved

ANNEXURE-I

MAKES OF SUB VENDORS ITEMS AS APPLICABLE TO ELECTRIC HOIST:

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
1.	STEEL	SAIL		
		TISCO		
		JINDAL		
		ESSAR		
2.	HOOKS	STEEL FORGING & ENGG. CO.,	KOLKATA	
		SIMRITI FORGING		



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SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		KARACHIWALA		UP TO 25T CAPACITY
3.	GEAR COUPLINGS	ALLIANCE		
		FLEX-TRANS (formerly known as HICLIFF)		
		SAHARA		
		NUTECH		
		OEM		
4.	WIRE ROPE	USHA MARTIN		
		FORT WILLIAMS		
		BHARAT WIRE ROPES		
5.	BEARINGS	SKF		
		FAG		
		TATA		
		NBC		
6.	MOTORS	SIEMENS		
		NGEF (up to 15KW)		
		CROMPTON		
		KIRLOSKAR		
		BHARAT BIJLI		
		MARATHON		
		ABB		
		LHP		
7.	BRAKES	ELECTROMAG		
		SPEED-O- CONTROL		
		BCH		FOR DCEM BRAKES ONLY
		KAKKU		
		PETHE		
8.	CONTACTOR	SIEMENS		
		L&T		
		SCHNEIDER (Earlier TELE MECHANIQUE)		
		BCH		
9.	OVER LOAD RELAYS	SIEMENS		
		L&T		
		ABB		
		SCHNEIDER (Earlier TELE MACHANIQUE)		
10.	HRC FUSES	SIEMENS		
		L&T		
		ENGLISH ELECTRIC		
		GE POWER		
		EATON (BUSSMANN)		
		ABB		
11.	ISOLATING SWITCH	SIEMENS		
		L&T		
		CONTROL & SWITCH GEAR		



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SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		ABB		
12.	SWITCH FUSE UNITS	SIEMENS		
		L&T		
		CONTROL & SWITCH GEAR	-	
		ABB		
13.	TIME DELAY RELAYS	SIEMENS		
		L&T		
		ABB		
		BCH		
		SCHNEIDER (Earlier TELE MACHANIQUE)		
14.	TRANSFORMERS	INDCOIL		
		LOGICSTAT		
		KAPPA		
		AUTOMATIC ELECTRIC		
		PRECISE ELECTRICALS		
		SILKAAN ELECTRIC MFG. CO. LTD.		
		SOUTHERN ELECTRIC		
		NEC		
15.	CABLE LUGS (HEAVY DUTY)	DOWELLS		
		UML ENGINEERS	KOLKATA	
		JAINSON		
16.	PVC POWER CABLES	APAR INDUSTRIES LTD.	MUMBAI	
		CORDS CABLE INDUSTRIES LTD.	NEW DELHI	
		DIAMOND POWER INFRASTRUCTURE LTD	VADODARA	
		GOYOLENE FIBRES (INDIA) PVT.LTD	MUMBAI	
		GOVIND CABLE INDUSTRIES	KOLKATA	
		GUPTA POWER INFRASTRUCTURE LIMITED	BHUBNESWAR	
		HAVELLS INDIA LIMITED	NOIDA	
		KEI INDUSTRIES LTD.	NEW DELHI	
		KRISHNA ELECTRICAL INDUSTRIES LTD	GWALIOR	
		KEC INTERNATIONAL LIMITED	MUMBAI	
		MANSFIELD CABLES COMPANY LTD.	NOIDA	
		NICCO CORPORATION LTD.	KOLKATA	
		PARAMOUNT COMMUNICATIONS LTD.	NEW DELHI	
		POLYCAB WIRES PVT. LTD.	MUMBAI	
		RADIANT CORPORATION PRIVATE LIMITED	HYDERABAD	



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SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		RAVIN CABLES LIMITED	MUMBAI	
		SUYOG ELECTRICALS LTD.	VADODARA	
		SRIRAM CABLES PVT. LTD.	NEW DELHI	
		SCOT INNOVATION WIRES AND CABLES PVT. LTD.	SOLAN	
		SAM CABLES & CONDUCTORS (P) LTD	UDHAM SINGH NAGAR	
		THERMO CABLES LTD	HYDERABAD	
17.	PVC CONTROL CABLES	ADVANCE CABLE TECHNOLOGIES (P) LTD	BANGALORE	
		APAR INDUSTRIES LTD., CMI LTD	MUMBAI	
		CMI LIMITED	FARIDABAD	
		CORDS CABLE INDUSTRIES LTD	NEW DELHI	
		CRYSTAL CABLE INDUSTRIES LTD	KOLKATA	
		DELTON CABLES LTD	NEW DELHI	
		DIAMOND POWER INFRASTRUCTURE LTD	VADODARA	
		ELKAY TELELINKS LTD	NEW DELHI	
		GEMSCAB INDUSTRIES LTD	NEW DELHI	
		GOVIND CABLE INDUSTRIES	KOLKATA	
		GUPTA POWER INFRASTRUCTURE LIMITED	BHUBNESWAR	
		HAVELLS INDIA LIMITED	NOIDA	
		INCOM CABLES (P) LTD	NEW DELHI	
		KEI INDUSTRIES LTD	NEW DELHI	
		KRISHNA ELECTRICAL INDUSTRIES LTD	GWALIOR	
		KEC INTERNATIONAL LIMITED	MUMBAI	
		MANSFIELD CABLES COMPANY LTD	NOIDA	
		NICCO CORPORATION LTD	KOLKATA	
		PARAMOUNT COMMUNICATIONS LTD	NEW DELHI	
		POLYCAB WIRES PVT. LTD	MUMBAI	
		RAVIN CABLES LIMITED	MUMBAI	
		SUYOG ELECTRICALS LTD	VADODARA	
		SPECIAL CABLES PVT. LTD	NEW DELHI	
		SCOT INNOVATION WIRES AND CABLES PVT. LTD	SOLAN	
		SAM CABLES & CONDUCTORS (P) LTD	UDHAM SINGH NAGAR	
		SPM POWER & TELECOM PVT. LTD	HYDERABAD	
		TORRENT CABLES LTD	AHMEDABAD	



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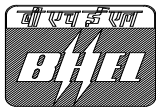
SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		THERMO CABLES LTD	HYDERABAD	
		TIRUPATI PLASTOMATICS PVT. LTD	JAIPUR	
		UNIVERSAL CABLES LTD	SATNA	
18.	TRAILING CABLES	NICCO	KOLKATA	
		UNIVERSAL	SATNA	
		INCAB		
		ICL	NEW DELHI	
		APAR INDUSTRIES LTD	MUMBAI	
		CMI LTD	FARIDABAD	
		KEI INDUSTRIES LTD	NEW DELHI	
		SUYOG ELECTRICALS LTD	VADODARA	
19.	XLPE POWER CABLES	APAR INDUSTRIES LTD	MUMBAI	
		CORDS CABLE INDUSTRIES LTD	NEW DELHI	
		CRYSTAL CABLE INDUSTRIES LTD	KOLKATA	
		DIAMOND POWER INFRASTRUCTURE LTD	VADODARA	
		GEMSCAB INDUSTRIES LTD	NEW DELHI	
		GOVIND CABLE INDUSTRIES	KOLKATA	
		GUPTA POWER INFRASTRUCTURE LIMITED	BHUBNESWAR	
		HAVELLS INDIA LIMITED	NOIDA	
		KEI INDUSTRIES LTD	NEW DELHI	
		KRISHNA ELECTRICAL INDUSTRIES LTD	GWALIOR	
		KEC INTERNATIONAL LIMITED	MUMBAI	
		MANSFIELD CABLES COMPANY LTD	NOIDA	
		PARAMOUNT COMMUNICATIONS LTD	NEW DELHI	
		POLYCAB WIRES PVT. LTD	MUMBAI	
		RAVIN CABLES LIMITED	MUMBAI	
		SUYOG ELECTRICALS LTD	VADODARA	
		SPECIAL CABLES PVT. LTD	NEW DELHI	
		SCOT INNOVATION WIRES AND CABLES PVT. LTD	SOLAN	
		SRIRAM CABLES PVT. LTD	NEW DELHI	
		TORRENT CABLES LTD	AHMEDABAD	
		THERMO CABLES LTD	HYDERABAD	
		TIRUPATI PLASTOMATICS PVT. LTD	JAIPUR	
20.	XLPE CONTROL CABLES	APAR INDUSTRIES LTD	MUMBAI	
		CABLE CORPORATION OF INDIA LTD	MUMBAI	
		CRYSTAL CABLE INDUSTRIES	KOLKATA	



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SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		LTD		
		DIAMOND POWER INFRASTRUCTURE LTD	VADODARA	
		GEMSCAB INDUSTRIES LTD	NEW DELHI	
		HAVELLS INDIA LIMITED	NOIDA	
		KEI INDUSTRIES LTD	NEW DELHI	
		KRISHNA ELECTRICAL INDUSTRIES LTD	GWALIOR	
		KEC INTERNATIONAL LIMITED	MUMBAI	
		PARAMOUNT COMMUNICATIONS LTD	NEW DELHI	
		POLYCAB WIRES PVT. LTD	MUMBAI	
		RADIANT CORPORATION PRIVATE LIMITED	HYDERABAD	
		RAVIN CABLES LIMITED	MUMBAI	
		SUYOG ELECTRICALS LTD	VADODARA	
		SRIRAM CABLES PVT. LTD	NEW DELHI	
		TORRENT CABLES LTD	AHMEDABAD	
		UNIVERSAL CABLES LTD	SATNA	
21.	CABLE GLAND	COMMET		
		SUNIL&CO		
		ARUP ENGINEERING		
		JAINSON		
		DOWELL		
22.	PUSH BUTTONS	SIEMENS		
		L&T		
		BCH		
		SCHNEIDER		
23.	LIMIT SWITCHES	SPEED-O-CONTROL		
		ELECTROMAG		
24.	PENDENT PUSH BUTTON STATION	OEM		
25.	INDICATING LAMPS	TECKNIC		
		BCH		
		SIEMENS		
		STANDARD		
26.	MCB	MDS		
		INDO COPP		
		STANDARD		
		SIEMENS		
		L&T		
		ABB		
		SCHNEIDER		
27.	PANELS	OEM		



**TECHNICAL SPECIFICATION
ELECTRIC HOISTS & CHAIN PULLEY BLOCKS
1X800 MW NORTH CHENNAI TPP STAGE III**



SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		RITTAL		
		PYROTECH		
28.	RESISTANCE BOXES	ENAPROS		
		OEM		
		SAFEX FIRE SERVICES LTD		
		UNITED FIRE EQUIPMENTS PVT. LTD		
		ZENITH FIRE SERVICES (INDIA) PVT LTD		
29.	VVVF	YASKAWA		
		ABB		
		SIEMENS		
		SCHNIEDER		
		FUJI ELECTRIC		
		MITSUBISHI ELECTRIC		
30.	SHROUDED DSL	SUSHEEL		
		STROMAG		
31.	LOAD CELL	IPA		
		SARTORIUS		
32.	GEAR BOX	OEM		* = Applicable for Geared Motors only
		ELECON ENGINEERS		
		SHANTI GEARS		
		PBL*		
		NAW*		
		NORD*		
		SEW*		
		BONGFILIOLI*		

NOTE:

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

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

2. DEALERS ARE NOT ACCEPTABLE FOR ANY ITEM OF THE PACKAGE. BIDDER SHALL PROCURE ALL ITEMS INCLUDING PLATES, STRUCTURAL, FLANGES; COUNTER FLANGES ETC. FROM APPROVED SUB VENDOR ONLY.
3. THE INSPECTION CATEGORY WILL BE INTIMATED AFTER AWARD OF CONTRACT BY BHEL/CUSTOMER. HOWEVER THE SAME WILL BE ADHERED BY THE BIDDER WITHOUT ANY COMMERCIAL AND DELIVERY IMPLICATION TO BHEL/ CUSTOMER.



**TECHNICAL SPECIFICATION
ELECTRIC HOISTS & CHAIN PULLEY BLOCKS
1X800 MW NORTH CHENNAI TPP STAGE III**



MAKES OF SUB VENDORS ITEMS AS APPLICABLE TO CHAIN PULLEY BLOCKS:

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
1.	STEEL	SAIL		
		TISCO		
		JINDAL		
		ESSAR		
2.	HOOKS	STEEL FORGING & ENGG. CO.,	KOLKATA	
		SIMRITI FORGING		
		KARACHIWALA		UP TO 25T CAPACITY
		NASHIK FORGE		

NOTE:

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

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

5. DEALERS ARE NOT ACCEPTABLE FOR ANY ITEM OF THE PACKAGE. BIDDER SHALL PROCURE ALL ITEMS INCLUDING PLATES, STRUCTURAL, FLANGES; COUNTER FLANGES ETC. FROM APPROVED SUB VENDOR ONLY.
6. THE INSPECTION CATEGORY WILL BE INTIMATED AFTER AWARD OF CONTRACT BY BHEL/CUSTOMER. HOWEVER THE SAME WILL BE ADHERED BY THE BIDDER WITHOUT ANY COMMERCIAL AND DELIVERY IMPLICATION TO BHEL/ CUSTOMER.



**TECHNICAL SPECIFICATION
ELECTRIC HOISTS & CHAIN PULLEY BLOCKS
1X800 MW NORTH CHENNAI TPP STAGE III**



PAINTING SPECIFICATION

1. Painting specification for steel structures:-

Surface preparation: De greasing and Mechanical cleaning with wire brush or blasting according to SIS 055900, Grade 2 ½ .

Primer : Zinc Silicate of approved brand. - 2 coat, DFT 60 µm per coat.

Intermediate : MIO Epoxy paint- 2 coat, DFT 90 µm per coat

Finish Coat : Polyurethane coating- 1 coats, DFT 30 µm per coat.

Total DFT : 330 µm

2. Painting specification for Indoor components such as motors, electrical parts etc:-

Surface preparation: blasting according to SIS 055900, Grade 2 ½ . Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 25 µm may be used.

Primer : Zinc phosphate epoxy - 2 coat, Total DFT 75 µm.

Finish Coat : Chlorinated rubber paint- 2 coats, Minimum DFT 30-40 µm per coat.

Total DFT : 135 – 155 µm

3. Color Shade:

SL. No	Item Description	Color Shade	Remarks
1	Crane Structure	Golden Yellow shade 356 as per IS-5	Colour band-Black
2	Trolley and hook	Crimson shade 540 as per IS-5	
3	Motors	Light Gray shade 631 as per IS-5	
4	Control Panels	Light Gray (Powder coated) as per IS-5	

		MANUFACTURERS NAME & ADDRESS		MANUFACTURING QUALITY PLAN				PROJECT		1X800 MW NORTH CHENNAI TPP STAGE III			
		AS PER APPROVED VENDOR LIST		ITEM:	ELECTRIC WIRE ROPE	QP NO		PACKAGE		ELECTRIC WIRE ROPE HOIST			
						REV	0	CONTRACT No					
						DATE	Mar, 2017	CONTRACTOR		BHEL-PEM			
						PAGE	1 of 4						
SI.No	COMPONENT & OPERATIONS	CHARACTERISTICS	CATEGORY	TYPE OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY		REMARKS	
									D*	M	C	N	
1	2	3	4	5	6	7	8	9		**	10		11
1.0	RAW-MATERIALS												
1.1	a) STRUCTURAL MATERIAL b) RAW MATERIAL FOR HOIST AND GEAR BOX HOUSING, TROLLEY PLATE, ROPE DRUM IF FABRICATED ETC	CHEM & MECH PROPS	MA	Lab analysis	1 SAMPLE PER LOT%	IS 2062 /APPD. DRG./ DATA SHEET		MTC/IR	√	P/V	V	V	Test shall be carried out in absence of mill TC or non-correlation of TC with material.BHEL to identify Samples for testing. Test to be carried out at NABL accredited Lab. Reports to be submitted for verification during inspection.
		NDT	MA	UT	100%	ASTM A388-2004	NOTE 1	IR	√	P	V	V	For dia / plate thickness above 25 mm
1.1 A	SEAMLESS PIPE FOR ROPE DRUM	CHEMICAL , MECHANICAL	MA	Lab analysis	1 SAMPLE /pipe	Approved drg/ASTM A 106 Grade A or B		MTC/IR	√	P/V	V	V	Test shall be carried out in absence of mill TC or non-correlation of TC with material.BHEL to identify Samples for testing. Test to be carried out at NABL accredited Lab. Reports to be submitted for verification during inspection
		Flattening & Acid Etching test	MA	PHYSICAL & METALLOGRAPHY	1 SAMPLE /pipe	No cracks, pitting, rusting , damage etc		IR	√	P	V	V	
		SURFACE DEFECTS	MA	Visual	100%								
1.2	FORGINGS FOR GEARS BLANKS ,PINIONS, SHAFT/AXLES, WHEELS , STEEL CASTINGS	MECH , CHEM. PROPS	MA	Lab analysis	100%	APPD. DRG./ DATA SHEET	APPD. DRG./ DATA SHEET / IS:3938	LAB. REPORT / MANUFACTURER'S TEST CERTIFICATE	√	P	V	V	
		NDT	CR	UT	100%	ASTM A 388	NOTE 1	INSPN. REPORT	√	P	V	V	IF DIA or THK > 50mm
		Hardness , surface defects after hardfacing and machining/grinding	MA	DPT/MPI	100%	ASTM E -165 /E-709, No linear indication		MTC	√	P	V	V	
1.3	WIRE ROPE	Dimensional, type, construction ,	MI	measurement	100%	APPD. DRG./ DATA SHEET	APPD. DRG./ DATA SHEET	MFRS' TEST CERT.	√	P	V	V	
		EXAMINATION OF REPORT OF BREAKING LOAD CAPACITY	CR	Review of TC	100%		IS: 2266	MFRS' TEST CERT.	√	P	V	V	
1.4	HOOKS	MECH. , CHEM. PROPS.	MA	Lab analysis	100%	APPROVED DRG/DATA SHEET IS:15560		MFRS' TEST CERT.	√	P	V	V	
		U.T IF SHANK DIA > 50mm	CR	NDT	100%	ASTM A 388	NOTE 1	INSPN. REPORT	√	P	V/W	V	SHANK PORTION ONLY
		Dimension & PROOF LOAD TESTING	CR	Measurment , PROOF LOAD TEST	100%	APPROVED DRG/DATA SHEET / IS:3938 / IS:15560		QCR	√	P	V/W	V	IF REQUIRED BY END CUSTOMER.
		DPT AFTER PROOF LOAD	CR	NDT	100%	ASTM E-165	NO CRACKS	INSPN. REPORT	√	P	V/W	V	
1.5	SHEAVES	MECH	MA	Tensile & hardness	1/lot	Approved drgs		MTC/IR	√	P	V	V	

		MANUFACTURERS NAME & ADDRESS		MANUFACTURING QUALITY PLAN				PROJECT		1X800 MW NORTH CHENNAI TPP STAGE III				
		AS PER APPROVED VENDOR LIST		ITEM:	ELECTRIC WIRE ROPE	QP NO		PACKAGE		ELECTRIC WIRE ROPE HOIST				
						REV	0	CONTRACT No						
						DATE	Mar, 2017	CONTRACTOR		BHEL-PEM				
						PAGE	1 of 4							
Sl.No	COMPONENT & OPERATIONS	CHARACTERISTICS	CATEGORY	TYPE OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY		REMARKS		
									D*	M	C	N		
1	2	3	4	5	6	7	8	9		**	10		11	
1.6	CASTING FOR BEARING PLATED, ROPE GUIDES, PULLEYS ETC	CHEMICAL & MECHANICAL	MAJOR	LAB ANALYSIS	1/LOT	APPROVED DRG/MFG STANDARD	APPROVED DRG/MFG STANDARD	LAB REPORT	√	P	V	V		
2.0	IN-PROCESS													
2.1	Welding process capability and welder skill	WPS,PQR & WPQ	MA	Welding procedure approval and Welder performance qualification in accordance with ASME Section IX	100%	ASME Section IX		WPS,PQR & WPQ		P	V	V	In case approved WPS/PQR/WPQ from BHEL/NTPC/EIL/LLOYDS/TPL available, then documents/records to be submitted for verification during inspection, else, Vendor shall get the approval of Welding Procedure / Welder from the identified agency	
2.2	Welding of trolley, rope drum etc	Fillet weld	MA	DPT	10%	ASTM E165 or Eq/ No cracks or linear indication		INSPN. REPORT	√	P	V	V		
		Butt welds	MA	RT, DPT	100%	ASME SEC VIII, DIV 1, UW 51/52		RT FILM & REPORT	√	P	V	V	100% RT for butt weld in tension and 10 % in compression. 100% RT on butt weld of rope drum	
		DPT AFTER STRESS RELIEVING OF ROPE DRUM	MA	NDT	100%	ASTM E-165	NO CRACKS	INSPN. REPORT	√	P	V	V		
2.3	NDT OF LOAD BEARING BUTT WELDS (IF ANY)	WELD QUALITY OF BUTT WELDS IN TENSION	CR	PT & RT	100%	ASME SEC. VIII DIV. I	ASME SEC. VIII DIV. 4 . CLUW-51 FOR RT APPENDIX -8 FOR PT	INSPN. REPORT ND FILM	√	P	W	V/W	FILMS TO BE REVIEWED BY BHEL & END CUSTOMER/THIRD PARTY. DPT SHALL BE CHP .	
2.4	GEAR BOXES													
	COMPLETE ASSEMBLY	OVERALL DIMENSIONS. LEAK TEST, REDUCTION RATIO, BACK LASH AND CONTACT PATTERN	MA	MEAS./VISUAL	100%	MFG. DRG./KERSON E TEST	MFG. DRG./NO LEAKAGE WHEN FILLED	INSPN. REPORT	√	P	V			
	NO LOAD RUN TEST FOR 4 HRS	CHECK FOR OIL LEAKAGE, VIBRATION, NOISE ,TEMP. RISE. REDUCTION RATIO, BACKLASH , CONTACT PATTERN	MA	PERFORMANCE	100%	APPROVED DRGS /No leakage,Noise 85dbA maxat 1 mtrs, vibration 75 microns max, oil temp rise 20 deg above ambient max		- DO -	√	P	V	V		
3.0	ELECTRICALS													
1	MOTORS & CABLES	Make, type , rating	MA	Visual /measurment	100%	Apprvd drg	IS 325 / IS:3938	IR, MTC	√	P	V	V	For motor refer Note: 2	
		ROUTINE TESTS												
3	LIMIT SWITCHES,SFU, ISOLATOR/ O/L RELAY, MCB, FUSES,PUSH BUTTONS,CONTACTOR, INDICATING LAMPS etc	Make , type , rating, functional, Continuity	MA	Review of TC	100%	Approved drgs		IR	√	P	V	V		
4	BRAKES	Make , type , rating, HV/IR, Functional test	MA	Review of TC	100%	Approved drgs		IR, MTC	√	P	V	V		
5	DSL	Make , type , rating, dimension	MA	Review of TC	100%	Approved drgs		IR	√	P	V	V		
6	Control transformer	Make , type , rating, input/output	MA	Review of TC	100%	Approved drgs		IR	√	P	V	V		

[illegible]

[illegible]

	MANUFACTURER'S NAME & ADDRESS :	<u>MANUFACTURING QUALITY PLAN</u> ITEM : Chain Pulley Block QP No.: REV.:0, Date.: , PAGE: 1 OF 4	PROJECT : 1X800 MW NORTH CHENNAI TPP STAGE III PACKAGE : CHAIN PULLEY BLOCK

Sr. No.	COMPONENT / OPERATION	CHARACTERISTICS	CLAS S	TYPE OF CHECK	QUANTU M OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
					M	C/N				M	C	N	
					6.					10.			
1.	2.	3.	4.	5.			7.	8.	9.				11.

1	<u>RAW MATERIAL & B/OUT ITEMS:</u>												
1.1	HOOKS	CHEMICAL & MECH MARK & IDENTIFICATION INTERNAL DEFECTS PROOF LOAD TEST NDT AFTER PROOF LOAD TEST	MA MA MA MA MA	LAB ANALYSIS VISUAL UT REVIEW DPT	ONE SAMPLE PER HEAT 100% 100% 100% 100%	MATERIAL SPECIFICATION AS PER APPROVED DRAWINGS. HOOK TC FROM COMPETENT AUTHORITY ASTM A-388 (REFER NOTE I) IS 15560 ASTM E-165 NO RELEVANT INDICATION		MTC. TC IR TC TC	✓ ✓ ✓ ✓ ✓	P P P P P	V V V V V	V V V V V	ON SHANK PORTION
1.2	LOAD CHAIN	- DIMENSIONS - BREAKING STR & % ELONGATION - PROOF LOAD -HEAT TREATMENT -GRADE	MA MA MA MA MA	MEASUREMENT -TENSILE TEST -TENSILE TEST REVIEW REVIEW	100% 1/LOT 100% 100% 1/BATCH	APPD. DRGS -DO- -DO- -DO- -DO-	APPD. DRGS. -DO- -DO- -DO- -DO-	IR MTC MTC HT CHRT MTC	✓ ✓ ✓ ✓ ✓	P P P P P	V V V V V	V V V V V	

MANUFACTURER / CONTRACTOR SUB-CONTRACTOR SIGNATURE	LEGEND: ** M : MANUFACTURER / SUB-SUPPLIER C : BHEL / NOMINATED INSPECTION AGENCY. N : CUSTOMER/ NOMINATED INSPECTION AGENCY. INDICATE "P" PERFORM "W" WITNESS AND "V" VERIFICATION	FOR CUSTOMER USE	
		REVIEWED BY	NAME & SIGN OF APPROVING AUTHORITY & SEAL

	MANUFACTURER'S NAME & ADDRESS :	<u>MANUFACTURING QUALITY PLAN</u> ITEM : Chain Pulley Block QP No.: REV.:0, Date.: , PAGE: 2 OF 4	PROJECT : 1X800 MW NORTH CHENNAI TPP STAGE III PACKAGE : CHAIN PULLEY BLOCK

Sr. No.	COMPONENT / OPERATION	CHARACTERISTICS	CLAS S	TYPE OF CHECK	QUANTU M OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
					M	C/N				M	C	N	
					6.					10.			
1.	2.	3.	4.	5.			7.	8.	9.				11.

1.3	RAW MATL. (BAR /FORGING) FOR GEAR BLANKS/SHAFTS/ PINIONS/AXLE/ RATCHET PAWL / RATCHET WHEEL & PLATES FOR FABRICATION ETC	CHEMICAL COMPOSITION MECHANICAL INTERNAL DEFECTS NDT AFTER MACHINING	MA MA MA MA	Review Review UT DPT	ONE SAMPLE PER HEAT 100% 100%	Material specification as per approved drawings. ASTM A-388 REFER NOTE 1 ASTM E-165 NO RELEVANT INDICATION		MFR' S TC IR TC	✓ ✓ ✓ ✓	P P P P	V V V V	V V V V	TC or inspection report for components shall be given. For rounds ≥50mm and plates ≥25 mm.
1.4.	LOAD CHAIN WHEELS	- CHEMICAL & MECHANICAL PROPERTIES	MA	CHEMICAL MECHANICAL PROPERTIES	ONE SAMPLE PER LOT	APPD. DRG.	APPD. DRG.	MTC	✓	P	V	V	
1.5	BEARINGS	MAKE, TYPE, CATALOUGE NO.	MA	VISUAL	RANDOM	APP DRG / MFR"S CATALOGUE	APP DRG / MFR"S CATALOGUE	IR	✓	P	V	V	
1.6	HAND CHAIN WHEEL	CHEMICAL MECHANICAL PROPERTIES	MA	CHEMICAL MECHANICAL PROPERTIES	ONE SAMPLE PER LOT	AS PER DRAWING	AS PER DRAWING	MTC	✓	P	V	V	
1.7	HAND CHAIN	GRADE/ DIMENSION	MA	GRADE DIMENSION	100%	AS PER DRAWING	AS PER DRAWING	MTC	✓	P	V	V	

	LEGEND:	FOR CUSTOMER USE	
MANUFACTURER / CONTRACTOR	** M : MANUFACTURER / SUB-SUPPLIER C : BHEL / NOMINATED INSPECTION AGENCY. N : CUSTOMER/ NOMINATED INSPECTION AGENCY. INDICATE "P" PERFORM "W" WITNESS AND "V" VERIFICATION		
SUB-CONTRACTOR		REVIEWED BY	NAME & SIGN OF APPROVING AUTHORITY & SEAL
SIGNATURE			

	MANUFACTURER'S NAME & ADDRESS :	MANUFACTURING QUALITY PLAN ITEM : Chain Pulley Block QP No.: REV.:0, Date.: , PAGE: 3 OF 4		PROJECT : 1X800 MW NORTH CHENNAI TPP STAGE III PACKAGE : CHAIN PULLEY BLOCK

Sr. No.	COMPONENT / OPERATION	CHARACTERISTICS	CLAS S	TYPE OF CHECK	QUANTU M OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
					M	C/N				M	C	N	
					6.					10.			
1.	2.	3.	4.	5.			7.	8.	9.				11.

1.8	TROLLEY GEARS, PINION,WHEELS, AXLE	CHEMICAL & MECHANICAL	MA	LAB ANALYSIS,	100%	APPVD DRGS	APPVD DRGS	IR/TC	✓	P	V	V	
2	IN PROCESS												
2.1	RATCHET PAWL / RATCHET WHEEL	-HARDNESS -SURFACE CRACK	MA MA	HARDNESS DPT	100% 100 %	IS:3832/ APPD DRG. ASTM E165	IS:3832/ APPD. DRG. NO DEFECT	IR IR	✓ ✓	P P	V V	V V	
2.2	COMPONENTS AFTER HARDFACING & MACHINING	HEAT TREATMENT SURFACE HARDNESS SURFACE CRACK DIMENSION	MA MA MA MA	HT CHART HARDNESS DPT FOR SURFACE CRACK MEASURE	100% 10% 100% 10%	IS 1875/IS 4367/IS 3832 --DO-- ASTM E 165	NO DEFECT	IR IR IR IR	✓ ✓ ✓ ✓	P P P P	V V V V	V V V V	
3.0	FINAL INSPECTION												
3.1	COMPLETE ASSEMBLY	OVERALL DIMENSION ENDURANCE TYPE TEST OPERATIONAL PROOF LOAD & LIGHT LOAD TEST, EFFORT. HEIGHT OF LIFT	CR MA CR MA	MEASUREMENT TYPE TEST LOAD TEST VISUAL	100 % 1 PER SIZE 100% 100 %	IS:3832 /APPD DRG IS 3832 -DO- -DO-	IS:3832 /APPD DRG IS 3832 -DO- -DO-	IR TC IR IR	✓ ✓ ✓ ✓	P P P P	W V W W	V V V V	

MANUFACTURER / CONTRACTOR	LEGEND: ** M : MANUFACTURER / SUB-SUPPLIER C : BHEL / NOMINATED INSPECTION AGENCY. N : CUSTOMER/ NOMINATED INSPECTION AGENCY. INDICATE "P" PERFORM "W" WITNESS AND "V" VERIFICATION	FOR CUSTOMER USE	
SUB-CONTRACTOR		REVIEWED BY	NAME & SIGN OF APPROVING AUTHORITY & SEAL
SIGNATURE			

	MANUFACTURER'S NAME & ADDRESS :	MANUFACTURING QUALITY PLAN ITEM : Chain Pulley Block QP No.: REV.:0, Date.: , PAGE: 4 OF 4	PROJECT : 1X800 MW NORTH CHENNAI TPP STAGE III PACKAGE : CHAIN PULLEY BLOCK

Sr. No.	COMPONENT / OPERATION	CHARACTERISTICS	CLAS S	TYPE OF CHECK	QUANTU M OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
					M	C/N				M	C	N	
					6.					10.			
1.	2.	3.	4.	5.			7.	8.	9.				11.

		SWIVELING OF HOOK	MA	VISUAL	100%	APPROVED DRG	APPROVED DRG	IR	✓	P	W	V	
		EFFORT	MA	PULL ON CHAIN	100%	-DO-	-DO-	IR	✓	P	W	V	
3.2	PAINTING	-CLEANING - SHADE & DFT OF PAINT	MA MI	VISUAL VISUAL	AT RANDOM AT RANDOM	APPROVED DRAWING/ SPECIFICATI ON	APPROVED DRAWING/ SPECIFICATI ON	IR IR		P p	--- W	--- ---	
3.3	NAME PLATE	VERIFICATION	MA	VISUAL	100%			IR		P	V	---	
3.4	PACKING	-VERIFICATION	MI	VISUAL	100%	SPECS.	SPECS.	IR		P	---	---	
3.5	REVIEW OF QA DOCUMENTATION	VERIFICATION	MA	VISUAL	100%	APPD. QP	APPD. QP		✓	V	V	V	
CR – CRITICAL, MA – MAJOR , MI – MINOR													

NOTE 1: WHEN BACK WALL ECHO (BWE) IS SET AT 100% OF FULL SCREEN HEIGHT (FSH) IN DEFECT FREE AREA THEN

(A) DEFECT ECHO SHALL NOT EXCEED 20% OF FSH &

(B) BWE SHOULD BE MINIMUM 80% OF FSH IN ANY AREA.

NOTE 2: RECORDS IDENTIFIED WITH TICK SHALL BE ESSENTIALLY INLCUDED IN QA DOCUMENTATION.

	LEGEND: ** M : MANUFACTURER / SUB-SUPPLIER C : BHEL / NOMINATED INSPECTION AGENCY. N : CUSTOMER/ NOMINATED INSPECTION AGENCY. INDICATE “P” PERFORM “W” WITNESS AND “V” VERIFICATION	FOR CUSTOMER USE	
MANUFACTURER / CONTRACTOR			
SUB-CONTRACTOR			
SIGNATURE		REVIEWED BY	NAME & SIGN OF APPROVING AUTHORITY & SEAL



TITLE:
ELECTRICAL EQUIPMENT SPECIFICATION
FOR EOT CRANES / ELEVATORS / ELECTRIC HOISTS
SYSTEM
(ELECTRICAL PORTION)
1X800 MW NORTH CHENNAI TPP STAGE III

SPECIFICATION NO.
PE-TS-323-A001
VOLUME NO. : II-B
SECTION: C
REV NO. : 0 DATE: 31.01.17
SHEET: 1 OF 2

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:

The equipment and services to be provided by bidder under this specification shall be as detailed here below but shall not be limited to the following:

- 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 bidder without any extra charge shall provide the same.
- c) Supply of mandatory spares as specified in the specifications of mechanical equipments.
- d) Erection and Commissioning spares.
- e) Erection & Maintenance tools & tackles.
- f) Electrical load requirement for ~~EOT CRANES / ELEVATORS /~~ ELECTRIC HOISTS System.
- g) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
- h) 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.
- i) Various drawings including GA drg, data sheet as per required format, quality plans, calculations, test reports, test certificates, operation and maintenance manuals, characteristic curves, wiring diagrams/schemes etc shall be furnished as specified at contract stage. All documents shall be subject to customer / BHEL approval without any commercial implications to BHEL.
- j) Motors shall meet minimum requirement of Electric motor specification.
- k) All routine tests and type tests reports as per applicable standards shall be furnished at contract stage.
- l) Purchaser will furnish data sheets to the vendor after award of contract. Vendor shall furnish filled in data sheets meeting the specification requirements.
- m) LV Power Cables and Control Cables shall be as per cable annexure.
- n) Cable trays shall be as per attached Cable Tray Annexure.
- o) Panel shall be as per attached Panel Annexure.
- p) Technical requirements shall be as per specifications listed in Clause 4.1 to 4.9. In case of any discrepancy between Basic technical Particulars for HT or LT motors and BHEL standard specification, Basic technical particulars for HT or LT motors shall prevail.

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) A copy of this sheet "Electrical Equipment Specification for ~~EOT CRANES /~~ ~~ELEVATORS /~~ ELECTRIC HOISTS System and sheet "Electrical Scope between BHEL and Vendor" with bidder's signature and company stamp.
- b) List of Erection and Commissioning spares.
- c) List of Erection & Maintenance tools & tackles.



TITLE:
ELECTRICAL EQUIPMENT SPECIFICATION
FOR EOT CRANES / ELEVATORS / ELECTRIC HOISTS
SYSTEM
(ELECTRICAL PORTION)
1X800 MW NORTH CHENNAI TPP STAGE III

SPECIFICATION NO.
PE-TS-323-A001
VOLUME NO. : **II-B**
SECTION: **C**
REV NO. : **0** DATE: 31.01.17
SHEET: **1** OF **2**

- d) Electrical load requirement.
- 3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

4.0 **LIST OF ENCLOSURES**

- 4.1 Electrical scope between BHEL & vendor.
- 4.2 Technical specification – Specification for Electric Motors/Actuators
- 4.3 Basic Technical Particulars of HT/LT motors.
- 4.4 Testing Requirements.
- 4.5 Quality Plan for LV Motors.
- 4.6 Load Data Format.

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGE: **ELECTRIC HOISTS**SCOPE OF VENDOR: SUPPLY, **ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT**

PROJECT :

<u>S. NO</u>	<u>DETAILS</u>	<u>SCOPE SUPPLY</u>	<u>SCOPE E&C</u>	<u>REMARKS</u>
1	Isolating Switch	Vendor	Vendor	BHEL will provide one number 415 V(3ph, 4W) supply feeder only up to isolating switches for cranes/hoists. Any other voltage level (AC/DC) required will be derived by the vendor. Motor starter shall be part of crane/ hoist control panel.
2	Power cables, control cables, screened control cables and any special cables (if required) between equipment supplied by vendor.	Vendor	Vendor	Cable from supply feeder to isolating switch shall be in BHEL scope.
3	Cabling material (cable trays, accessories, cable tray supporting system, conduits etc).	Vendor	Vendor	
4	Equipment Earthing	BHEL	BHEL	All equipment metallic enclosures / frames, metal structure etc. shall be grounded at two points each to the nearest grounding points / risers provided by BHEL
5	Motors	Vendor	Vendor	
6	Cable glands and lugs for equipment supplied by vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power & control cables.
7	a) Input cable schedules (C & I) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for Control and Instrumentation Cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
8	Equipment layout drawings	Vendor	-	
9	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.



1x800 TANGEDCO NORTH CHENNAI TPP
AIR CONDITIONING SYSTEM
STANDARD TECHNICAL SPECIFICATIONS

SPECIFICATION No: PE-TS-423-553-A001

SECTION : I

SUB-SECTION : D

REV. 01

DATE: NOV 2017

SECTION: I

SUB-SECTION: D

STANDARD TECHNICAL SPECIFICATIONS



**STANDARD TECHNICAL
SPECIFICATION
FOR
CENTRAL AIR-CONDITIONING**

SPECIFICATION NO.PES-553-01

VOLUME II B

SECTION D

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DATE: 17.09.2012

SHEET 1 OF 6

**STANDARD TECHNICAL SPECIFICATION
FOR
CENTRAL AIR-CONDITIONING PLANT**

	STANDARD TECHNICAL SPECIFICATION FOR CENTRAL AIR-CONDITIONING	SPECIFICATION NO.PES-553-01	
		VOLUME II B	
		SECTION D	
		REV. 02	DATE: 17.09.2012
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1.	<u>GENERAL</u>
1.1	This specification covers the design, manufacture, testing at Manufacturer’s works, delivery to site, handling at site, installation, commissioning and carrying out acceptance tests and final painting at site of various equipment of the central air conditioning plant, as specified hereinafter.
2.	<u>CODES & STANDARDS</u>
2.1	The design, manufacture and performance of air conditioning equipment shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment are to be installed. The equipment shall also conform to the latest applicable Indian/British/American standards. Nothing in this specification shall be construed to relieve the tenderer of this responsibility. In particular the equipment shall conform to the latest editions of the following standards.
2.1.1	IS-660 : Safety code for Mechanical Refrigeration.
2.1.2	ARI 520-90 : Standard for Positive Displacement Refrigerant compressors and condensing units.
2.1.3	IS-5111 : Code of Practice of Measurement for Testing Refrigeration compressors.
2.1.4	ASHRAE/23-93 : Method of Testing for Rating Positive Displacement Refrigerant compressors and condensing units.
2.1.5	ARI-450: Standard for water-cooled Refrigerant condensers, Remote Type.
2.1.6	ASME : Unfired pressure Vessels Code. (Section VIII)
2.1.7	IS-2825 : -do-
2.1.8	IS-4503 : Shell and tube type heat exchangers.
2.1.9	ASHRAE/22-92 : Method of Testing for rating of Water Cooled refrigerant condensers.
2.1.10	IS-659 : Safety code for Air conditioning.
2.1.11	IS-2379 : Color Code for Identification of pipe lines.
2.1.12	TEMA : Standards of Tubular Exchanger manufacturers Association.
2.1.13	IS-1239 (Part-I) : Seamless steel tubes (Up to & including 168.2 mm OD.).
2.1.14	IS-3589 : For piping above 168.2mm to 2032mm Outside Diameter.
2.1.15	IS-778 : Valves up to 50 MM.
2.1.16	IS-780 : Valves 50 MM to 300 MM.
2.1.17	ASHRAE 24 : Method of Testing for Rating liquid coolers.

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2.1.18	ARI-480:	Standard for refrigerant cooled liquid coolers-Remote type.		
3.	<u>DESIGN & CONSTRUCTION REQUIREMENTS</u>			
3.1	The components of Central air conditioning plant comprising compressor, chiller refrigerant piping, valves and fittings etc. Shall be as given in Data sheet A. The type of all accessories, controls and instrumentation shall also be as indicated in data sheet A.			
3.2	The various equipments supplied under this specification shall be fully compatible with each other & capable of operating as fully balanced integrated system to deliver the specified output under design conditions.			
4.	<u>TESTING AND INSPECTION</u>			
	(Refer standard quality plan)			
4.1	Hydrostatic, Volumetric and refrigerant leak tests etc. shall be carried out at manufacturers works before dispatch of equipment in accordance with the applicable codes and standards.			
	Following minimum tests amongst others shall be conducted.			
4.1.1	Material analysis, testing and identification (Data sheet/ Drg. Shall clearly indicate the specification, grade, class and Heat treatment condition of material for which TC will be furnished)			
4.1.2	Hydrostatic pressure test of all pressure parts.(Testing pressure shall be clearly indicated for each component/ subassembly/ assembly)			
4.1.3	Static and Dynamic balancing test of rotating parts at rated and over speed and to determine vibration & noise level.(Grade of balancing, type- whether dynamic or single plane balancing for components/ subassembly/ assembly shall be clearly indicated in data sheet/ approved drg.. Permissible vibration (velocity and displacement –peak to peak and noise level in dB(A) to be indicated in Data Sheet/Approved Drg.)			
4.1.4	Radiography & magna-flux examination of materials & welds.(Components to be subjected to NDT with applicable, procedures and acceptance norms to be clearly indicated in Data sheet/ approved drg. If in a component only certain areas are to be subjected to NDT same shall be clearly brought out else it will be understood that the entire component is subject to NDT)			
4.1.5	Ultrasonic test of castings & forgings.(Procedure and acceptance norms with areas subject to NDT to be clearly indicated in Quality Plan).			
4.1.6	Performance test including determination of capacity, efficiency & characteristics etc.(Applicable standard, Acceptance norms, Procedure for test (if not covered in applicable standard),performance characteristics with applicable tolerances and drive to be used during shop test to be clearly indicated in Quality Plan). Performance data to be indicated in Approved Drg./ Data Sheet)			

	STANDARD TECHNICAL SPECIFICATION FOR CENTRAL AIR-CONDITIONING	SPECIFICATION NO.PES-553-01	
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4.1.7	Functional checks and adjustments of controls & instrumentation. (Functional checks required to be clearly indicated with extent of check and applicable standard in approved check list / Quality plan. Class of instruments / tolerances and performance data to be incorporated in Approved Data Sheet / Drg.)		
4.1.8	Checking of working clearances.(desired working clearances to be indicated in approved Drg.)		
4.1.9	Examination after selective opening up after testing.(basis/ reasons for selective opening up, areas to be examined and parameters to be checked to be brought out in Quality Plan)		
4.2	TESTS AT SITE Tests to prove guaranteed performance of the air conditioning plant, shall also be carried out at site after proper installation. The site test shall include performance testing (as per FQP) of equipment for 72 continuous hours each in all three seasons i.e. Summer, Winter and Monsoon. Unless specified elsewhere. All instruments, tools etc. as may be required to carry out site tests shall be arranged by the tenderer.		
5.	<u>PERFORMANCE GUARANTEE</u>		
5.1	Each equipment of air conditioning system shall be guaranteed for its rated capacity under the specified site conditions.		
5.2	If the shop/site performance tests indicate failure of equipment to meet specified requirement, it would be tenderer’s responsibility to carry out required alterations at no extra cost to purchaser. Tests shall be repeated after carrying out the modifications to demonstrate the performance.		
5.3	The air conditioning plant before being taken over by purchaser shall be subjected to running test for a minimum period of one week during which all readings shall be recorded. Any deficiencies noted during this period, shall be rectified by the tenderer /at no extra cost to purchaser. These running tests shall be in addition to the seasonal performance test specified under clause 4.2. The inside design conditions shall be guaranteed throughout the year.		



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6. DRAWINGS/DOCUMENT/DATA REQUIRED AFTER AWARD OF CONTRACT

- 6.1 Final version of all drawings & data submitted with the along with technical schedules enclosed in Volume III.
- 6.2 Drawings including equipment layout, foundation & loading details etc. for civil works for the entire plant. These drawings must cover sufficient details so that design of civil works can be completed.
- 6.3 Inspection, operation & Maintenance Manuals.
- 6.4 Manuals for method of testing & calibration of all instruments.
- 6.5 Equipment description giving complete design calculations, basis of design, selection criteria etc.
- 6.6 Schematic piping diagrams.
- 6.7 Layout of piping.
- 6.8 Electrical drawings.
- 6.9 Test Certificates.
- 6.10 Final as built documentation i.e. final-version of all drawings, data & information as per the requirement specified elsewhere.



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CENTRAL AIR-CONDITIONING PLANT
DATA SHEET - A

VOLUME II-B

SECTION D

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SHEET 1 OF 4

DESCRIPTION

DATA

1. GENERAL

1.1	Type of AC plant	: Chilled Water Type.
1.2	Plant configuration/capacity.	: Refer to Section-C of Specific Technical Requirements.
1.3	Location of AC plant rooms	: As per Tender drawings.
1.4	Type of lifting facility provided.	: Chain Pulley block with monorail (by BHEL)
1.5	Electrical work scope: -	
	i) MCC for AC plant	: By Others
	ii) Power cables / Control cables.	: By Others
	iii) Drives	: By Bidder.
	iv) Whether separate alarm/annunciation Panel/control panels required	: Yes (By bidder), Refer to Section-C of Specific Technical Requirements.
	v) Termination of cabling & earthing at Equipment end.	: By Bidder for bidder supplied equipment.

2. REFRIGERATION COMPRESSOR

2.1.	Type	: SCREW CHILLE
2.2.	Nos. (working + standby)	: Refer to Section-C of Specific Technical Requirements.
2.3.	Type of capacity control	: Automatic.
2.4.	Type of drive	: Direct driven.
2.5.	Restart after tripping	: Manual.
2.6.	Type of start	: As per manufacturing standard.
2.7.	Shaft Seal	: Mechanical shaft seal.
2.8.	Purge Recovery unit	: As per manufacturing standard.
2.9.	Type of lubrication	: As per manufacturing standard.
2.10.	Refrigerant used	: Environment friendly HCFC, (CFC is not acceptable)



CENTRAL AIR-CONDITIONING PLANT
DATA SHEET - A

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3. DESIGN REQUIREMENTS

- 3.1. Minimum capacity at Design conditions : Refer to Section-C of Specific Technical Requirements.
- 3.2. Capacity control : Microprocessor based Control Panel sheet metal panel, located on each Compressor/chiller unit including protection devices
- 3.3. Vibration isolator : Neoprene rubber pads/Equivalent approved to suit chiller package.
- 3.4. Type of foundation : Floating / As per manufacturing standard

4.0 CONDENSER

- 4.1 Type : Horizontal shell & tube type water-cooled
- 4.2 Number required : One no. for each machine.
- 4.3 Design requirements
- 4.3.1 Fluid : Refrigerant (Shell side) Water (tube side)
- 4.3.2 Cooling Water Quantity : To suit requirement.
- 4.3.3 Capacity of condensers : To match compressor & to provide at least 2°C sub cooling.
- 4.3.4 Cooling water inlet temp. : Refer to Section-C of Specific Technical Requirements.
- 4.3.5 Leaving Water Differential. : Refer to Section-C of Specific Technical Requirements.
- 4.3.6 Max. flow velocity through tubes. : 2.5 m/sec.
- 4.3.7 Design fouling factor : 0.0002 (MKS Unit)
- 4.3.8 Maximum pressure drop. : 0.6 Kg/cm² (g)
- 4.3.9 Tube wall Thickness : Not less than 18 SWG
- 4.4 Materials of construction
- i/ Shell : M.S. Plate fusion welded.
- ii/ Tube : Integrally bonded Seamless copper



CENTRAL AIR-CONDITIONING PLANT
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iii/ Head ends	: Cast Iron.
iv/ Tube sheet material	: Steel
v/ Baffle plate	: Steel.
- 4.5 Accessories required
- | | |
|---|---|
| i/ Purge & drain connections with valves. | : Yes |
| ii/ Relief valves | : Yes |
| iii/ Liquid line shut off valve. | : Yes |
| iv/ Isolating valves on water side. | : Yes |
| v/ Flow switch | : Yes (interlocked with control of individual refrigeration system) |
| vi/ Pressure/temperature gauges at inlet/outlet | : Yes |
| vii/ Descaling tee | : Yes |
| viii/Charging valve | : Yes |
| ix/ MS supporting frame work | : Yes |
| viii/Cooling thermostat | : Yes |
| ix/ MS supporting frame work. | : Yes |
- 5.0 **CHILLER** (Applicable for chilled water type plant only.)
- | | |
|-----------------------------|--|
| 5.1 Type | : Horizontal shell & tube flooded type |
| 5.2 Number required/standby | : One no. for each chiller package. |
- 5.3 Design requirements
- | | |
|---|------------------------------------|
| 5.3.1 Fluid to be cooled | : Water |
| 5.3.2 Water flow rate (Inside tube) | : To suit requirement. |
| 5.3.3 Water inlet temperature | : 12 °C approx. |
| 5.3.4 Water outlet temperature | : 7 °C approx. |
| 5.3.5 Super heating of refrigerant material | : By at least 3 deg. C. |
| 5.3.6 Insulation /thickness/finish | : As per the manufacture standard. |
| 5.3.7 Design fouling factor | : 0.00010(MKS Unit) |



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- 5.3.8 Maximum pressure drop. : 0.6 Kg/cm² (g)
- 5.3.9 Tube wall Thickness : Not less than 22 SWG.
- 5.4 Materials of construction
- i/ Shell : M.S. Plate fusion welded.
- ii/ Tube : Integrally Seamless copper (internally Corrugated)
- iii/ Head ends : Cast Iron.
- iv/ Tube sheet material : Steel.
- v/ Baffle plate : Steel.
- 5.5 Accessories required
- i/ Purge & drain : Yes
- ii/ Gate valves at water inlet/outlet. : Yes
- iii/ Flow switch : Yes
- iv/ Pressure/temperature gauges at inlet/outlet : Yes
- v/ Anti-freeze thermostat : Yes
- vi/ Thermostatic expansion valves : Yes
- vii/ Pilot solenoid valve : Yes
- viii/ Cooling thermostat : Yes
- ix/ MS supporting frame work. : Yes

Note :-

The system shall also incorporate:

- 1) Auto operation of chilling plant for operation of the whole AC system.
- 2) A Central Control Panel with fault annunciators with provision for remote extension besides local control kiosks.
- 3) Water Chiller package shall be skid-mounted unit with microprocessor based control panel complete with all accessories and controls are assembled at manufacturing works on single unit.
- 4) Screw chiller shall be suitable for 415V $\pm$ 10 %/50 Hz $\pm$ 3%/3 phase operation with voltage & frequency variation as specified with built in starter etc.
- 5) Only supply feeders shall be provided for chillers.



TECHNICAL SPECIFICATION

AIR HANDLING UNITS

SPECIFICATION NO.PES-553-02

VOLUME II B

SECTION D

REV. 02

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STANDARD TECHNICAL SPECIFICATION FOR AIR HANDLING UNITS

	TECHNICAL SPECIFICATION AIR HANDLING UNITS	SPECIFICATION NO.PES-553-02	
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1.	<u>GENERAL</u>
1.1	This specification covers the design, manufacture, Construction features, installation, commissioning, inspection and performance testing at site of AHUs.
2.	<u>CODES AND STANDARDS</u>
2.1	The design manufacture and performance of AHU shall comply with all currently applicable statutes, regulations and safety codes in the locality where the AHU is to be installed. The equipments shall also conform to the requirements of the latest editions of applicable Indian/British/US standards. Nothing in this spec. shall be construed to relieve vendor of this responsibility. In particular the equipment shall conform to the latest editions of the following standards:
2.1.1	IS-659 : Safety code for air conditioning
2.1.2	IS-660 : Safety code for mechanical refrigeration
2.1.3	ASHRAE: Method of testing forced circulation air-cooling and air heating coils. standard 33
2.1.4	ARI 41 : Standard for forced circulation air cooling and air heating coils.
2.1.5	ARI 430/435 : Air-cooling and air heating coils Central Station AHU / Application of Central Station AHU.
2.1.6	AMCA : 211 and 311
	In case of any conflict in the standards and this specification the decision of PEM,BHEL shall be final and binding.
3.	<u>CONSTRUCTION FEATURES</u>
3.1	The casing of AHU shall be made of insulated double wall construction of min. 24 gauge galvanized sheet steel - IS 277 Gr. 120 (parent sheet: D/DD-IS-513) ribbed and reinforced for structural strength and rigidity with 25 mm thick polyurethane insulation of minimum 40 kg/m³ density in between. The external wall will be pre-plasticised over GI coating on the outside. Angle irons or channel sections made of 16 gauge galvanized sheet steel shall be used for reinforcing. The casing shall be of sectionalized construction with proper sealing at the joints to make them air tight. Fan section and panels with bearing support shall be reinforced with heavy gauge channels (min. 5 mm thick). Suitable number of forged hot dip galvanized (610 gm/sq.m) U brackets shall be provided for AHU suspended from ceiling/roof. Necessary arrangement shall be provided on the casing for measuring temperature and pressure in cooling/heating coil. Class of instruments shall be min. 2.
3.2	Fan impeller shall be forwardly/backwardly inclined curved blade centrifugal type. Impeller shall be double width double inlet type. Fans shall be preferably low rpm (<=1500) to minimize vibration and noise. Noise shall be within 85 dB(A) at 1 metre distance from AHU casing. Max. Vibration level shall be acceptance and norms to be specified. Two to three wheels (impellers) shall be provided for each AHU. Impeller blades shall be fabricated from (min. 1.0 mm) galvanized/ epoxy powder coated sheet steel. Fan shall be of epoxy powder coated / galvanized sheet steel (min. 1.6



TECHNICAL SPECIFICATION

AIR HANDLING UNITS

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mm) scroll with die formed inlets for uniform air flow. Fan shafts shall be solid cold rolled carbon steel (EN8 normalised), ground and polished. Fan shaft bearings shall be of heavy duty type selected for average operating life of 100,00 hours. Bearings shall be self-aligning, permanently lubricated type. Make of Brgs(SKF/FAG/NORMA/TATA) to be specified. Bearing Housing shall be of casting of min. IS Gr. 210, split type and suitably supported. The V-belt drive with belt guard shall be provided. Motors shall have minimum 15% margin over maximum BHP in working range.

3.3 DX or chilled water cooling coils and steam/hot water coils shall be internally corrugated copper/ cupronickel tubes (as per manufacturer's standard) with smooth non corrugated external fins of aluminium (thickness 0.14 mm and grade 1100 as per spec) unless specified otherwise in specification. At least 5 fins /per cm. shall be provided. The chilled water/hot water coils shall have suitable (standardize class, size, threading) drain and vent connections.

3.4 The filters in the filter section shall be provided as detailed in data sheet A.

3.5 Humidifier shall be Pan type/as specified in the specification.

Pan type Humidifier consisting of SS304/316 tank, heater, geyserstat with piping connection to supply air duct shall be provided unless specified otherwise in data sheet A.

Heaters and branch line shall be of galvanized steel and nozzles shall be of brass (matl. grade) /SS 304.

3.6 Condenser water from coil or surplus water from spray humidifier shall be collected in 16 gauge SS-304 pan. Minimum 50mm dia GI pipe nipple shall be provided on each end for drain connection. The drains for these points shall be extended to the main drain in AHU room. Condensate drain pipe (GI) of required length with sealing loop shall be provided and insulated as specified in the specification for insulation. Minimum requirement For GI Pipes and fittings shall be ERW/Seamless of medium thickness as per IS-1239/3589 and Hot dip galvanized

3.7 Suitable number of Spring type vibration isolators shall be provided for fan and motor assembly. Neoprene rubber pads shall be provided below the AHU.

The AHU shall be provided with 18 G SS drain pan.



TECHNICAL SPECIFICATION
AIR HANDLING UNITS

SPECIFICATION NO.PES-553-02

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4.

TESTING AND INSPECTION AT MANUFACTURERS WORKS:

List of TCs arranged as per Approved Quality Plan shall be furnished along with copy of TCs at the time of inspection.

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4.1	Visual inspection of GI sheets and angles, channels etc. – dents, black spots, chipping of zinc coating, white dust on galvanised sheets shall be avoided. Pitting , lamination in angles and channels shall be avoided.		
4.2	Galvanised sheets - Test certificate shall be furnished for visual check, coating thickness, adhesion test, sheet thickness, uniformity of coating. For pipes and fittings compliance report shall be furnished by Manufacturer for visual check, coating thickness, adhesion test, sheet thickness, uniformity of coating.		
4.3	Shaft: Mechanical and chemical.		
4.4	Motors (of approved make): Routine TC.		
4.5	Workmanship and dimensional check as per manufacturing drg. and approved Drgs.		
4.6	Balancing of impellers- Dynamic balancing certificates shall be furnished –grade 6.3 or better to ISO-1940. Balancing weights shall be positively locked to avoid loosening. Balancing weights and fasteners used shall be galvanized.		
4.7	Performance test of one Centrifugal fan/per type/per size as per AMCA standard (for indigenous make).		
4.8	Centrifugal fans for AHUs will be 100% run tested by main contractor of BHEL. One centrifugal fan/per type/per size will be run tested. Vibration shall be within good zone of VDI 2056 / ISO 10816-1(group- K) machines when measured on bearing housing and noise level <85 dbA at 1 metre distance. Max. Temp. on bearing housing- 40 degrees Centigrade + ambient.		
4.9	Complete assembly of one AHU/per type/ per size (excluding cooling coil and filter) shall be witnessed.		
4.10	Run test of one complete assembly/per type/per size (excluding cooling coil and filter). Vibration shall be within satisfactory zone of VDI 2056 / ISO 10816-1(group- K) machines when measured on bearing housing and noise level <85 dbA at 1 metre distance. Max. Temp. on bearing housing- 40 degrees Centigrade + ambient.		

**TECHNICAL SPECIFICATION****AIR HANDLING UNITS****SPECIFICATION NO.PES-553-02****VOLUME II B****SECTION D****REV. 02****DATE: 17.09.2012****SHEET 6 OF 6****5. DRAWINGS/DOCUMENT/DATA REQUIRED AFTER AWARD OF CONTRACT**

- 5.1 GA drawing of AHU & data- sheet to be submitted along with technical schedules enclosed in Volume III.
- 5.2 Drawing including equipment layout, foundation & loading details etc. for civil works. These drawings must cover sufficient details so that design of civil works can be completed.
- 5.3 Inspection, operation & Maintenance Manuals.
- 5.4 Equipment description giving complete design calculations, basis of design, selection criteria etc.
- 5.5 Test Certificates.
- 5.6 Final as built documentation i.e. final-version of all drawings, data & information as per the requirement specified elsewhere.
- 5.7 Performance Test Certificates.



AIR HANDLING UNIT
DATA SHEET - A

VOLUME - II-B

SECTION - D

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SHEET 1 OF 2

DESCRIPTION

DATA

1. Nos. required/working	: Refer to Section-C of Specific technical requirement.
2. Location	: Refer to Section-C of Specific technical requirement.
3. Service/type	: Air Conditioning /Double skin.
4. Fan type	: Centrifugal (forward/backward curve Blade) limit load.
a) Capacity	: To Suit as per calculation.
b) Static pressure	: To suit but not less than 60 mm wc for AHU's Micro-V filters.
c) Discharge direction	: To suit layout.
d) Motor	: By Bidder,
e) Local push button station (Start/Stop)	: By Others
f) Motor location	: Inside AHU Casing.
g) Drive	: Belt, pulley, belt guard.
5. Face and Bypass Damper	: Required (Opposed blade type) DX AHU's having
6. Cooling coil	
a) Duty sensible heat	: To suit as per calculations
b) Duty latent heat	: -do-
c) Type of coil	: Chilled Water/DX/Hot Water.
d) No. of rows	: To suit but not less than four (4)
e) Material of tube /Thickness	: Seamless Copper to ASTM-A-75/Equivalent.
f) Material of fins	: Aluminium to SAE-1100-/1145-0
g) Number of fins	: Not greater than 5 per cm (13 per inch).
h) Max. face velocity	: 2.5 m/sec.
i) Air flow quantity	: To suit as per tender drawings/documents.
7. 3 - way motorised mixing valve with thermostat.	: Required with thermostat & actuator for chilled water system for each AHU.



AIR HANDLING UNIT
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8.	Damper at discharge	: Manually operated at discharge of each AHU outlet.
	a) Material of construction	: Mild Steel, galvanised.
9.	Filters (Pre-filters)	
	a) Type & thickness	: Dry panel type/ 50 mm
	b) Filter area.	: To suit as per velocity requirements. "V" - Bank.
	c) Filter efficiency	: Average arrestance efficiency of 65-80 %
	d) Press drop (Clean)	: Not to exceed 2.5 mmwc when clean & 6.5 mmwc while dirty.
10.	Humidification section	: As per the System requirement.
	a) Type	: Pan type, unless otherwise specified.
	b) Operation	: Automatic with Humidification.
11.	Fresh air arrangement	: Required.
	a) Fresh air fan	: Tube axial flow fans with motor.
	b) Accessories	: i) Inlet cone with Bird screen. : ii) Dry panel pre-filters, : iii) High efficiency filters for control room areas. : iv) Volume Control Dampers, : v) Supports etc.
12.	Vibration isolator required.	: Yes
13.	Type of vibration isolator.	: Neoprene ribbed Rubber for AHU's.
14.	Any other requirement	: i) In addition to dry panel filters on AHU, High efficiency filters(average arrestance efficiency of 80-90 %) shall be provided in supply air duct side of AHU for all control room and allied areas. : ii) Bidder to also provide suitable electrical strip heaters for winter heating & monsoon reheating with Contactor box etc. Heaters to be interlocked with airstat.
15.	Instrument & controls	: Lot.(including Control box for strip heaters, pan humidifiers etc. in each AHU room.)
16.	Insulation of drain piping	: Lot.



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TECHNICAL SPECIFICATION

COOLING TOWER

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1. GENERAL

- 1.1 this standard specification covers the design, manufacture assembly, inspection & testing at manufacturer's works, suitable painting & packing, delivery, erection & commissioning at site of all materials and equipments for mechanical induced draught cooling tower complete with all accessories as specified hereinafter.

2. CODES & STANDARDS

- 2.1 the design, manufacture, inspection & testing and performance of the cooling tower as specified hereinafter shall comply with the requirements of all applicable latest Indian/British/American standards and codes of practice. the latest editions of the following standards & publications shall be followed in particular:
- 2.1.1 Cooling tower institute USA bulletin ATP-10S: Acceptance test procedure for industrial water-cooling tower.
- 2.1.2 PTC-23 ASME performance test code for Atmospheric water-cooling equipment.
- 2.1.3 In case of any conflict between the above codes & standards and-this specification, the later shall prevail.

3. DESIGN REQUIREMENTS

- 3.1 the cooling tower shall be designed for continuous operation to cool not less than design flow of water from specified inlet temperature to the outlet temperature at a design ambient wet bulb temperature as indicated under data sheet a.
- 3.2 all the components shall be capable of safe, proper and continuous operation at all cooling water flows upto & including those specified under data sheet a & shall be designed with regard to case of maintenance, repair, cleaning & inspection.
- 3.3 the cooling tower shall be of induced draught cross flow or counter flow type and with multiple cells (if specified in data sheet a.) the cooling tower shall be suitable for handling the fluid and also for achieving the specified parameter as per data sheet a. the cooling tower shall be designed such that the drift losses & evaporation losses are minimum.

4. CONSTRUCTIONAL FEATURES

4.1 CASING & LOUVERS

- 4.1.1 The cooling tower casing shall be made of FRP/as specified in data sheet A. The louvers shall be made of FRP/as specified. Louvers, if provided, shall be designed for air entry to the tower with low velocity for minimum pressure drop & less chance of recirculation of moist air. To eliminate splash out, louvers shall slope to shed water inwards. Air intake shall be all along the base circumference of the casing & hotdip galvanised expanded metal mesh shall be provided to protect the air intake.

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4.2	FILL
4.2.1	Cooling tower fills shall be made of noncombustible PVC/as specified in data sheet A. The design & arrangement of the fills shall be so as to expose maximum air/water surface with minimum pressure drop.
4.3	Drift Eliminators
4.3.1	Multi-pass drift eliminators with minimum two pass zig-zag path shall be provided so to minimise the drift losses.
4.3.2	In case of FRP cooling tower the drift eliminators shall be of multi-blade rotary type.
4.4	Fans & Accessories
4.4.1	The fans shall be multiple blade, low speed, high efficiency axial flow type located above the top deck level of the cooling tower. Fan rotating assembly shall be statically & dynamically balanced. The fan blades shall be preferably adjustable in stand still condition for propeller action. The fan shall be either directly mounted on the shaft of a totally enclosed weather proof motor or shall be suitable for V-belt drive.
4.4.2	The rating of drive motor shall have at least 15% margin over maximum fan power consumption. The design & construction of the drive motor shall be in accordance with enclosed specification for LVAC motors.
4.5	Water basin
4.5.1	The material of construction of water basin shall be FRP or RCC as specified in data sheet A. The basin shall be provided as a part of cooling tower in case of FRP construction. The sump shall have sufficient storage capacity for safe operation of AC plant.
4.6	Hot water distribution system
4.6.1	Manually operated flow control valves shall be provided in hot water distribution piping such that each cooling tower can be isolated without affecting the operation of other cells.
4.6.2	The nozzles shall be spaced to give even distribution of water over entire space occupied by top row of fills. The nozzles shall be made of brass /SS 304/316/316L (brass shall be as per manufacturer’s standard) unless specified in data sheet A:
4.6.3	In case of FRP tower water shall be distributed over the fill by means of a multiple area fail safe rotary sprinkler made of PVC pipes fitted on a aluminium alloy (as per manufacturers standard) rotary head and mounted on sealed ball bearings (make) .
4.7	Access
4.7.1	A stair case paddle ladder (as per manufacturer’s standard) shall be provided external to the cooling tower at one end of each tower along with stairways hand rails etc give safe & convenient access to the top deck from ground level.



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4.8 Painting

4.8.1 The cooling towers shall be painted with suitable anti-corrosive paint as per approval of purchaser. All galvanized external surfaces shall be painted to match colouring scheme. Before painting galvanized surfaces -etch primer to be applied.

5. SHOP INSPECTION & TESTING

5.1 Compliance certificates for nozzles (Or rotary sprinkler), piping, fill material, drift eliminator, louvers components etc.

5.2 Certificate of conformance for all other material components.

5.3 Balancing report for Static & dynamic balancing of fan assembly.

6. TESTS AT SITE

6.1 Hydrostatic testing of complete hot water distribution piping at site.

7. PERFORMANCE GUARANTEE

7.1 The cooling tower shall be guaranteed to meet the performance requirements as specified & when tested in accordance with ATP-105.

7.2 The vendor shall furnish performance curves for the cooling tower showing variations in performance from design duty point with change in approach to wet bulb temperature, cooling range, water loading of cooling tower.

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8.	<u>DATA TO BE FURNISHED BY VENDOR AFTER THE AWARD OF CONTRACT</u>
8.1	General arrangement drawing of complete cooling tower (showing plan, front elevation and side elevation) incorporating principal dimensions, limits of scope of supply of piping, limits of civil works included showing extent of platforms, walkways, handrails, access doors, staircase etc. and the limits of scope of supply of electrical works.
8.2	General arrangement and sectional assembly drawings pertaining to the following components of the cooling tower: i) Tower fill with supporting arrangement. ii) Drift eliminator installation and details. iii) Complete hot water distribution system including flow regulating valves, distribution basin/pipes and nozzles etc.
8.3	Cooling tower performance curves showing WBT Vs cold-water temperature for design cooling range, 90% cooling range and 110% cooling range at 100%, 90%, and 110% design flow.
8.4	Performance curves of cooling tower fans.
8.5	Test procedure along with details of tests to be conducted for the offered cooling tower.
8.6	Quality Plan along with complete details of the testing and inspection requirements of mechanical and electrical items of the cooling tower in BHEL format.
8.7	Operation and maintenance instructions.



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A. GENERAL DATA

- 1) Service : Cooling of condenser water of AC plant.
- 2) Type : Fibreglass reinforced plastic construction induced draught.
- 3) Quantity : Refer to Section-C of Specific Technical Requirements.
- 4) Place of installation : Refer to Section-C of Specific Technical Requirements.

B. DESIGN DATA

- 1) Capacity at specified conditions. : To suit the system requirement.
- 2) Water flow rate : To suit the system requirement.
- 3) Design wet bulb temperature : 25 Deg. C.
- 4) Hot water inlet temperature : To suit requirement.
- 5) Cooled water temperature : To suit requirement.
- 6) Depth of sump Tank : As per manufacturer's standard.

C. MATERIAL

- 1) Sump tank & Casing : FRP
- 2) Louvers : FRP/PVC/Aluminium.
- 3) Type of fill : Non-combustible PVC/Eq.
- 4) Nozzles : Brass with chrome plating/polypropylene.
- 5) Ladder : Hot dip galvanized steel ladder for each tower.
- 6) Bird screen : 25 mm square made of GI/SS wire mesh of 16 gauge.
- 7) Fan impeller : Cast Aluminium Alloy/FRP propeller type and multi-blade aerofoil construction with adjustable pitch..
- 8) Supporting structure : MS with spray galvanization of epoxy painting.
- 9) Strainer : Plant strainer made of GI/SS wire mesh of 16 gauge.

D. ACCESSORIES

- 1) Make up connection : Yes.



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- 2) Quick fill connection : Yes.
- 3) Overflow & drain & blow down connection : Yes.
- 4) Access door in louvers/fan deck : Yes (if applicable).
- 5) Supports & supporting structure for mounting : Yes.
- 6) Level switch : Yes.
- 7) Rain protection for motor : Yes (suitable Canopy by Bidder)
- E. ELECTRICAL DATA
- i) Power supply : 415 V $\pm$ 10%/50 Hz $\pm$ 3%/3 phase.
- ii) Motor : As per specification attached.
- F. INSPECTION & TESTING : As per approved quality plan.



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STANDARD TECHNICAL SPECIFICATION
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TECHNICAL SPECIFICATION
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1. GENERAL

1.1 This specification covers the design, manufacture, construction features, installation, inspection testing and air balancing of air distribution system upto a total pressure of 95mm w.g. The specification is intended to cover the air distribution for air conditioning system and ventilation system not involving localised exhaust.

2. CODES AND STANDARDS

2.1 The design, construction and performance of complete system shall conform to all currently applicable statutes, regulations, safety codes in the locality where the equipment are to be installed

2.2 Unless specified otherwise the equipments shall generally conform to latest applicable Indian Standards. Nothing in this specification shall be construed to relieve the vendor of this responsibility. In particular the equipment shall generally conform to latest editions by the following standards:-

- a) IS: 655 - Specifications for metal air ducts.
- b) IS:277 - Specifications for galvanised steel sheets.
- c) IS:737 - Specification for wrought aluminium and aluminium alloy sheet and strip.

3. MATERIAL

3.1 Metal air ducts shall be either of galvanised steel sheets or aluminium sheets, as indicated in data sheet-A.

3.2 The rolled steel sheets before galvanising shall be properly annealed or normalised so as to allow fabrication of ducts without developing cracks. Zinc coating on the steel shall be as per technical requirement refer to Section-C of Specific Technical Requirements.

3.3 The aluminium sheets shall be of grade S1C or NS3 and shall be suitable for duct fabrication work as per IS-737 latest

4. CONSTRUCTION/FABRICATION

4.1 The thickness of sheets, the type of bracing and other fabrication details shall generally conform to requirements given hereunder unless specified otherwise in data sheet A and/or indicated on drawings.

4.2 RECTANGULAR DUCTS

4.2.1

S.No.	Max Side	Sheet Thickness	Type of transverse	Bracings



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		(mm) GI	(mm) AI	Joint connections	
a)	Up to 600	0.63 (24G)	0.80	S-drive, pocket or bar slips or flanged joints on 2.5m centres	None
b)	601 to 750	0.63 (24G)	0.80	S-drive, 25mm pocket or 25mm bar slips or flanged joints on 2.5m centres	25x25x3 mm MS angles, 1.2m from joints
c)	751 to 1000	0.80 (22G)	1.00	S-drive, 25mm pocket or 25mm bar slips or flanged joints on 2.5m centres	25x25x3 mm MS angles, 1.2m from joints
d)	1001 to 1500	0.80 (22G)	1.00	40x40x3mm MS angle, flanged connections or 40mm pocket or 40mm bar slips with 35x3mm bar reinforcing on 2.5m centres	40x40x3 mm MS angles, 1.2m from joints
e)	1501 to 2250	1.00 (20G)	1.50	40x40x3mm MS angle, flanged connections or 40mm pocket or 40mm bar slips, 1M maximum centres, with 35x3mm bar reinforcing	40x40x3 mm diagonal angles or 40x40x3mm angles, 600mm from joints
f)	2251 & above	1.25 (18G)	1.80	50x50x3mm MS angles, connections or 40mm pocket or 40 mm bar slips, 1M maximum centres with 35x3mm bar reinforcing.	50x50x3mm diagonal angles or 50x50x3mm angles 600 mm from joints.
g)	No bracing is required if transverse joints are less than 600mm apart				
h)	For ducts larger than 2250mm, special handling and supporting methods shall be provided as per the approval of Purchaser				

4.2.2 All rectangular ducts having either dimension larger than 450mm shall be cross broken except these ducts which are insulated with sand cement plaster. Air outlet connections on ducts need not be cross broken.

4.2.3 The seams on duct cones shall be of Pittsburgh type. Longitudinal seams shall be smooth inside the ducts.

4.2.4 The flanges used for transverse joints shall be joined together with GI bolts (grade 4.6) and nuts spaced at 125mm centres as per following:

- a) Upto 1000mm - 6 mm dia GI bolts
- b) 1001 to 1500 - 8 mm dia GI bolts
- c) 1501 and above - 10mm dia GI bolts



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4.2.5 The MS angle flanges shall be connected to ducts with rivets at approx. 100mm centres. The flanged joints shall have 6mm thick felt packing stuck to flanges with shellac varnish. The holes in the felt packing shall be burnt through. The ducts are to be tapped 6mm across the MS flanges.

4.2.6 MS angles used for bracings shall be tack welded to the ducts or rivetted at 125mm centres, as applicable.

4.3 ROUND DUCTS

4.3.1

S.No.	Duct dia-mm	Sheet Thickness		Reinforcing
		(mm) GI	(mm) Al	
a)	Up to 150	0.63 (24G)	0.80	None
b)	151 to 600	0.80 (22G)	1.00	None
c)	601 to 1000	1.00 (20G)	1.50	40x40x3mm girth MS
d)	1001 to 1250	1.00 (20G)	1.50	40x40x3mm girth MS angles at 2.0 meter centres
e)	1251 & above	1.25 (18G)	1.80	40x40x3mm girth MS angles at 1.2m centres

4.3.2 The seams on round ducts may be continuously welded or grooved longitudinal seam. In case of welding of GI sheet, zinc rich paint shall be applied on the welded zone.

4.3.3 Round ducts shall either be joined by welding or the ducts shall be swedged 40mm from the ends such that larger end will butt against the swedge and is held in place with sheet metal screws.

4.4 DUCT SUPPORTS

Unless specified otherwise on drawings, rectangular ducts with larger side of 2250mm or above shall be supported by 15mm MS rods and 50x50x3mm and MS angles while those below 2250 mm shall be supported by 10mm MS rods and all angles shall be given a coat of primer paint. The duct supports shall be at a distance not exceeding 1800mm. The MS rods shall be fixed to MS angle cleats, which in turn are fixed to ceiling slab by suitable anchor fasteners. All anchor fasteners, MS angle cleats, coach screws, hooks and other supporting material required shall be provided by vendor.

However, If ducts are thermally insulated, the MS angles and supports shall not be in

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direct contact with ducts, for which purpose wooden pieces/ Resin bonded fibre glass sheets (50 mm thick) shall be used in between.

4.5

FLEXIBLE CONNECTIONS

Wherever the sheet metal ducts connects to intake or discharge of fan units a flexible connection of at least 150mm width made by closely woven double layer Fire resistant or canvas shall be provided. The same shall be attached to angle iron frames on equipment and to similar frame on duct or casing by means of a steel band 9r (or) collar fitting over the end of the flexible connection and bolted through angle iron frame so as to clamp securely between the band and the angle frame.

4.6

TRANSFORMATIONS AND BREACHES

All curves, bends, offsets and other transformations shall be made for easy and noiseless flow of air. The throat of every branch duct shall be sized to have a velocity not exceeding that in the main duct to which the branch is connected.

4.7

CAULKING

Wherever duct passes through wall, the opening between masonry and duct work shall be neatly caulked or sealed to prevent movement of air from one space to adjoin by space with a rated fire resistant material.

4.8

EASEMENT

Normally pipe hangers, light fitting rods etc. shall not be allowed to pass through the ducts. Wherever, It becomes absolutely essential to pass these hangers/rods etc. Through the ducts, prior approval of purchaser shall be taken and light streamlines easement around the same shall be provided to maintain smooth air flow.

4.9

ACCESS DOORS

Access doors shall be provided in ducts, plenums etc. on both sides to allow access and servicing of equipment viz. pipes, dampers, coils, valves, heaters etc.

All access doors shall be adequately sized and lined suitably with felt to prevent air leakage. The doors shall be of built-up construction, structurally strong and shall have at least two hinges each, and shall be with two rust proof window sash locks of approved type. All doors shall be so set as to flush with outer finish of duct insulation etc.

4.10

DAMPERS AND SPLITTERS

4.10.1

Dampers and splitters shall be provided at suitable points for proportional volume control of the system. Splitters and dampers shall be made of minimum 18 gauge GSS of quadrant type with locking device mounted outside the duct at accessible location.

4.10.2

FIRE DAMPERS

Fire dampers shall be provided as specified in Data Sheet -A and shall be installed at locations indicated on drawings and/or as required/approved by purchaser, including all openings in passage of duct work through fire walls and floors etc. The fire damper shall be of electrical type with damper motor actuated by thermal

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sensor or fusible link type.

4.10.3

VANES

Unless otherwise shown in the drawings all elbows shall be such that the throat radius is 75% of the duct width. In case throat radius is smaller, suitable single thickness vanes of approved details shall be provided.

4.10.4

FLASHING

For the ducts penetrating roofs or outside walls, provision of flashing shall be made by the ducting vendor.

4.11

DIFFUSERS AND GRILLS

The type and quantity of diffusers and grills is indicated on enclosed drawings/data sheet A. The size/quantity of diffusers/ grills indicated in the drawing/data sheet is indicative and is for vendor’s reference purpose only. Vendor shall ensure that the diffusers/grills offered are of requisite capacity, throw and terminal velocity. The pressure drop and noise levels shall be as per data sheet. A enclosed. The diffusers/grills shall be approved by purchaser.

Unless specified otherwise the diffusers/grills shall be of mild steel land painted with two coats of primer paint. Supply air grills shall be complete with volume control dampers. Supply air grills shall be double deflection type while Return Air grills can be single deflection type. Ceiling outlets/diffusers shall have volume control dampers, fixed grids and blanking baffles. All volume control dampers shall be operated by a key from the front of grills/diffusers.

Suitable vanes shall be provided in duct collars to have uniform air distribution. Blank-off baffles wherever required, shall also be provided.

4.12

PLENUMS AND RA BOXING

All plenum chambers and/or connections to fans, dampers etc. shall be constructed in 18 gauge GI sheet. supported on 40x40x6mm MS angle frames. All vertical angles shall be riveted at appox. 125mm. centres to the casing. Suitable caulking compound (Pecora or equivalent) shall be inserted between the base of the angle and all masonry construction to which angles are fastened.

Return air boxing requirements if any are indicated in data sheet-A and the same shall be provided by vendor. The return air box shall be fabricated out of GI sheets shall be insulated with 25mm thick fibre-glass.

4.13

ACCOUSTIC LINING

The ducts shall be lined acoustically from inside as given in data- sheet A and/or section C of the specification.

4.14

PAINTING

Wherever specified the ducts shall be painted or lined with suitable anti-corrosive paint/ lining as per approval of purchaser. In particular the ducts coming in contact with acid fumes shall be epoxy coated, inside and outside.

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4.15

THERMAL INSULATION

Thermal insulation shall be as per data sheet - A and the insulation shall conform to enclosed spec. no. PES-553-08.

5.

INSPECTION AND TESTING

5.1

INSPECTION & TESTING DURING FABRICATION

5.1.1

Visual inspection of GI sheets and angles, channels etc. – dents, black spots, chipping of zinc coating, white dust on galvanised sheets shall be avoided. Pitting , lamination in angles and channels shall be avoided.

5.1.2

Galvanised sheets - Test certificate shall be furnished for visual check, coating thickness, adhesion test, sheet thickness, uniformity of coating.

5.1.3

Check for dimensions & mass as per latest IS-277.

5.1.4

Check for defect, twists, ungalvanised spots as per IS-2629.

5.1.5

Bend test & wrapping test as per IS-277.

5.1.6

Zinc coating test on samples as per IS-6745.

5.2

INSPECTION & TESTING AT SITE.

5.2.1

The duct branches, elbows etc. shall be inspected and the joints and connections etc, are to be checked before they are assembled in position.

5.2.2

After completion, all duct systems shall be checked and tested for air leakage, tightness, velocity, pressure drop, vibration and noise etc.

6.

BALANCING

6.1.1

The entire air distribution system shall be balanced by vendor to supply the air quantities as required in various rooms so as to maintain the requisite temperature and air flow in the conditioned spaces. The final balance of air quantities through each grill/diffuser etc. shall be recorded and submitted to purchaser for approval. Proper steps shall be taken to have a uniform temperature in all enclosures, with utmost care for noise level to be within tolerance limit

6.1.2

All instruments required for testing/balancing etc. of the air distribution system shall be provided by vendor.



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7. DATA TO BE FURNISHED BY VENDOR AFTER THE AWARD OF CONTRACT

- 7.1 Fabrication drawings of ducts and grilles, louvers, dampers, etc, including typical details of grilles dampers etc.
- 7.2 Test certificates in line with scope of inspection.
- 7.3 Other dimensional drawings & documents as may be required by purchaser for better understanding of the system & for preparation of operation, maintenance & instruction manual.



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Description**Data**

1. General (List of areas)	: As per Specification/Tender drawing.
2. GSS Duct Work	
a) Type	: GSS as per IS: 277 (Zinc coating as per Section-C of Specific Technical Requirements.)
b) Size	: As per Section-C of Specific Technical Requirements and bill of quantity.
3. Acoustic lining	: Up to 5m length from AHU Outlet.
4. Special painting	: Galvanised.
5. Thermal Insulation	: Required in supply air duct in AC entire length.
6. Diffusers (Circular/Square)	
300 mm size	} : Bidder to estimate as per drawings./specification. All grille frame and louvers shall be manufactured of at least 16 SWG Aluminium
350 mm size	
450 mm size	
550 mm size	
600 mm size	
Any other size	
7. SA grilles (for each size)	: To suit air flow as per System requirements / Tender Drawings.
8. RA grilles (for each size)	: -do-

NOTE:

1. Duct sheet thickness shall be as per IS-655
2. Opposed blade type volume control damper shall be provided at each supply air diffusers/grilles.
3. Bidder to provide suitable gasketing at each duct flange.
4. Fire damper shall be motor operated type, when otherwise specified under Section-C.
5. Access door in ducting system shall be provided as required.
6. MS Angle (painted) shall be used for duct supports etc.
7. Velocity thru duct shall normally not exceed 9.0 M/sec for Air conditioning system. Maximum velocity (outlet) for supply air diffuser shall not exceed 2.5 m/sec.



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8. All Grilles & diffusers shall be supported with frame. Frame etc. shall be supplied by bidder.



TECHNICAL SPECIFICATION
CENTRIFUGAL PUMPS

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TECHNICAL SPECIFICATION
CENTRIFUGAL PUMPS

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1. GENERAL

1.1 This specification covers the design, material, constructional features, manufacture, assembly, inspection and testing at manufacturer's or his subcontractor's works, suitable painting requirements of centrifugal pumps and drives complete with all accessories as specified hereinafter.

2. CODES AND STANDARDS

2.1 The design, manufacture, inspection, testing & performance of the pumps as specified hereinafter, shall comply with the requirements of the latest revision of the following standards as indicated below (as applicable):

- 2.1.1 IS-1520 : Horizontal centrifugal pumps for clear, cold and fresh water.
- 2.1.2 IS-5120 : Technical requirements - Rotodynamic special purpose pump.
- 2.1.3 IS-1710 : Vertical turbine pumps for clear, cold and fresh water.
- 2.1.4 BS - 599 : Method of testing Pumps.
- 2.1.5 PTC - '6' : Centrifugal Pumps Power test code
- 2.1.6 API - 610
- 2.1.7 Hydraulic Institute Standards of USA

Wherever standards for certain aspects materials etc., not mentioned, the same shall be as per the applicable Indian or International standards.

2.2 In case of any conflict between the above codes/standards and this specification, the later shall prevail and in case of any further conflict in this matter, the decision of Purchaser's engineering shall be final and binding.

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3.

DESIGN REQUIREMENTS

3.1

The pumps shall be of heavy duty suitable for long periods of uninterrupted service and shall be standard product of the manufacturer thoroughly proven for satisfactory performance and reliability.

3.2

The materials of construction of various components shall be as indicated under Data Sheet-A and where not specified to the applicable Indian/British/American standards..

3.3

All pressure containing components including the pump casing, nozzles and stuffing box housing shall be designed, fabricated and tested in accordance with applicable Indian standards if not specified otherwise.

3.4

The pump shall be suitable for handling the fluid as specified in Data Sheet-A.

4.

CONSTRUCTION FEATURES:

4.1

PUMP CASING

4.1.1

Pump casing may be axially or radially split or barrel type construction as specified in the pump data specification sheet. The casing shall be designed to withstand 1.5 times the maximum pressure developed by the pump at the pumping temperature.

4.1.2

Pump casing shall be provided with adequate number of vent and priming connections with valves, unless the pump is made self venting & priming. Casing drain, as required, shall be provided complete with drain valves or plugged with threaded plugs as required.

4.1.3

Pump shall preferably be of such construction that it is possible to service the internals of the pump without disturbing suction and discharge piping connections.

4.1.4

Under certain conditions, the pump casing nozzles will be subjected to reactions from external piping. Pump design must ensure that the nozzles are capable of withstanding external reactions not less than those specified in API-610

4.2

IMPELLER

4.2.1

Unless specifically indicated under Data Sheet-A enclosed, the pump impellers shall be of closed vane type. The impellers shall be secured to the shaft and shall be retained against circumferential movement by keying, pinning or lock rings. Impellers shall be checked for eccentricity and statically and dynamically balanced individually. The assembled rotor shall be dynamically balanced and checked for eccentricity. Supplier shall ensure during balancing that wall thickness of impeller vane, shroud etc is maintained above the minimum thickness requirement as per design.

4.3

WEARING RING

4.3.1

Renewable wearing rings for the casing and/or the impellers and renewable shaft sleeves, shall be provided for all pumps. Length of the shaft sleeves must extend



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beyond the outer faces of gland packing or seal and plate so as to distinguish between the leakage between shaft & shaft sleeve and that past the seals/gland.

4.4 SHAFT

4.4.1 Shaft size selected shall take into consideration the critical speed which shall be away from the operating speed as recommended in applicable Code/Standard. The critical speed shall also be at least 10% away from runaway speed.

4.5 BEARING

4.5.1 Bearings and hydraulic devices, of approved make, (if provided for balancing axial thrust) of adequate design shall be furnished for taking the entire pump load arising from all probable conditions of continuous operation throughout its Range of Operation and also at the shut off condition. The bearing shall be designed on the basis of 20,000 working hrs minimum for the load corresponding to the duty point. Proper lubricating arrangement for the bearings shall be provided. The design shall be such that the bearing lubricating element does not contaminate the liquid being pumped. Where there is a possibility of liquid entering the bearing, suitable arrangement in the form of deflectors or otherwise shall be provided ahead of bearing assembly. Bearings shall be easily accessible without disturbing the pump assembly.

4.6 STUFFING BOX

4.6.1 Packed type stuffing boxes of adequate depth with lantern rings shall be provided to minimize the leakage. In all cases where the pump suction is below atmospheric pressure, the shaft packing shall be sealed by the liquid pumped by tapping off from the pump discharge itself and all pipes, valves, fittings etc., required for this shall be furnished by the manufacturer. Tubings used for connections shall be flexible metallic type preferably SS-304/316. PVC/ rubber tubings are not acceptable.

4.7 SHAFT COUPLING

4.7.1 The pumps shall be directly coupled to their drives through heavy-duty flexible coupling. Suitable sturdy coupling guards of min. 1.5 mm MS sheet/ Aluminium sheet shall be provided along with the coupling. The pump and its drive motor shall be mounted on a common base plate.

4.8 BASE PLATE AND SOLE PLATE

4.8.1 Unless otherwise stated the data specification sheet, a common base plate mounting both for the pump and drive shall be furnished. The base plate shall be of rigid construction, suitably ribbed and reinforced. Base plate and pump supports shall be so constructed and the pumping unit so mounted as to minimize misalignment caused by mechanical forces such as normal piping strain, hydraulic piping thrust, etc. Suitable drain taps and drip lip shall be provided. The external corners of the base plate shall be rounded to avoid sharp corners. Drilled holes shall have sufficient space around for proper seating of washer with nut. If required in the data specification sheet, steel sole plates shall be provided, below the base plate.

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4.9	PRIME MOVER
4.9.1	The drive motor selected shall conform to the requirements of the enclosed motor specifications.
4.10	LIFTING ARRANGEMENT
4.10.1	Each pump and motor shall incorporate suitable lifting attachments e.g. lifting lugs or eye bolts etc., to facilitate erection and maintenance..
5.	<u>PERFORMANCE REQUIREMENTS</u>
5.1	The pump shall be designed to have best efficiency at the specified duty point. The pump set shall be suitable for continuous operation at any point within the Range of Operation as stipulated in the data specification sheets.
5.2	Pump shall have a continuously rising head capacity characteristics from the specified duty point towards shut off point, the maximum being at shut off. Power capacity characteristic will be non-overloading type i.e. 110% of the design flow the power required to drive the pump will be practically the same as that at the design flow.
5.3	Wherever specified in data sheet, pumps of each category shall be suitable for parallel operation. The head vs capacity, input power vs. capacity characteristics, etc., shall match to ensure equal load sharing and trouble free operation throughout the range.
5.4	The pump motor set shall be designed in such a way that there is no damage due to the reverse flow through the pump which may occur due to any malfunction of the system.
6.	<u>DRIVE RATING</u>
6.1	The power rating of the drive shall be selected such that a minimum margin of 15% is available over the pump input power required at the rated duty point. However, the drive rating shall not be less than the maximum power requirement at any point within the ‘Range of Operation’ specified.
6.2	In cases where parallel operation of the pumps are specified the actual drive rating is to be selected by the bidder considering overloading of the pumps in the event of tripping of one of the operating pumps.
6.3	The bidder under this specification shall assume full responsibility in the operation of the pump and the drive as one unit.
7.	<u>SCOPE OF INSPECTION AND TESTING</u>
7.1	CASTING
7.1.1	The Witnessing pouring and thereafter physical testing of castings of ‘Critical’ nature such as casings, impellers, diffusers. Castings shall have ‘as cast’ heat numbers

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		unless they require overall machining. For partially machined components manufacturer shall ensure availability of as cast heat nos. on unmachined area.	
7.1.2	Identification and correlation with test reports for all tests as per the relevant material specifications for castings of ‘Major’ nature such as suction bell, discharge elbow, stuffing box, gland, wearing rings, shaft sleeves etc.		
7.1.3	Foundry’s conformity certificate for castings of ‘Minor’ nature such as base plates, covers etc.		
7.1.4	Verification of Heat treatment charts (as applicable)		
7.1.5	Castings may be required to meet NDT requirements such as Radiography, Magnetic Particle Testing or Dye-penetrant testing prior to Hydro-test as per requirements specified in Quality Plan.		
7.1.6	Surface finish of Steel castings shall meet MSS SP-55.		
7.2	FORGING		
7.2.1	Identification and correlation with mill test certificates for all tests as per the relevant specifications for important forgings like casings, stage bodies, diffusers, shaft material.		
7.2.2	Verification of heat treatment charts (time temperature) (as applicable).		
7.2.3	Forgings may be required to meet NDT requirements such as Radiography, Magnetic Particle Testing or Dye-penetrant testing prior to Hydro-test as per requirements specified in Quality Plan.		
7.3	FABRICATED ITEMS		
7.3.1	Identification and correlation with mill test certificates for material of items such as discharge bellows, column pipes etc.		
7.3.2	Approval of welding procedure specifications and qualifications of weld procedures and personnel as per ASME Sec IX.		
7.3.3	Dye penetrant tests of weldment as per ASTM E-165 and acceptance norm as per ASME Sec.VIII, Div.1, Appendix 8		
7.3.4	Verification of heat treatment charts (time temperature), (as applicable)		
7.3.5	Note: For para 7.1.2, 7.2.1 and 7.3.1 above; in case correlating original test certificates are not available, material shall be identified by Main Vendor and test conducted at NABL approved Laboratory.		
7.4	IN PROCESS INSPECTION AND TESTING		
7.4.1	Identification Dye penetrant testing after machining for impellers including vanes, pump shaft, diffusers as per applicable code; in absence of which, as per ASTM E - 165. Permissible defects and acceptance norms need to be specified. On static parts acceptance norms are as per ASME Sec.III NB 2546.		
7.4.2	Ultrasonic testing of dynamic duty component, i.e. pump shafts (50mm dia and above) and static duty forgings i.e. Barrel, casting (15mm and above wall thickness)		

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		as per applicable code, in absence of which as per ASTM E388 and acceptance norms as stipulated hereunder. Probe shall be of min. 2 MHz frequency.	
7.4.3	Acceptance norms for UT for dynamic duty components. the following defects are unacceptable		
	a) Cracks, flakes, seams and laps		
	b) Defects giving indications longer than that from a 4mm equivalent flaw.		
	c) Group of defects with maximum indications less than that from a 4mm equivalent flaw, which cannot be separated at testing sensitivity, if the back echo is reduced to less than 50%.		
	d) Defects giving indications of 2 to 4mm dia. equivalent flaw separated by distance less than four times the size of the larger of the adjacent flaw.		
7.4.4	For static duty components - as per NB 2542.2 of ASME Sec. III		
7.4.5	Hydro tests of all pressure parts such as casings, column pipes, discharge elbows etc., at two times duty point pressure or 1.5 time shut off pressure, whichever is higher for 30 min., without any leakage.		
	Note : In case the pump is required to boost certain pressure, the inlet pressure head shall also be taken into consideration to compute test pressures		
7.4.6	Static and dynamic balancing of individual impellers and also assembled rotors as per V.D.I. 2060 Q 6.3 or ISO 1940 G 6.3.		
7.5	PERFORMANCE TEST		
7.5.1	Pump testing with unit supply motor as per specifications and acceptance norms cited elsewhere, in absence of which as per IS 5120 latest edition. Performance shall be checked for minimum of 7 points (including shut off head and over load) following characteristics shall be checked.		
	a) Capacity V/s Head		
	b) Capacity V/s Power absorbed by pump		
	c) Capacity V/s pump efficiency		
	Note : For pump of fire protection system, performance test shall be conducted up to 150% of rated capacity.		
7.5.2	NPSH test in case specifically mentioned elsewhere.		
7.5.3	Vibration, noise level and temperature rise measurement. Noise level shall be within 85dB(A) at 1 metre distance. Vibration within satisfactory zone of VDI 2056 Group G machines. Temperature shall not exceed ambient + 40 deg. C.		
7.5.4	Overall dimensions as per GA drawings. One pump/type/size assembly with job motor shall be mounted on base plate, provided the components are ordered on the same manufacturer.		
7.5.5	Examination after selective opening up after running for pumps operating at speed over 1800 rpm and capacity exceeding 68M3/hr.		
7.5.6	Painting and packing as per technical specification.		



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7.6 TEST AT SITE

7.6.1 The pumps will be tested at site by the purchaser to verify their performance. If the pumps fail to operate smoothly or within the required performance all such deficiencies shall be rectified by the manufacturer by making suitable alternatives in the pump set and additional tests required to show the effect of such alterations shall be performed by him.

7.7 PERFORMANCE GUARANTEE

7.7.1 The vendor shall guarantee the material and workmanship of all components as well as the operation of the pump as per requirement of this specification. The vendor shall also guarantee for each pump the total dynamic head at the specified rated capacity and also corresponding efficiency, brake horse power and shut off head

8. CLEANING, PROTECTION , PAINTING & PACKING

8.1 Before shipment of the equipment to be supplied under this specification the necessary cleaning, flushing etc., as per manufacturers standard/ as specified for the contract in Data Sheet A/ elsewhere shall be done to remove all dirts, scales etc. Shop coats of rust inhibiting paints, lacquers etc., shall be applied to various parts as per manufacturers standard/ as specified for the contract in Data Sheet A/ elsewhere. Flanges, inlet and outlet pipe, etc shall be protected. Packing shall be done as per manufacturers standard/ as specified for the contract in Data Sheet A/ elsewhere.

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9.

DRAWINGS, TECHNICAL DOCUMENTS AND OTHER INFORMATION REQUIRED WITH THE PROPOSAL

9.1

Fully dimensioned outline GA drawings of the pump motor assembly unit for each type and size offered. This drawing should include:

a)

Foundation base plate and sole plate details as applicable

b)

Civil foundation and anchor bolts details and loading data

c)

Minimum submergence required for the pump (if applicable)

9.2

Cross sectional drawing of the equipment showing the details of assembly of components and their material of construction and/ make with standard applicable codes.

9.3

Performance characteristics (Discharge capacity vs head, BHP and efficiency of the pumps.

9.4

Motor speed torque curve superimposed on pump speed torque curve. Required NPSH of pump.

9.5

Experience list about the supply and successful operation of similar pumps for similar application.

9.6

A comprehensive write up or brochure on the details of manufacturing and testing facilities in the shop of the manufacturer.

9.7

Quality plan for the equipment being offered, in BHEL format as practiced in the manufacturer’s works and Field Quality Plan for receipt, storage erection, commissioning & testing at site.

9.8

Data sheet-B with all the particulars filled in.

10.

MANUFACTURERS NAME AND TAG. PLATES

10.1

Each pump shall have a permanently attached brass/ Stainless steel tag on the body indicating the following information both in Hindi and English:

a)

Manufacturer’s name and trade mark.

b)

Design Capacity and Head.

c)

Design.

d)

Purchaser’s tag no. as furnished during the contract. The purchaser’s tag no. will be indicated by the Purchaser on the drawing submitted for approval by the vendor.



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11. DRAWINGS/DOCUMENT/DATA REQUIRED AFTER AWARD OF CONTRACT

- 11.1 Certified GA drawings of pump motor assembly weights, crane.
- 11.2 Detailed cross sectional drawings of the pump and motor assembly and all equipment & accessories supplied under the this specification along with details of material of construction with applicable standard codes.
- 11.3 Foundation drawings with details of foundation pocket indicating static as well as dynamic load and other data with dimensions.
- 11.4 Certified characteristics curves (discharge capacity vs. head, BHP and efficiency) of each type of pump and motor.
- 11.5 Material and other test certificates as required by the application clauses of this specification.
- 11.6 Motor speed torque curves super imposed on pump speed torque curves.
- 11.7 Quality plan along with complete details of testing and inspection requirements of centrifugal pumps in BHEL format. Vendor shall also furnish Field Quality Plan.
- 11.8 Installation , operation and maintenance manual.
- 11.9 Other drawings and data, if necessary.



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DESCRIPTION

DATA

1. Designation	: Condenser water and Chilled Water pumps for AC plant.
2. Type	: Horizontal, Centrifugal pump or vertical split type casing pump .
3. Quantity	: Refer to section-C of Specific Technical Requirements
4. Installation	: On floating type foundation.
5. Fluid to be handled	: Water
6. Temperature of fluid	: To suit.
7. Capacity M3/hr and TDH at rated	: To suit system requirements but head shall not be less than 25 MWC.
8. Duty	: Continuous (24 hours / day)
9. Suction condition	: Flooded
10. Type of drive	: Direct
11. Prime Mover	: LV AC motor
12. Maximum speed	: 1500 RPM
13. Type of lubrication	: Grease Lubrication
14. Material	
a) Impeller	: Bronze to Grade IS: 318 Grade 2
b) Pump shaft	: EN - 8 / Equivalent (Approved).
c) Casing	: CAST IRON TO IS: 210 Grade - 260.
d) Wearing ring	: Bronze to Grade IS:318 GR-2, Renewable type.
e) Shaft Sleeve	: -do-
f) Base plate	: Cast Iron to Grade FG-200 IS-210/M.S. fabricated.
g) Bolt and nuts.	: MS
h) Stuffing Box gland/bush case.	: Deep Bronze packing to be renewable with



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i) Stuffing box Packing. : Flexible Graphite or PTFE (Asbestos shall not be used)

j) Pump motor coupling. : Flexible.

15. ACCESSORIES REQUIRED:-

The following accessories shall be provided by the bidder for each pump:

a) Suction & Discharge pressure gauges. : Yes.

b) Vent connection : Yes.

c) Drain piping up to common drain point : Yes
in plant room.

d) Companion flanges. : Yes

e) Common base plate. : Yes.

f) Suction strainer. : Yes

g) Isolating valve : Yes

h) NRV at pump outlet at inlet/outlet : Yes

i) Any special requirements : The Chilled Water pumps shall be suitably insulated as per spec.

j) Inspection & Testing : As per specification enclosed elsewhere.



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**STANDARD TECHNICAL SPECIFICATION
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1 GENERAL

- 1.1 This specification covers the design, manufacture, inspection and testing at the manufacturer's works and suitable packing delivery and testing of the packaged air conditioning unit.

2 CODES AND STANDARDS

- 2.1 The design, manufacture, inspection, testing and performance of the packaged type air conditioning unit shall comply with all statutes, regulations and safety codes currently applicable in the locality where the equipment will be installed. The equipment shall also conform to the latest editions of the codes and standards specified herein under. Nothing in this specification shall be construed to relieve the vendor of this responsibility.

In particular, the packaged air conditioning Unit (max 7.5 TR capacity, ductable or non ductable type) or cassette type (up to 5 TR) shall conform to the latest editions of the following standards:

- 2.1.1 I.S.660 : Safety code for Mechanical Refrigeration.
- 2.1.2 I.S.5111 : Code of practice for measurement, and testing of refrigerant compressor.
- 2.1.3 I.S.659 : Safety code for air conditioning.
- 2.1.4 I.S.2494 : V Belt for industrial purpose.
- 2.1.5 I.S.3142 : V grooved pulleys for V Belts.
- 2.1.6 I.S.4503 : Shell and tube type heat exchanger.
- 2.1.7 ARI 210 : Standard for/unitary air conditioning equipment
- 2.1.8 ARI 270 : Standard for application installation and servicing of unitary equipment.
- 2.1.9 ASHRAE-37 : Standard methods of testing for rating unitary air conditioning and heat pump / equipment.
- 2.1.10 ANSI-B9-1 : Safety code for mechanical refrigeration.

3 DESIGN AND CONSTRUCTIONAL REQUIREMENTS

3.1 Compressor

The compressor shall be hermetic or semi-hermetic or screw rotary type or scroll type. The same shall be suitable for R410A/R407C/R134A refrigerant. The compressor shall be mounted on anti-vibration spring/rubber pads and shall be positioned in such a way that it is freely accessible with sufficient space all around for easy maintenance. Safety controls like High and Low pressure cut-out overload and single phasing protection for the motors shall be provided. A crankcase heater shall also be provided, if considered necessary by the vendor.

3.2 CONDENSING UNIT

Shell and tube type water cooled condenser or air cooled condenser with adequate area shall be provided as specified in Data Sheet-A. The condensing unit shall be complete with



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multi-pass heads and shall be fitted with the following:

- 3.2.1 Hot gas inlet and liquid outlet connection with shut off valve for liquid.
- 3.2.2 Drain plug, air vent and test valve.
- 3.2.3 Water inlet and outlet connection with thermowell and suitable cocks respectively.
- 3.2.4 Relief valve and air purge valve (Fusible plug in place of relief valve not acceptable)
- 3.2.5 Any other accessory as recommended by the manufacturer for proper functioning of the equipment.

3.3 AIR HANDLING FAN

The air handling fan shall be of the centrifugal type and with forward curved blades. This shall be driven by means of a three phase induction motor through V belt drive. The fan static pressure shall be selected for passing air through high efficiency absolute filters, if specified in Data Sheet-A.

3.4 FILTERS

Filters shall be of dry panel type and shall be cleanable. The velocity of air across the filters shall not exceed 1.75m/sec (350FPM).

3.5 COOLING COIL

The cooling coil shall be of direct expansion type and shall be made of heavy gauge copper with aluminium fins. The fins shall be bonded to the copper tubes under hydraulic pressure. A distributor shall be provided for feeding the refrigerant to different sections of the coil. Rows shall be staggered in the directions of airflow. The velocity of air across coil shall not exceed 2.5M/Sec. (500 FPM).

3.6 CONTROLS

All necessary controls and accessories like thermostatic expansion valve, refrigerant solenoid valve, distributor, filter drier in the liquid lines, shut off valves, HP/LP cut out for compressor, thermostat with adjustable settings, overload and single phasing preventer for motor etc. are to be provided. The microprocessor based control panel shall be provided outside the packaged unit on one side. The control panel shall generally be in line with the specification for control panels given elsewhere.

The control shall be so interlocked that the fan shall be started independently first, and then only the compressor. Tripping of the compressor by the thermostat or compressor cut outs shall not trip the fan. The thermostat setting shall be adjustable

3.7 REFRIGERANT PIPING

The refrigerant piping shall be either heavy gauge copper as furnished in Data Sheet-A. The piping shall be completely factory assembled, pressure tested, dehydrated and initially charged with FREON gas and compressor oil. The line accessories shall include liquid line shutoff valve dehydrator, strainer, flow indicator and distributor etc.

3.8 CABINET

All the equipments, except control panel, mentioned above shall be provided within a heavy gauge sheet metal cabinet, of floor/ wall mounted type. This shall be given two coats of anti-corrosive and rust proof paint, finished with two coats of final paint. Painting shall be as per manufacturers std unless specified otherwise in data sheet 'A'. The interior of the cabinet shall be provided with thermal and acoustic insulation of minimum 25mm thick. The insulating material shall be fire proof.



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The front and back side of the cabinets shall be easily removable providing maintenance to all the interior parts.

All the electric wires within the cabinet shall run in flexible conduits and carry identification tags. The bottom side of the panel shall be specially ribbed to take care of the transportation.

3.9 OTHER ACCESSORIES

Each packaged air conditioner shall be provided with required number of neoprene rubber isolating pads.

4 CONTROL AND INTERLOCK REQUIREMENTS

The compressor shall have all protective devices like HP/LP cutouts, overload protection for the motor, single phasing preventor for motor etc.

The interlocking requirement shall be as indicated below:

4.1 The compressor shall not start, unless condenser water flow is achieved for water cooled condenser. The condenser flow shall be sensed by means of a flow switch.

4.2 The compressor shall not start unless the evaporator fan is started.

4.3 The tripping of compressor on HP/LP, overload or on thermostat shall not trip the fan.

4.4 Strip heater (if provided in the ducting system) shall not be switched on, unless the evaporator fan is started and airflow is established. For this purpose, an air stat on flow switch shall be used. The heater shall be separately controlled by humidistat/thermostat

4.5 A humidifying package, if specified in data sheet A, shall be controlled by humidistat.

5 TEST AND INSPECTION

5.1 Inspection and Testing at Manufacturer's Works

5.1.1 static and dynamic test for fans

5.1.2 Hydrostatic static test on condenser and cooling coil.

5.1.3 vacuum/pressure test for the complete refrigeration circuit.

5.1.4 Visual and Free running test of the packaged unit on test bed.

5.1.5 Free running test on compressor.

5.1.6 AIR CAPACITY WITH ANEMOMETER.

5.1.7 NOISE LEVEL- ≤ 85 dB(A).

5.1.8 Other tests as per approved qualities plan/scope of inspection.

5.2 Inspection and Testing at Site

5.2.1 Performance testing of the packaged unit for 72 hours in summer / monsoon & 24-hours in winter- Up-to 3 TR (individual M/c capacity) inside room temperature (Dry & wet bulb) will be checked with all machines in the room operating.

The actual days of testing shall be mutually agreed. During the above testing, the following readings shall be taken to compare the same with guaranteed performance data.

5.2.1.1 Condenser inlet and outlet pressure and temperature

5.2.1.2 Entering and leaving air temperature of the cooling coil air filters.



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- 5.2.1.3 Motor current for the compressor and blower.
- 5.2.1.4 Air quantity delivered by the fan. This shall be computed by adding air quantity leaving all the grilles entering the air filters.
Room temperature (Dry & wet bulb)
- 5.2.1.5 Test to ensure all controls and safety instruments are working properly.
During the above testing, noise level also will be checked to ensure that the same are within acceptable limits. Any undue vibration detected physically will be corrected.
All tools and instruments required for the above testing will be provided by the vendor.
- 6** **PAINTING:**
The packaged unit shall be given two coats of primer paint finished with two coats of finish paint as per Manufacturers std. unless specified otherwise elsewhere/ Data sheet 'A'. The colour of finish paint will be as specified in Data Sheet-A.
- 7** **GUARANTEES**
The package unit shall be guaranteed for performance measured in terms of the inside temperature maintained.
The packaged unit shall also be free from any manufacturing defects and shall be guaranteed as per contract after the first test as per 5.0 is successfully carried out, and the plant taken over by the purchaser.
- 8** **NAME PLATES**
Suitable Name plate as per Data Sheet 'A', depicting the equipment number as designated in Data Sheet A shall be provided for each packaged unit and screwed to a prominent position on the packaged unit.



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9. DATA TO BE FURNISHED AFTER AWARD OF CONTRACT

- 9.1 Final technical data as per Data Sheet-B
- 9.2 G.A. and interior view of packaged unit
- 9.3 Electrical wiring diagram
- 9.4 Catalogues for all controls
- 9.5 O & M Manual
- 9.6 Erection Manual



PACKAGE-CONDITIONING UNIT
DATA SHEET - A

VOLUME II-B

SECTION D

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DESCRIPTION

DATA

1) Capacity of the unit at operating conditions.	: As specified
2) Numbers required	: Refer to Section-C of Specific Technical Requirements
3) Designation of the unit	: Package AC Unit
4) Whether air cooled/water cooled	: Refer to Section-C of Specific Technical Requirements
5) The plant shall be suitable for maximum- - ambient temp.	: Refer outdoor design condition as specified.
6) Whether a plenum Chamber required	: Units shall be connected to fresh air ducts.
OR	
Whether to be connected duct system.	: Yes.
7) Whether Humidifier required for humidity- -control.	: Refer to Section-C of Specific Technical Requirements
8) Whether strip heaters required for winter heating.	: Refer to Section-C of Specific Technical Requirements
9) Whether strip heater required for Humidity control.	: Refer to Section-C of Specific Technical Requirements
10) Final painting colour shade stage.	: Subject to approval / during detail engineering
11) Whether fan static pressure is to be designed for filters arrangement shown.	: Yes.
12) Installation supporting structure/ drain piping, insulation.	: Required. Drain piping with insulation up to the nearest drain point.
13) Controls & Instruments	: Yes (Lot)
14) Isolation Switch	: Yes



**STANDARD TECHNICAL SPECIFICATION
FOR
AIR FILTER**

SPECIFICATION NO.PES-553-06

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**STANDARD TECHNICAL SPECIFICATION
FOR
AIR FILTER**



**STANDARD TECHNICAL SPECIFICATION
FOR
AIR FILTER**

SPECIFICATION NO.PES-553-06

VOLUME II B

SECTION D

REV. 02

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SHEET 2 OF 4

1. GENERAL

This specification covers the design, manufacture, inspection and testing at manufacturer's work or his sub-contractor's works of Air filters to be used for air-conditioning and ventilation system.

2. CODES AND STANDARDS

This design, manufacture and performance of AIR FILTERS shall comply with all currently applicable statutes, regulation and safety codes in the locality where the equipment will be installed. The equipment shall also conform to latest applicable Indian/British/USA standards. Nothing in this specification shall be construed to relieve the vendor of this responsibility. The following standards, in particular, shall be applicable for certified ratings of filters and for conducting performance test, if required.

a) BS EN - 779 -Methods of test for air filters used in air conditioning and general ventilation.

3. GENERAL

The enclosed Data sheet A gives the type and other particulars of filters required.

3.1 POLY FIBRE AIR FILTERS

Filtering media shall consist of a suitable fibrous material (e.g. polyethylene extruded sections coir etc.) packed into a 20 gauges GSS framework, complete with handles etc. The filter element shall be supported by galvanised steel wire mesh of 10mm. sq. on either side, Velocity across the filters shall not exceed 2.5 M/sec. Average efficiency E_m (%) shall be ≥ 80 as per BS EN - 779.

3.2 DRY FABRIC AIR FILTERS

Filter element shall be pressed felt filter fabric or suitable material recommended by the manufacturer, stitched on to galvanised wire gauge support and crimped to form deep folds. Suitable aluminium spacers shall be provided to ensure uniform distribution of air flow through filters. Filter casing shall be provided with neoprene sponge rubber sealing, The filter shall have Average efficiency E_m (%) of ≥ 95 as per BS EN - 779.

3.3 PANEL TYPE METALLIC FILTERS (DRY/VISCOUS)

Filter shall consist of V-fold galvanised wire mesh interspaced with flat layers of galvanised wire mesh. The density of media shall increase in the direction of air flow. Edges of wire mesh shall be suitably hemmed to prevent abrasion during handling. The media shall be supported on either side by galvanised expanded metal casing. The framework shall be at least 18 gauge GSS. Filter shall be either dry or wetted type as per data sheet=A. The oil shall be mineral oil of approved quality and make. As a the filter frame made of Aluminium alloy conforming to IS:737 can be considered unless use of aluminium is prohibited otherwise due to site conditions being saline/corrosive.

All filters shall be capable of being cleaned of their accumulated dust by tap water flushing. The dry metallic filter shall have Average arrestance A_m (%) shall be ≥ 90 .



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However oil wetted air filters shall have Average Efficiency E_m (%) ≥ 90 as per BS EN - 779..

3.4 AUTOMATIC CLEANING FILTERS

This shall consist of a filter mat and drop eliminator, driven by a suitably rated geared motor unit being supported on a steel framework. The filter mat shall consist of an endless steel wire mat insets of steel mesh held between an upper & a lower shall drop eliminator shall consist of an endless steel wire without insets of steel mesh. The unit shall include a suitable oil pump, gludge raking mechanism and sludge container and tensioning device. Pressure drop shall be limited to 0.5 / mm WG when clean & 10 mm when dirty. Air velocity across filter shall not exceed 3 M/sec.

3.5 ABSOLUTE FILTERS

Filters shall be constructed by pleating a continuous sheet of filter medium into closely spaced pleats separated by heavy corrugated aluminium spacers. They shall be individually tested and certified to have an efficiency of not less than 99.97% when tested with 0.3 micron dioctylphthalate smoke as per IS:2831. The clean filter initial static pressure drop shall not be greater than 25mm WC at rated capacity. A neoprene sponge rubber sealing shall be provided on either face of filter frame.

3.6 WATER REPELLANT NYLON FILTERS

This shall be constructed of water repellent nylon fabric with continuous water spraying on it from a header for keeping it clean. Efficiency of this filter shall be 85% down to 10 microns. This filter shall be used for unitary air filtration system only.

4. INSPECTION & TESTING

The scope of inspection for air filters shall be as below:

4.1 Dimensional inspection of frame & filter media.

4.2 Witnessing of type tests on one per type per size air filters for the following properties.

- a) Gravimetric efficiency.
- b) Pressure drop in clean & dirty (choked - %age to be specified) condition.
- c) Efficiency as per BS EN - 779.

4.3 Verification of type test certificates for similar type & size of filters for sodium flame test as per BS-3928 (if applicable- refer data sheet).



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5. DATA TO BE FURNISHED BY VENDOR AFTER AWARD OF CONTRACT

- 5.1 GA Drawing.
- 5.2 Drawing showing material/construction detail
- 5.3 Installation and\service manual
- 5.4 Rating curves/charts
- 5.5 Test certificates
- 5.6 Elect. diagrams (when automatic cleaning type)



**AIR FILTER
DATA SHEET - A**

VOLUME II-B

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SHEET 1 OF 1

DESCRIPTION

DATA

1) General

1.1 Service	: Air Conditioning.
1.2 Location	: Central Air conditioning plant, & package AC plant, fresh air fan system. Also for split AC.
1.3 Nos.	: Refer Section 'C' of Specification.
1.4 Total air flow/type	: Refer Section 'C' of Specification.
1.5 Temperature	: As per project information.
1.6 Relative Humidity	: 100%
1.7 Gas Composition	: Atmospheric Air (Dusty) as prevalent in power Station.
1.8 Filter Media	: Synthetic non-woven
1.9 Efficiency	: Average arrestance efficiency of 65-80 % for Dry Panel filter (pre-filters) and average arrestance Efficiency of 80-90 % for fine filters.
1.10 Allowable pressure drop	: 2.5 mm & 6.5 mm in clean and dirty condition respectively for dry panel filters(prefilters). 12 mm in clean condition for fine filters.
1.11 Frame Work	: 18 G, GSS.
1.12 Mounting	: Ladder Type M.S Angles (galvanised)
1.13 Size	: 600 x 600 mm

Note:-

- 1) Face velocity of air across the filters shall not exceed 2.5 m/sec.



TECHNICAL SPECIFICATION
THERMAL INSULATION FOR COLD
SURFACES

SPECIFICATION NO.PES-553-08

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STANDARD TECHNICAL SPECIFICATION
FOR
THERMAL INSULATION FOR COLD SURFACES



TECHNICAL SPECIFICATION
THERMAL INSULATION FOR COLD
SURFACES

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1. SCOPE

This specification covers design, manufacture, testing at manufacturers works, supply, application & finishing of insulation for cold piping, air conditioning ducting & equipment for low temperature service.

2. CODES & STANDARDS

The design, manufacture and performance of materials covered under this specification shall comply with all currently applicable statutes, regulations & safety codes in the locality where the equipment/material are to be installed. The material shall also conform to the latest applicable Indian/British/American codes & standards. Nothing in this specification shall be construed to relieve the vendor of his responsibility. In particular, the material shall conform to the latest editions of the following standards :-

IS:3069: GLOSSARY OF TERMS & SYMBOLS & UNITS RELATING TO THERMAL INSULATION

materials.

2.1 IS:4671: Expanded polystyrene for thermal insulation purposes.

2.2 IS:3677: Mineral wool for thermal insulation.

2.3 IS:8183: Resin bonded mineral wool.

3. DESIGN REQUIREMENTS

3.1 The insulating material as well as protective covering shall be new & unused, non-corrosive, vermin/rodent proof and shall be guaranteed to withstand continuously & without deterioration the maximum/minimum temperatures to which they may be subjected to, under specified site conditions.

3.2 The insulation material must be light weight, strong, free from shots & coarse fibre & shall provide high insulation efficiency at low weight & coat. It should be non-hygroscopic & should not rot. It shall not settle or shake down even when subjected to prolonged vibrations.

3.3 The insulation material, density and thickness etc. Shall be as specified in DATA SHEET A.

4. APPLICATION DETAILS

4.1 The surface to be insulated shall be thoroughly cleaned and allowed to dry. Pressure/hydrostatic tests, if any, shall be carried out before application of insulation.

4.2 A layer of solvent free, anticorrosive paint shall be applied & allowed to dry.

4.3 Hot industrial bitumen of grade 85/40 or 85/25 conforming to latest IS:702 shall be uniformly applied @ 1.5 kg/sq.m on the surface to be insulated. A similar layer shall also be applied on the inside surface & edges of the insulation. A suitable cold adhesive compound may also be used in place of bitumen.

4.4 Insulation in the form of pipe sections/rolls slabs of specified density & thickness shall be stuck to the coated surface with joints staggered & well butted & secured. The adjoining sections shall be tightly pressed together. All the joints shall be sealed with

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bitumen/equivalent adhesive. Voids if any shall be packed with suitably cut pieces of insulation material.

4.5 In case of double layer application both circumferential & longitudinal joints shall be suitably staggered.

5. **VAPOR SEALING & INSULATION FINISH**

The insulation shall be treated for vapor sealing & weather proofing & finished as specified in DATA SHEET A The acceptable types of finishes are outlined below:-

5.1 **FINISHING SYSTEM I: EXTERNAL INSULATION WITH PLASTER FINISH**

5.1.1 A thick vapor seal of hot bitumen @ 2.5 kg/Sqm shall be applied on the outer surface of insulation & allowed to dry.

5.1.2 The surface shall then be wrapped with 20mm (3/4"_ hexagonal mesh of 24 SWG GI wire, butting all the joints & laced down with 22 SWG GI lacing wire.

5.1.3 12.5mm (1/2 inch) thick sand cement plaster in the ratio of (1:1) shall be applied in two layers, the second layer being brought to a smooth finish. A water proofing compound shall be added to the cement before its application.

5.2 **FINISH SYSTEM II: EXTERNAL INSULATION WITH PLASTER FINISH OVER POLYTHENE.**

5.2.1 The insulation shall be covered with 500 g polythene/polythene bonded Hessians (PBH) with 50mm overlap on longitudinal & circumferential joints. Overlaps shall be sealed with synthetic adhesive in case o-f polythene & liberal coat of bitumen in case of PBH:

5.2.2 The surface shall then be wrapped with 20mm (3/4") mesh of 24 SWG GI wire butting all the joints & laced down with 22 SWG GI lacing wire.

5.2.3 12.5mm thick (1/2 inch) sand cement plaster in ratio of(4:1) shall be applied in two layers, the second layer being brought to a smooth & even finish similarly as described above.

5.3 **FINISH III:EXTERNAL INSULATION WITH SHEET METAL FINISH**

5.3.1 The insulation shall be covered with 500g polythene with 50mm overlaps at joints which shall be sealed with synthetic adhesive or equivalent compound.

5.3.2 The polythene shall be covered with 24 gauge GI/aluminum sheet

5.3.3 25mm wide x 22 SWG GI/aluminum peripheral straps shall be fixed over the GI/aluminum sheet at 300mm centres to secure.

5.4 **FINISH IV: EXTERNAL INSULATION WITH PLASTER & WATER PROOFING COMPOUND**

For ducts & piping exposed to atmosphere, the finish shall be as follows:

5.4.1 A thick vapor seal of hot bitumen at 2.05 kg/sq.m shall be applied on the outer surface of insulation & allowed to dry.

5.4.2 The surface shall then be wrapped with 20mm (3/4") hexagonal mesh of 24 SWG GI Wire butting all the joints & laced down with 22 SWG GI lacing wire.

5.4.3 12.5mm thick (1/*2 inch) sand cement plaster in ratio of (4:1) shall be applied in two layers, the second layer being brought to a smooth finish with water proofing compound added to the cement.



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5.4.4

3 mm (1/8") thick coat of water proofing compound shall be applied & wrapped with fibre glass RP tissue. A final coat of 3mm thick water proofing compound shall then be applied over the fiberglass RP tissue & allowed to dry. Alternatively, in place of water proofing as desired above, tar felt type 3 grade 1 of IS 1322 with joints overlapped by 75mm shall be fixed & sealed with bitumen & over this 24 SWG. 25mm hexagonal GI mesh shall be fixed with 22 swig. GI lacing wire & finally bitumen paint shall be applied over wire netting.

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6.

6.1

For all inspection covers & hatches on equipment, pump casing & valve bodies, flanges etc. the insulation shall be applied such as to facilitate removal with minimum damage to the insulation. This shall be achieved by encasing the insulation in 22 gauge aluminum sheet metal boxes, which shall be bolted together around the equipment to permit easy removal & replacement. Proper care shall be taken to maintain continuity of vapor seal between the static & removable partitions of the insulation.

6.2

The tenderer may offer thickness of insulation & finishes other than that specified in DATA SHEET A. However, calculations/reasons in support of alternative proposal shall be furnished for purchaser's approval.

7.

7.1

All necessary tests, as required to ensure that the material supplied conform to the requirements of applicable codes & standards, shall be carried out at manufacturer's works & test certificates including these for material/accessories shall be furnished for purchasers approval.

8.

8.1

Pipe work having insulation & cladding shall be provided with color identification for the fluids handled and for indicating direction of flow.

8.2

Equipment surfaces having insulation and cladding shall also have identification numbers and any other relevant data provided on the insulated surface.

8.3

All painting for insulated surfaces shall conform to the requirement specified elsewhere.



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THERMAL INSULATION FOR COLD SURFACES

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9. DATA TO BE FURNISHED AFTER AWARD OF CONTRACT

- 9.1 Final version of data sheet 'B' incorporating changes if any along with design data.
- 9.2 Test certificates/reports giving result of insulation to ensure conformance to applicable codes & standards & in particular the following:-
- a) Thermal conductivity test.
 - b) Sound absorption coefficient test.
 - c) Corrosion test.
 - d) Sulphur content, moisture content, shot content, moisture absorption etc.
 - e) Compressive strength & cross breaking strength test.
- 9.3 Sketches/technical literature/sectional drgs. indicating insulation materials finish and method of application etc.
- 9.4 Manual dealing with safety aspects & instructions for combating fire arising out of insulation work.
- 9.5 Instructions on maintenance of insulation work.



THERMAL INSULATION
FOR COLD SURFACE
DATA SHEET - A

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Insulation Material

Insulation	Code	Thermal Conductivity MW/cm ⁰ C	Density Kg/m ³
Resin bonded mineral wool / glass wool	IS:8183	0.49 at 50 °C	At least 24 for duct insulation and 48 for acoustic lining.
Mineral Wool Pipe Section (min. Gr.2)	IS:9842	0.43 at 50 °C	At least 81
Expanded Polystyrene	IS:4671	0.37 at 10 °C	At least 15

Type of Insulation

S.No.	Surface	Insulation Material	Insulation Form	Thickness (mm)
i)	Supply & Return air duct for air-conditioning system	Resin bonded roll Mineral Wool (IS:8183)		25
ii)	Refrigerant Piping	a) Expanded Polystyrene or b) Mineral Wool	Pipe Section Pipe Section	75 75
iii)	AHU drain pipe	a) Expanded Polystyrene or b) Mineral Wool	Pipe Section Pipe Section	25 25
iv)	AHU drain pan coil section and fan section	a) Expanded Polystyrene or b) Mineral Wool	Slabs Slabs	25 25
v)	Chilled water piping, valves & specialties	a) Expanded Polystyrene or b) Mineral Wool	Pipe Section Pipe Section	75 75
vi)	Chiller	a) Expanded Polystyrene or b) Mineral Wool	Slabs Slabs	100 100
vii)	Chilled Water Pumps	a) Expanded Polystyrene or b) Mineral Wool	Slabs Slabs	50 50
viii)	Expansion tank with pipe	a) Expanded Polystyrene or b) Mineral Wool	Slabs/Pipe Section Slabs/Pipe Section	50 50



AIR CONDITIONING SYSTEM

LIST OF MAKES OF SUB-VENDOR ITEMS

LIST OF MAKES OF SUB-VENDOR ITEMS



AIR CONDITIONING SYSTEM

LIST OF MAKES OF SUB-VENDOR ITEMS

SLNo	ITEM	VENDOR
1	SCREW CHILLER	YORK
		TRANE
		CARRIER
		KIRLOSKAR
		DUNHAM BUSH
		MCQUAY (DAIKIN)
		BLUE STAR
		VOLTAS
2	VAPOUR ABSORBTION MACHINE	VOLTAS
		THERMAX
		KIRLOSKER
3	PRECISION PACKAGE UNITS	STULZ
		UNIFLAIR
		EMERSON PROCESS MANAGEMENT (ROSEMOUNT)
		BLUEBOX
		CLIMADENTA
4	PACKAGE UNIT	VOLTAS
		BLUE STAR
		CARRIER
5	SPLIT AIR CONDITIONER	VOLTAS
		BLUE STAR
		CARRIER
		HITACHI-HIREL
		LG
6	AIR HANDLING UNITS	VOLTAS
		BLUE STAR
		ZECO
		CARRYAIRE (FLAKT)
		EDGETECH
		ETHOS
		SYSTEM AIR
		WAVES AIRCON
7	AHU FAN (CENTRIFUGAL FAN)	CB DOCTOR
		FLAKT
		KRUGER
		NICOTRA
		COMEFRI
		MARATHON
		PATEL AIR
		ADVANCE
		DRAFT AIR



AIR CONDITIONING SYSTEM

LIST OF MAKES OF SUB-VENDOR ITEMS

		HYDERABAD POLLUTION
		SK SYSTEM
		SARLA
8	PUMPS	BEST & CROMPTON
		JYOTI
		SAM TURBO
		KBL
		KSB
		M&P
		VOLTAS
		BEACON-WEIR
		WORTHINGTON
		FLOWMORE
		SULZER PUMPS INDIA LTD.
		BHARAT PUMPS & COMPRESSORS LTD
		FLOWERVE INDIA CONTROL PVT LTD
		V-FLOW PUMPS & SYSTEMS CO
		KISHORE PUMPS
9	COOLING TOWER	PAHARPUR
		MIHIR
		PCT
		FLOWTECH
		BELL
10	LV MOTORS (NON FLAME PROOF)	SIEMENS
		ABB
		CGL
		MARATHON
		KEC
		BHARAT BIJLEE
		NGEF
		JYOTI
		LHP
		BHARAT ELECTRIC
11	AIR FILTER	PUROLATOR
		FMI
		ANFILCO
		TENACITY
		JOHN FOWLER
		SPECTRUM
		AIR TECH
		PUROMATIC
12	FRESH AIR/ SUPPLY/ EXHAUST/ RE	FLAKT



AIR CONDITIONING SYSTEM

LIST OF MAKES OF SUB-VENDOR ITEMS

	UNIT FANS	KHAITAN PATEL AIR NICOTRA SARLA (SITAL) KRUGER MARATHON C B DOCTOR HYDERABAD POLLUTION SK SYSTEM ADVANCE
13	INSULATION MATERIAL	BEARDSHEL K-FLEX PARAMONT ARMAFLEX SUPREME LLOYDS UP TWIGA AEROCELL
14	BALANCING VALVE	ADVANCE
15	BUTTERFLY VALVES	ADVANCE AUDCO FOURESS ENGG INTER VALVE BDK WEIR BDK TYCO CRANE PROCESS KEYSTONE FLUIDLINE INSTRUMENTATION LTD R AND D MULTIPLES (METAL CAST) PVT LTD SURYA VALVES AND INSTRUMENTS MFG CO PENTAIR VALVES AND CONTROLS INDIA PRIVATE LIMITED UPADHAYA VALVES MANUFACTURERS PRIVATE LIMITED VENUS PUMPS AND ENGG. WORKS
16	NON RETURN VALVE	LEADER VALVES H SARKAR FLUIDLINE HI-TECH CRESCENT VALVES



AIR CONDITIONING SYSTEM

LIST OF MAKES OF SUB-VENDOR ITEMS

		A V VALVES
		BANKIM
		SHIVADURGA
		SURYA VALVES AND INSTRUMENT MANUFACTURING
		ATAM VALVES
		GM DAULI & SONS
		KBL
		VENUS PUMPS AND ENGINEERING WORKS
17	STEEL GATE/GLOBE/NR VALVES(WATER SYSTEM)	CRESCENT VALVES
		BDK
		AUDCO
		FOURESS ENGG
		KIRLOSKAR BROTHERS LTD.
		SANT VALVES
		BOMBAY METAL & ALLOYS
		BANKIM
		LEADER VALVES
		H SARKAR
		AV VALVES
		VENUS PUMPS
		FLUIDLINE
		HI -TECH
		SHIVADURGA
		SURYA VALVES AND INSTRUMENT MANUFACTURING
		ATAM VALVES
		GM DAULI & SONS
		KBL
18	4 WAY MIXING VALVE WITH ACTUATING MOTOR	SIEMENS BUILDING TECHNOLOGY
		JOHNSON
		BELIMO
		HONEYWELL AUTOMATION
		RAPID CONTROL
		ALC
19	BUTTERFLY VALVE (MOTORIZED)	ANERGY
		ADVANCE
		BELIMO
		JOHNSON
		HONEYWELL AUTOMATION
		SIEMENS
		LEADER
		H.SARKAR
		FLUID LINE



AIR CONDITIONING SYSTEM

LIST OF MAKES OF SUB-VENDOR ITEMS

		A V VALVES
		BANKIM & COMPANY
		SURYA VALVES AND INSTRUMENT MANUFACTURING
		ATAM VALVES
		GM DAULI & SONS
		KBL
		VENUS PUMPS AND ENGINEERING WORKS
20	ACTUATOR FOR MOTORIZED BUTTERFLY VALVE	SIEMENS BUILDING TECHNOLOGY
		JOHNSON
		BELIMO
		HONEYWELL
		RAPID CONTROL
		ALC
		AUMA
		LIMITORQUE
21	Y / POT STRAINER	MULTITEX
		GREAVES COTTON
		JAYPEE
		SANT VALVES
		OTOKLIN
		GRAND PRIX
		GUJARAT OTOLIFT
		DS ENGG
		SAROJINI ENTERPRISE
		BHATIA ENGINEERING
		FILTRATION ENGINEERS INDIA PVT LTD
		SUNGOV ENGINEERING
22	Pipes (MS/GI) - ERW	SURYA ROSHNI
23	Pipes (MS/GI) - ERW	TISCO
		DADU PIPES
		INDUS TUBES
		WELSPUN
		TATA
		BST
		JINDAL
		SAIL
		PSL
		LALIT PROFILE
		SAMSHI PIPE INDUSTRIES
		S MUKUT PIPES
		MANN INDUSTRIES
		SURENDRA ENGINEERING



AIR CONDITIONING SYSTEM

LIST OF MAKES OF SUB-VENDOR ITEMS

		PRATIBHA PIPES AND STRUCTURES PVT LTD
		JCO GAS PIPES
		NUKAT TANK AND VESSELS
		GOODLUCK TUBES
		ADVANCE STEEL TUBES
		BIHAR TUBES
		HITECH PIPES
		RATNAMANI
		MAHARASHTRA SEAMLESS
24	PIPING - CS SEAMLESS (ASTM A 106)	ISMT
		MAHARASTRA SEAMLESS
25	GI SHEETS FOR DUCTING	TISCO
		INDIAN IRON & STEEL CO
		RASHTRIYA ISPAT NIGAM LIMITED
		ESSAR
		ISPAT INDUSTRIES
		JSW
		LLOYDS
		BHUSHAN STEELS
		TATA
		SAIL
		JINDAL
26	FIRE DAMPER	TSC
		CARRYAIRE
		RAVISTAR (SYSTEM AIR)
27	GRILL/DIFFUSER/VOLUME CONTROL DAMPER	AIR FLOW
		TSC
		AIR MASTER
		CARRYAIRE
		RAVISTAR (SYSTEM AIR)
28	STRIP HEATER	ESCORTS
		RACOLDS
		DASPASS
		ALCO
		HEATCO
		HOTSET
29	PAN HUMIDIFIER	RAPID COOL
		HOTSET
		ALCO
30	RELIEF / PURGE VALVE	BRASSOMATIC
31	THERMOSTATS	HONEYWELL AUTOMATION
		RANCO



AIR CONDITIONING SYSTEM

LIST OF MAKES OF SUB-VENDOR ITEMS

		PENN
		DANFOSS
		INDFOSS
		JHONSON CONTROL
		RANUTROL
32	HUMID STAT	JHONSON CONTROL
		HONEYWELL AUTOMATION
		PENN
33	ANTI FREEZE THERMOSTAT	RANCO
		HONEYWELL AUTOMATION
		PENN
		DANFOSS
		INDFOSS
34	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	GENERAL INSTRUMENT CONSORTIUM
		BELLS CONTROLS LTD
		H. GURU IND
		WAAREE INSTRUMENTS
		H. GURU INST
		FORBES MARSHALL
		MANOMETER INDIA
		A. N INSTRUMENT
		GAUGES BOURDON
		GLUCK INDIA
		WIKI.
		ASHCROFT INDIA PVT LTD.
		BAUMER TECHNOLOGIES INDIA PVT. LTD.
		PRECISION MASS PRODUCTS
		BOSE PANDA INSTRUMENTS PVT.LTD.
35	TEMPERATURE GAUGE	H. GURU IND
		H. GURU INST
		FORBES MARSHALL
		DETRIVE INST & ELECTRONICS
		PYRO ELECTRIC
		TOSHNIWAL
		BROSS
		WAREE INSTRUMENTS
		A. N INSTRUMENT
		GOA INSTRUMENTS
		WIKI
		ASHCROFT INDIA PVT LTD.
		H. GURU IND
		BAUMER TECHNOLOGIES INDIA PVT. LTD.



AIR CONDITIONING SYSTEM

LIST OF MAKES OF SUB-VENDOR ITEMS

		GOA THERMOSTATIC
		GAUGES BOURDON
		BUDENBERG GAUGE
		PRECISION MASS PRODUCTS
36	LEVEL INDICATOR	GENERAL INSTRUMENT CONSORTIUM
		CHEMTROL
		SBEM
		AUTOMAT MUMBAI
		SIGMA
		TOSHNIWAL
		TECHNOMATIC
		TELACO
		LEVCON
		D K INSTRUMENTS
		PUNE TECHTROL
		FLOW STAR
		BLISS ANAND
37	PRESSURE/ DP/ VACUUM/ TEMPERATURE SWITCH	BELLS CONTROLS LTD
		DANFOSS
		DK INSTRUMENTS
		DRESSER
		SOR INC
		VASU
		SWITZER INSTRUMENT LTD.
		INDFOSS
		TRAFAG
		GIC
		ASHCROFT INDIA PVT LTD.
		KASTURBA UDYOG
		BARKSDALE GMBH
		PRECISION MASS PRODUCTS
		MITTAL REFRIGERATION
38	TEMPERATURE SWITCH	INDFOSS
		SIEMENS
		DANFOSS
		DK INSTRUMENTS
		SOR INC
		VASU
		DRESSER
		TOSHNIWAL
		SWITZER INSTRUMENT LTD.
39	FLOW SWITCH	SWITZER INSTRUMENT LTD.



AIR CONDITIONING SYSTEM

LIST OF MAKES OF SUB-VENDOR ITEMS

		LEVCON
		DK INSTRUMENTS
		SBEM
		V AUTOMAT
		SIEMENS
40	LEVEL SWITCH-FLOAT TYPE	SBEM
		BLISS ANAND
		HI-TECH
		RAMAN INST
		SIGMA
		SOR INC
		WAREE INST
		LEVCON
		DK INSTRUMENTS
		V AUTOMAT
		CHEMTROL
		SIEMENS
		FLOW STAR
		TRAC
		FLOW TECH
		NIVO CONTROLS
		PUNE TECHTROL
		SAPCON INSTRUMENT
		BAUMER TECHNOLOGIES INDIA PVT. LTD.
		GIC
41	LEVEL SWITCH-CAPACITANCE TYPE	SBEM
		BLISS ANAND
		HI-TECH
		RAMAN INST
		SIGMA
		SOR INC
		WAREE INST
		LEVCON
		DK INSTRUMENTS
		V AUTOMAT
		CHEMTROL
		SIEMENS
		FLOW STAR
		TRAC
		FLOW TECH
		NIVO CONTROLS
		PUNE TECHTROL



AIR CONDITIONING SYSTEM

LIST OF MAKES OF SUB-VENDOR ITEMS

		SAPCON INSTRUMENT
		BAUMER TECHNOLOGIES INDIA PVT. LTD.
		GIC
42	FLOW TRANSMITTERS	SBEM
		TAYLOR
		ABB
		BRISTOL BABCOCK
		BIRLA KENT TAYLOR
		BLISS ANAND
		SMART INST
		V AUTOMAT
		FISHER-ROSEMOUNT
		SIEMENS
		TATA HONEYWELL
		PUNE TECHTROL
		NIVO CONTROLS
		PANAM ENGINEERS
		EMERSON PROCESS MANAGEMENT (ROSEMOUNT)
		MOORE
		TOSHNIWAL
		YOKOGAWA
		E&H
		ABB
43	PRESSURE/ DIFF. PRESSURE TRANSMITTER	SBEM
		TAYLOR
		ABB
		BRISTOL BABCOCK
		BIRLA KENT TAYLOR
		BLISS ANAND
		SMART INST
		V AUTOMAT
		FISHER-ROSEMOUNT
		SIEMENS
		TATA HONEYWELL
		PUNE TECHTROL
		NIVO CONTROLS
		PANAM ENGINEERS
		EMERSON PROCESS MANAGEMENT (ROSEMOUNT)
		MOORE
		TOSHNIWAL
		YOKOGAWA
		E&H



AIR CONDITIONING SYSTEM

LIST OF MAKES OF SUB-VENDOR ITEMS

		ABB
44	SIGHT FLOW INDICATORS	SIGMA
		LEVCON
		V AUTOMAT
		TELLACE
		EUREKA INDUSTRIAL EQUIPMENTS PVT.LTD.
		TATA HONEYWELL
		BLISS ANAND
		SCIENTIFIC DEVICES
		BK EQUIPMENTS
		INSTRUMENTATION ENGINEERS
45	FLOW ELEMENT - ORIFICE	BRISTOL BABCOCK
		BALIGA LIGHTING EQPT PVT LTD
		LIGHTING EQUIP
		ENGINEERING SPECIALITIES
		IL
		MINCO
		MICRO PRECISION
46	TEMPERATURE ELEMENT	STAR-MECH CONTROLS (I) PVT.LTD.
		GENERAL INSTRUMENT CONSORTIUM
		PYRO ELECTRIC
		WAAREE INSTRUMENTS
		DETRIVE INST & ELECTRONICS
		TOSHNIWAL
		GOA INSTRUMENTS
		GAUGES BOURDON
		TECHNO INSTRUMENTS
		TEMPSSENS INSTRUMENTS
		THERMAL INSTRUMENTS
		TM TECNOMATIC SPA
		BAUMER TECHNOLOGIES INDIA PVT. LTD.
47	FLOW METER	EUREKA INDUSTRIAL EQUIPMENTS PVT.LTD.
		INSTRUMENTATION ENGINEERS
		PLACKA
		TRAC
		FLOW STAR
		SCIENTIFIC DEVICES
48	RH SENSOR/TEMP SENSOR	HONEYWELL AUTOMATION
		JOHNSON
		SIEMENS
		GENERAL INSTRUMENT CONSORTIUM



AIR CONDITIONING SYSTEM

LIST OF MAKES OF SUB-VENDOR ITEMS

49	PLC BASED PANEL	SIEMENS
		SCHNEIDER
		ROCKWELL AUTOMATION
		GE INTELLIGENT
		HONEYWELL AUTOMATION
		ABB
		MITSUBISHI ELECTRIC
50	OWS/PC	HP
		COMPAQ
		DELL
		HCL
		IBM
		LENOVO
51	PRINTER	HP
		CANNON
		EPSON
		XEROX
		IBM
		LEXMARK
52	UPS	HITACHI-HIREL
		APC
		DELTA
		EMERSON PROCESS MANAGEMENT (ROSEMOUNT)
		DB POWER
		APLAB
53	FIBRE OPTIC CABLE	BIRLA ERICSSON
		FINOLEX
		AKSH FIBRE
54	ANNUNCIATOR	ICC
		PECON
		PROCON
55	LT ADAPTER BOX FOR AL TO CU CABLE CONVERTOR	CONTROL DEVICE
		SYSTEM POWER CONTROL
		JACKSON ENGINEERS
		UNILEC
		ELECTRIC ALLIED PRODUCT
56	METERING PUMPS	SHAPO TOOLS
		VK PUMPS
57	WATER SOFTENING PLANT	THERMAX
		ION EXCHANGE
		DOSI ION
58	PRESSURE/ DIFF. PRESSURE	ABB



AIR CONDITIONING SYSTEM

LIST OF MAKES OF SUB-VENDOR ITEMS

	TRANSMITTER	ENDRESS+HAUSER (INDIA)
		MOORE
		SIEMENS
		SMART INST
		SBEM
		TOSHNIWAL
		V AUTOMAT
		EMERSON PROCESS MANAGEMENT (ROSEMOUNT)
		YOKOGAWA
		HONEYWELL AUTOMATION
		FUJI
59	TEMPERATURE TRANSMITTERS	ABB
		ENDRESS+HAUSER (INDIA)
		MOORE
		SIEMENS
		SMART INST
		SBEM
		TOSHNIWAL
		V AUTOMAT
		EMERSON PROCESS MANAGEMENT (ROSEMOUNT)
		YOKOGAWA
		HONEYWELL AUTOMATION
60	ROTAMETER	CHEMTROLS SAMIL (INDIA) PVT LTD.
		EUREKA INDUSTRIAL EQUIPMENTS PVT.LTD.
		IL
		TRANSDUCERS AND CONTROL
61	BATTERY CHARGER	AMARA RAJA POWER SYSTEMS LIMITED
		CHHABI ELECTRICALS PVT.LTD.
		DUBAS ENGG
		HBL POWER SYSTEM
		STATCON POWER CONTROLS LTD
		CALDYNE
62	DC LEAD ACID/NI-CD BATTERY	HBL POWER SYSTEM
		AMCO SAFT INDIA LTD
		SAFT



AIR CONDITIONING SYSTEM

LIST OF MAKES OF SUB-VENDOR ITEMS

NOTES:

1. THE SUB VENDOR LIST ABOVE IS INDICATIVE ONLY AND IS SUBJECT TO BHEL AND CUSTOMER APPROVAL DURING DETAILED ENGINEERING STAGE WITHOUT ANY COMMERCIAL & DELIVERY IMPLICATION TO BHEL. BIDDER TO PROPOSE SUB VENDOR WITHIN 4 WEEKS OF PLACEMENT OF LOI. THEREAFTER NO REQUEST FOR ADDITIONAL SUB-VENDOR SHALL BE ENTERTAINED.
2. THE INSPECTION CATEGORY WILL BE INTIMATED AFTER AWARD OF CONTRACT BY BHEL/CUSTOMER. HOWEVER THE SAME WILL BE ADHERED BY THE BIDDER WITHOUT ANY COMMERCIAL AND DELIVERY IMPLICATION TO BHEL/ CUSTOMER.
3. PLEASE ALSO REFER RESPECTIVE SUB-SECTION C-3, C-4 & C-5 FOR ELECTRICAL, C&I AND HANDLING RELATED EQUIPMENT LIST OF MAKE.



1x800 TANGEDCO NORTH CHENNAI TPP

**AIR CONDITIONING SYSTEM
MANDATORY SPARE LIST**

SPECIFICATION NO. PE-TS-423-553-A001

SECTION : I

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**SECTION-I
SUB SECTION -E**

**ANNEXURE-II
MANDATORY SPARE LIST**



1x800 TANGEDCO NORTH CHENNAI TPP
AIR CONDITIONING SYSTEM
PAINTING & COLOUR SCHEME

SPECIFICATION No: PE-TS-423-553-A001

SECTION : I

SUB-SECTION : E

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SUB SECTION E

ANNEXURE-III

PAINTING & COLOUR SCHEME (AS PER SECTION C2C)



1x800 TANGEDCO NORTH CHENNAI TPP

**AIR CONDITIONING SYSTEM
LIST OF TOOLS & TACKLES**

SPECIFICATION No: PE-TS-423-553-A001

VOLUME : II B

SECTION : E

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ANNEXURE-IV

LIST OF TOOLS & TACKLES



1x800 TANGEDCO NORTH CHENNAI TPP

**AIR CONDITIONING SYSTEM
LIST OF TOOLS & TACKLES**

SPECIFICATION No: PE-TS-423-553-A001

VOLUME : II B

SECTION : E

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LIST OF TOOLS & TACKLES

SL NO	ITEM DESCRIPTION	UNIT	QTY
1	FLAT D WRENCH - 6 MM TO 32 MM (12 Pcs)	SET	1
2	BOX WRENCHES - 6 MM TO 22 MM (14 Pcs)	SET	1
3	RING SPANNER - 6 MM TO 32 MM (12 Pcs)	SET	1
4	ALLEN KEYS - 2 MM TO 10 MM	SET	1
5	CRESCENT SCREW SPANNER	NO.	1
6	SCREW DRIVER	NO.	1
7	OFFSET SCREW DRIVER	NO.	1
8	INSULATED PLIER	NO.	1
9	TORCH LIGHT (SUITABLE FOR 2 CELL)	NO.	1
10	HAMMER 1 LB	NO.	1
11	OIL CAN	NO.	1
12	POCKET THERMOMETER - 0 TO 50 DEG. C	NO.	1
13	INSULATION TAPE ROLL	NO.	1
14	STEEL FOOT RULE - 12"	NO.	1
15	FEELER GAUGE 9 BLADES	NO.	1
16	PIPE WRENCH	NO.	1
17	FLARE NUT (1/4")	NOS.	6
18	FLARING TOOL	NO.	1
19	TUBE CUTTER	NO.	1
20	GAS CHARGING PIPE	NO.	1
21	NITROGEN CHARGING ADAPTER	NO.	1
22	PRESSURE GAUGE (2 1/2" DIA DIAL) 0 - 300 PSI	NO.	1
23	PRESSURE GAUGE (2 1/2" DIA DIAL) 0 - 500 PSI	NO.	1
24	COMPOUND GAUGE (2 1/2" DIA DIAL) (-)30" to 150 PSI	NO.	1
25	PSYCHRO METER	NO.	1
26	LOCK WITH KEY FOR TOOL BOX	NO.	1
27	RATCHET 1/4"	NO.	1
28	MS TOOL BOX	NO.	1

NOTE:-

The above mentioned list is tentative only, same shall be finalized during detailed engineering, as per system / customer requirement.



1x800 TANGEDCO NORTH CHENNAI TPP

**AIR CONDITIONING SYSTEM
SERVICE WATER ANALYSIS**

SPECIFICATION No: PE-TS-423-553-A001

SECTION : I

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SUB-SECTION-E

ANNEXURE-V

SERVICE WATER ANALYSIS

**1 x 800MW NORTH CHENNAI COAL BASED SUPER CRITICAL THERMAL POWER
PROJECT STAGE – III, TAMIL NADU, INDIA**

SERVICE WATER ANALYSIS

Sr. No	Parameter	Unit	SWRO Permeate (After Passivation)
1.	pH at 25 ⁰ C	-	7.5-8.5
2.	TDS	ppm	<600
3.	Calcium	ppm	>50
4.	Magnesium	ppm	3.3
5.	Sodium	ppm	175
6.	Potassium	ppm	5.9
7.	Stronium	ppm	0.03
8.	Ammonia	ppm	0.07
9.	Barium	ppm	0.003
10.	Alkalinity	ppm	>50
11.	Chlorides	ppm	<300
12.	Sulphate	ppm	9.2
13.	Nitrate	ppm	10.4
14.	Fluoride	ppm	0.05
15.	Boron	ppm	0.06
16.	Silica	ppm as SiO ₂	0.001



1x800 TANGEDCO NORTH CHENNAI TPP

**AIR CONDITIONING SYSTEM
DRAWINGS / DOCUMENTS SUBMISSION
PROCEDURE**

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ANNEXURE-VI

DRAWINGS / DOCUMENTS SUBMISSION PROCEDURE



1x800 TANGEDCO NORTH CHENNAI TPP

**AIR CONDITIONING SYSTEM
DRAWINGS / DOCUMENTS SUBMISSION
PROCEDURE**

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ALL DOCUMENTS & DRAWINGS SHALL BE IN ENGLISH AND IN METRIC UNITS

SI		Consultant	TANGEDCO (HQ)	TANGED CO-SITE	BHEL SITE	PMG BHEL	PEM/ UNITS/ PSSR
1	Master list of drawings / document (duly indicating schedule of submission)	Soft copy	Soft copy	Soft copy		Soft copy (S)	Soft copy
2	Drawings / docs for Approval/ Information (First Submission)	Soft copy	Soft copy + 1 print	Soft copy		Soft copy	Soft copy (S)
3	Return with comments/approval	Soft copy	Soft copy (S)	Soft copy		Soft copy	Soft copy
4	Drawings / Documents for approval (second & subsequent submissions till approval)	Soft copy	Soft copy	Soft copy		Soft copy	Soft copy (S)
5	Drawings / documents for distribution (RFC)(Approved in Cat. 1 or Received for Information)	Soft copy + 1 print	Soft copy + 1 prints	Soft copy + 2 prints	Soft copy + ~~3~~ (2) prints	Soft copy	Hard copy (S)
6	Erection Drawings / documents	-	Soft copy + 1 print	Soft copy + 2 prints	Soft copy + 3 prints	Soft copy	Soft copy (S)
7	As built Drawings / documents	Soft copy + 1 print	Soft copy + 1 print	Soft copy + 2 prints	Soft copy + 3 prints	Soft copy	Soft copy (S)
8	Operation & Maintenance Manual	-	Soft copy + 1 print	Soft copy + 2 prints	Soft copy + 3 prints	Soft copy	Soft copy (S)
9	Type Test Certificate	Soft copy	Soft copy + 1 print	Soft copy + 1 prints	Soft copy + 3 print	Soft copy	Soft copy (S)

NOTES:

1. The above schedule of submission does not include Docs/Drgs. of quality assurance/inspection and delivery/dispatches. QAP documents to be submitted as per distribution schedule.
2. Date of uploading drawing/documents in PEDM shall be taken as date of submission.
3. S – Source for generation of document.



**1x800 TANGEDCO NORTH CHENNAI TPP
AIR CONDITIONING SYSTEM
MASTER DRAWING LIST WITH SCHEDULE
OF SUBMISSION**

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ANNEXURE-VIII

**MASTER DRAWING LIST WITH SCHEDULE OF
SUBMISSION**



**1x800 TANGEDCO NORTH CHENNAI TPP
AIR CONDITIONING SYSTEM
MASTER DRAWING LIST WITH SCHEDULE
OF SUBMISSION**

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S. NO.	DRAWING NO	DRG./ DOC. TITLE	SCH. WEEK (FROM DATE OF LOI)
1	PE-V0-423-553-A001	INSPECTION CATEGORISATION PLAN	4
2	PE-V0-423-553-A002	QAP OF SCREW CHILLER PACKAGE	14
3	PE-V0-423-553-A003	QAP OF AIR HANDLING UNIT	14
4	PE-V0-423-553-A004	QAP OF PUMPS	15
5	PE-V0-423-553-A005	QAP OF COOLING TOWER	15
6	PE-V0-423-553-A006	QAP OF MOTORS	15
7	PE-V0-423-553-A007	QAP OF RELAY BASED PANEL	20
8	PE-V0-423-553-A101	HEAT LOAD CALCULATION FOR MAIN PLANT, ESP / VFD CONTROL ROOMS AND SERVICE BUILDING ETC	4
9	PE-V0-423-553-A102	OPERATION & CONTROL PHILOSOPHY FOR AIR CONDITIONING SYSTEM	12
10	PE-V0-423-553-A103	PRESSURE DROP CALCULATIONS FOR CHILLED AND CONDENSER WATER PIPING	10
11	PE-V0-423-553-A201	TDS AND GA OF SCREW CHILLER ALONG WITH FOUNDATION DETAILS	16
12	PE-V0-423-553-A202	TDS AND GA OF COOLING TOWER ALONG WITH FOUNDATION DETAILS	15
13	PE-V0-423-553-A203	TDS AND GA OF AIR HANDLING UNITS ALONG WITH FOUNDATION DETAILS	14
14	PE-V0-423-553-A204	TDS AND GA OF CONDENSER AND CHILLED WATER PUMPS ALONG WITH FOUNDATION DETAILS	15
15	PE-V0-423-553-A205	TDS AND GA OF PAC / SPLIT AIR CONDITIONER	12
16	PE-V0-423-553-A206	TDS AND GA OF MOTOR (PUMP, COOLING TOWER, AHU)	15
17	PE-V0-423-553-A207	TDS OF INSULATION MATERIAL (DUCT INSULATION, DUCT LINING, PIPE INSULATION)	12
18	PE-V0-423-553-A208	TDS AND GA OF FRESH AIR FANS	12
19	PE-V0-423-553-A209	TDS AND GA OF DESUPERHEATING STATION	14
20	PE-V0-423-553-A210	TDS AND GA OF ONLINE NON CHEMICAL TREATMENT PLANT	16
21	PE-V0-423-553-A211	TDS AND GA OF PACKAGE AC UNITS ALONG WITH FOUNDATION DETAILS	12
22	PE-V0-423-553-A212	TDS AND GA OF HEATERS AND HUMIDIFIER	7
23	PE-V0-423-553-A213	TDS AND GA OF FIRE DAMPER WITH ACTUATOR	10
24	PE-V0-423-553-A214	TDS AND GA OF FOR 3-WAY MIXING VALVE	8
25	PE-V0-423-553-A215	TDS AND GA OF VALVEES (BALANCING VALVE, GATE VALVE, CHECK VALVE , Y ATRAINER)	9
26	PE-V0-423-553-A216	TDS AND GA OF SUPPLY / RETURN AIR DIFFUSER/GRILL	8
27	PE-V0-423-553-A217	TDS OF GI SHEET	5
28	PE-V0-423-553-A218	TDS OF PIPES	5



**1x800 TANGEDCO NORTH CHENNAI TPP
AIR CONDITIONING SYSTEM
MASTER DRAWING LIST WITH SCHEDULE
OF SUBMISSION**

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S. NO.	DRAWING NO	DRG./ DOC. TITLE	SCH. WEEK (FROM DATE OF LOI)
29	PE-V0-423-553-A219	TDS AND GA OF EXPANSION TANK, MAKEUP WATER AND SOFT WATER TANK	5
30	PE-V0-423-553-A220	TDS AND GA OF FILTERS	10
31	PE-V0-423-553-A221	TDS FOR INSTRUMENTS (PRESSURE GAUGE, TEMPERATURE GAUGE, LEVEL GAUGE, PRESSURE SWITCH, TEMPERATURE SWITCH, LEVEL SWITCH, DP SWITCH, TEMPERATURE AND HUMIDITY SENSORS ETC)	12
32	PE-V0-423-553-A501	PID FOR MAIN PLANT, SERVICE BUILDING, ESP ETC	8
33	PE-V0-423-553-A502	TYPICAL Details DUCT FABRICATION DRAWING / SUPPORT / ERECTION. INSULATION OF DUCTING / PIPING & EQUIPMENTS CHILLED AND CONDENSER WATER PIPE ERECTION	7
34	PE-V0-423-553-A503	AC DUCT LAYOUT DRAWING FOR CONTROL ROOM AREAS AT 17M ALONG WITH AHU ROOM LAYOUT WITH FOUNDATION DETAILS	16
35	PE-V0-423-553-A504	AC DUCT & AHU ROOM LAYOUT WITH FOUNDATION DETAIL FOR UPS BATTERY CHARGER ROOM AT 8.5M AND SWAS ROOM AT 0 M	17
36	PE-V0-423-553-A505	AC DUCT LAYOUT DRAWING FOR ESP CONTROL ROOM AREAS ALONGWITH AHU/PU ROOM LAYOUT WITH FOUNDATION DETAILS FOR INDOOR AND OUTDOOR UNITS	18
37	PE-V0-423-553-A506	AC DUCT LAYOUT DRAWING FOR SERVICE BUILDING WITH AHU ROOM LAYOUT AND FOUNDATION DETAILS	18
38	PE-V0-423-553-A507	AC PLANT ROOM LAYOUT & COOLING TOWER AREA LAYOUT WITH COMPLETE FOUNDATION DETAIL OF ALL EQUIPMENT	15
39	PE-V0-423-553-A508	CHILLED & CONDENSER WATER PIPING LAYOUT WITHIN PLANT ROON & UPTO VARIOUS AHU ROOMS, & COOLING TOWER AREA.	20
40	PE-V0-423-553-A509	SPLIT AC SCHEDULE ALONGWITH HEAT LOAD CALCULATION FOR AUXILIARY BUILDING	22
41	PE-V0-423-553-A701	I/O LIST FOR AC SYSTEM	20
42	PE-V0-423-553-A751	ELECTRICAL FEEDER LIST	18
43	PE-V0-423-553-A752	CABLE SCHEDULE	22
44	PE-V0-423-553-A901	PG TEST PROCEDURE	12
45	PE-V0-423-553-A902	O&M MANUAL	25

Note:

The above is not the complete list and may change during detail engineering.



**1x800 TANGEDCO NORTH CHENNAI TPP
AIR CONDITIONING SYSTEM
FORMAT FOR OPERATION AND
MAINTENANCE MANUAL**

SPECIFICATION No: PE-TS-423-553-A001

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**SECTION-I
SUB-SECTION-E
ANNEXURE-IX
FORMAT FOR OPERATION AND MAINTENANCE
MANUAL**



**1x800 TANGEDCO NORTH CHENNAI TPP
AIR CONDITIONING SYSTEM
FORMAT FOR OPERATION AND
MAINTENANCE MANUAL**

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

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



**1x800 TANGEDCO NORTH CHENNAI TPP
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FORMAT FOR OPERATION AND
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Sl.no. & Sections	Description	Tick (✓)if included in Manual			Remarks
		Yes	No	Not Applicable	
4.0	COMMISSIONING ACTIVITIES (IF NOT COVERED IN SEPARATE DOCUMENT I.E. ERECTION MANUAL, COMMISSIONING MANUAL)				
4.1	Pre-Commissioning Checks				
4.2	handling of items at site				
4.3	Storage at site				
4.4	Unpacking & Installation procedure				
5.0	OPERATION GUIDELINES FOR PLANT PERSONAL/USER/OPERATOR				
5.1	Interlock & Protection logic along with the limiting values of protection settings for the equipment along with brief philosophy behind the logic, drawings etc. to be provided.				
5.2	Start up, normal operation and shut down procedure for equipments along with the associated systems in step by step mode. Valve sequence chart, step list, interlocks etc. with Equipment isolating procedures to be mentioned.				
5.3	Do's & Don't of the equipments.				
5.4	Safety precautions to be taken during normal operation. Safety symbols, Emergency instructions on total power failure condition/lubrication failure/any other condition				
5.5	Parameters to be monitored with normal values and limiting values				
5.6	Trouble shooting with causes and remedial measures				
5.7	Routine operational checks, recommended logs & records				
5.8	Changeover schedule if more than one auxiliary for the same purpose is given				
5.9	Painting requirement and schedule				
5.10	Inspection, repair , Testing and calibration procedures				
6.0	MAINTENANCE GUIDELINES FOR PLANT PERSONAL				



**1x800 TANGEDCO NORTH CHENNAI TPP
AIR CONDITIONING SYSTEM
FORMAT FOR OPERATION AND
MAINTENANCE MANUAL**

SPECIFICATION No: PE-TS-423-553-A001

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Sl.no. & Sections	Description	Tick (V)if included in Manual			Remarks
		Yes	No	Not Applicable	
6.1	List of Special Tools and Tackles required for Overhaul/Trouble shooting including special testing equipment required for calibration etc.				
6.2	Stepwise dismantling and re-assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained, clearances etc. to be mentioned. Tolerances for fitment of various components to be given.				
6.3	Preventive Maintenance & Overhauling schedules linked with running hours/calendar period along with checks to be given				
6.4	Long term maintenance schedules especially for structural, foundations etc.				
6.5	Consumable list along with the estimated quantity required during commissioning, normal running and during maintenance like Preventive Maintenances and Overhaul. Storage/handling requirement of consumables/self-life.				
6.6	List of lubricants with their Indian equivalent, Lubrication Schedule, Quantity required for each equipment for complete replacement is to be given				
6.7	List of vendors & Sub-vendors with their latest addresses, service centres ,Telephone Nos., Fax Nos., Mobile Nos., e-mail IDs etc.				
6.8	List of mandatory and recommended spare parts list				
6.9	Tentative Lead time required for ordering of spares from the equipment supplier				
6.10	Guarantee and warranty clauses				
7.0	Statutory and other specific requirements considerations.				
8.0	List of reference documents				
9.0	Binding as per requirement				



**1x800 TANGEDCO NORTH CHENNAI TPP
AIR CONDITIONING SYSTEM
SITE STORAGE AND PRESERVATION**

SPECIFICATION No: PE-TS-423-553-A001

SECTION : I

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**SECTION-I
SUB-SECTION-E
ANNEXURE-X
SITE STORAGE AND PRESERVATION**

SITE STORAGE AND PRESERVATION GUIDELINES

FOR

MECHANICAL BOPs

(Doc No: PE-DC-SSG-A001 REV.00)



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

CONTENT

- 1 SCOPE OF THE DOCUMENT
- 2 PURPOSE OF STORAGE & PRESERVATION
- 3 MEASURES TO BE TAKEN FOR STORAGE AND PRESERVATION
 - a) GENERAL STORAGE REQUIREMENTS
 - b) GENERAL PRESERVATION REQUIREMENTS
 - c) GENERAL INSPECTION REQUIREMENTS
- 4 TYPE OF STORAGE FOR VARIOUS EQUIPMENT
5. CONCLUSION
6. STACKING ARRANGEMENT FOR PLATES AND STRUCTURAL STEEL

1. SCOPE OF THE DOCUMENT

This guideline is prepared in intent to provide proper site storage and preservation of the Mechanical, Electrical and C & I items / equipment supplied under various bought out packages/items. This storage procedure shall be followed at different power plant sites by concerned agency for storage and preservation from the date of equipment received at site until the same are erected and handed over to the customer.

2. PURPOSE OF STORAGE & PRESERVATION

Many of the items may be required to be kept in stores for long period. It shall therefore be essential that proper methods of storage and preservation be applied so that items do not deteriorate, loose some of their properties and become unusable due to atmospheric conditions and biological elements.

3. MEASURES TO BE TAKEN FOR STORAGE, HANDLING & PRESERVATION

a) GENERAL STORAGE REQUIREMENTS

1. To the extent feasible, materials should be stored near the point of erection. The storage areas should have adequate unloading and handling facilities with adequate passage space for movement of material handling equipment such as cranes, fork lift trucks, etc. The storage of materials shall be properly planned to minimise time loss during retrieval of items required for erection.
2. The outdoor storage areas as well as semi-closed stores shall be provided with adequate drainage facilities to prevent water logging. Adequacy of these facilities shall be checked prior to monsoon.
3. The storage sheds shall be built in conformity with fire safety requirements. The stores shall be provided with adequate lights and fire extinguishers. 'No smoking' signs shall be placed at strategic locations. Safety precautions shall be strictly enforced.
4. Adequate lighting facility shall be provided in storage areas and storage sheds and security personnel positioned to ensure enforcement of security measures to prevent theft and loss of materials.
5. Adequate number of competent stores personnel and security staff shall be deployed to efficiently store and maintain the equipment / material.
7. The equipment shall be stored in an orderly manner, preserving their identification slips, tags and instruction booklets, etc., required during erection. The storage of materials shall be equipment-wise. Loose parts shall be stored in sheds on racks,

preserving the identification marks and tags in good condition. The group codes shall be displayed on the racks

6. At no time shall any materials be stored directly on ground. All materials shall be stored minimum 200 mm above the ground preferably on wooden sleepers

b) GENERAL PRESERVATION REQUIREMENTS

1. All special measures to prevent corrosion shall be taken like keeping material in dry condition, avoiding the equipment coming in contact with corrosive fluid like water, acid etc.
2. Materials which carry protective coating shall not be wrapped in paper, cloth, etc., as these are liable to absorb and retain moisture. The material shall be inspected and in case of signs of wear or damages to protective coating, that portion shall be cleaned with approved solution and coated with an approved protective paint. Complete record of all such observations and protective measures taken shall be maintained.
3. Generally equipment supplied at site are properly greased or rust protective oil is applied on machined/ fabricated components. However periodic inspection shall be carried out to ensure that protection offered is intact.
4. While handling the equipment, no dragging on the ground is permitted. Avoid using wire rope for lifting coated components. Use polyester slings (if possible) otherwise protective material (e.g. clothes, wood block etc.) should be used while handling the components with rope / slings
5. For Equipment supplied with finished paint, touch paint shall be done in case any surface paint gets peeled off during handling. Otherwise such surfaces shall necessarily be wrapped with polythene to avoid any corrosion. Further for equipment wherein finish coat is to be applied at site, site to ensure that equipment is received with primer coat applied.
6. It shall be ensured by periodic inspection that plastic inserts are intact in tapped holes, wherever applicable.
7. Pipes shall be blown with air periodically and it shall be ensured that there is no obstruction.
8. Silica gel or approved equivalent moisture absorbing material in small cotton bags shall be placed and tied at various points on the equipment, wherever necessary.
9. Heavy rotating parts in assembled conditions shall be periodically rotated to prevent corrosion/jamming due to prolonged storage.

10. All the electrical equipment such as motors, generators, etc. shall be tested for insulation resistance at least once in three months and a record of such measured insulation values shall be maintained.
11. Following preservatives/preservation methods can be used depending upon type of equipment
 - a. Rust preventive fluid (RPF)
 - b. Rust protective paints
 - c. Tarpaulin covers, in case of outdoor storage
 - d. De-oxy aluminate for weld-ments

c) GENERAL INSPECTION REQUIREMENTS

1. Period inspection of materials with specific reference to –
 - Ingress of moisture and corrosion damages.
 - Damage to protective coating.
 - Open ends in pipes, vessels and equipment -
 - In case any open ends are noticed, same shall be capped.
2. Any damages to equipment / materials.
 - In case of any damages, these shall be promptly notified and in all cases, the repairs / rectification shall be carried out.
 - Any items found damaged or not suitable as per project requirements shall be removed from site. If required to store temporarily, they shall be clearly marked and stored separately to prevent any inadvertent use.

4. TYPE OF STORAGE FOR VARIOUS EQUIPMENT

The types of storage are broadly classified under the following heads:

i **Closed storage with dry and dust free atmosphere. (C)**

The closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated asbestos sheets / galvanised iron sheets for roofing. Brick walls / asbestos sheets can be used to cover all the sides. The floor of the shed can be finished with plain cement concrete suitably glazed. The shed shall be provided with proper ventilation and illumination.



ii **Semi-closed storage. (S)**

The semi closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated / asbestos sheets for roofing. The floor shall be brick paved. If required a small portion of sides can be covered to protect components from rainwater splashing onto the components.





iii Open storage (O)

The open yard shall be levelled, well consolidated to achieve raised ground with the provision of feeder roads for crane approach along with access roads running all sides. One part of the open yard shall be stone pitched, levelled and consolidated with raised ground suitable for storing / stacking heavier and critical components with due space to handle them by cranes etc . Adequate number of sleepers, concrete block etc. to be provided to make raised platforms to stack critical materials.

A separate yard to be identified as “scrap yard” slightly away from main open yard to store wooden/steel scraps, which are to be disposed off. This is required to avoid mix up with regular components as well as to avoid fire hazard.

Some of the components, which are having both machined & un-machined surfaces and are bulky, shall be stored in open storage area on a raised ground and suitably covered with water proof / fire retardant tarpaulin.



The equipment listed below shall be stored and inspected as per requirement mentioned in the table below.

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
Raw material /mechanical items like pipes, plates, structure sections etc.)				
1.	Steel pipes (lined/unlined)	S	Damage , paint, corrosion, rubber lining peeling	Provide end cap
2.	MS Plates	S	Damage, paint, corrosion	
3.	SS Plates	S	Damage	
4.	Non-metallic pipes	S	Damage, cracks	Provide end cap
5.	Stainless steel pipes	S	Damage ,	Provide end cap
6.	MS sections, beams	S	Damage, paint, corrosion	
7.	Cable trays	S	Damage, condition of preservations	
8.	Insulation sheets	S	Damage	
9.	Insulation	C	Damage, packing	
10.	Hangers Rods	S	Damage, paint, packing	
11.	Tubes	S	Damage, paint , packing	Provide end cap
12.	Hume pipes	O	Damage	
13.	Castings	O	Damage, paint, corrosion	
Fabricated mechanical items (pressure vessels, tanks etc.)				
14.	Pressure vessels (unlined)	O	Damage, paint, corrosion,	Covered nozzles
15.	Atmospheric storage tanks (unlined)	O	Damage, paint, corrosion	Covered nozzles

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
16.	Pressure vessels (lined)	S	Damage, paint, corrosion, rubber lining	
17.	Atmospheric storage tanks(lined)	S	Damage, paint, corrosion, rubber lining	
18.	Support structures	O	Damage , paint, corrosion	
19.	Flanges	C	Damage , paint, corrosion	
20.	Fabricated pipes	S	Damage , paint, corrosion	Provide end cap
21.	Vessels internals	C	Damage , paint, corrosion ,packing	
22.	Grills	S	Damage , paint, corrosion	
23.	Angles	S	Damage , paint, corrosion	
24.	Bridge mechanism/clarifier mechanism	O	Damage , paint, corrosion	
25.	Cranes, rails	S	Damage , paint, corrosion	
26.	Stair cases	O	Damage , paint, corrosion	
27.	Ladders/handrails	O	Damage , paint, corrosion	
28.	Fabricated ducts	S	Damage , paint, corrosion	
29.	Isolation Gates	O	Damage , paint, corrosion	
30.	Fabricated boxes/panels	S	Damage , paint, corrosion	
Mechanical components like valves, fittings, cables glands, spares etc.)				
31.	Valves	S	Damage , packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
32.	Fittings	S	Damage , packing	Provide end cap
33.	Cable glands	C	Damage , packing	
34.	Tools & tackles	C	Damage , packing	
35.	Nut , bolts, washers,	C	Damage , packing	
36.	Gasket & Packings	C	Damage , packing	
37.	Copper tubes	C	Damage , packing, corrosion	Provide end cap
38.	SS tubing	C	Damage , packing	Provide end cap
Rotating assemblies (pumps, blowers, stirrers, fans, compressors etc.)				
39.	Pumps	S	Damage , packing, corrosion	Shaft rotation
40.	Blowers/Compressors	S	Damage , packing, corrosion	Shaft rotation
41.	Agitators/stirrers/radial launders	C	Damage , packing, corrosion	Shaft rotation
42.	Rollers for chlorine tonner mounting	C	Damage , packing, corrosion	
43.	Centrifuge	S	Damage , packing,	
44.	Gear box	C	Damage , packing, corrosion	
45.	Bearings	C	Damage , packing, corrosion	
46.	Fans	S	Damage , packing, corrosion	
47.	Dosing skids	S	Damage , packing, corrosion	
48.	Pump assemblies	S	Damage , packing, corrosion	
49.	Air washers(INTERNALS)	S	Damage , packing	
50.	Air conditioners (split)	C	Damage , packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
51.	Elevators(CONTAINERIZED)	O	Damage , packing, corrosion	
52.	Chillers/VA machines	S	Damage , packing	
53.	Air handling Unit/Package unit	S	Damage , packing	
54.	Chlorinators & Evaporators	C	Damage , packing	
55.	Ejectors	C	Damage , packing	
56.	Electrolyser	C	Damage , packing	
Miscellaneous items like chain pulley blocks, hoists etc.				
57.	Chain pulley blocks	S	Damage, Packing	
58.	Electric hoists	S	Damage, Packing	
59.	Fire extinguishers	C	Damage, expiry date	
60.	Fork Lift Truck	S	Damage, Packing	
61.	Hydraulic Mobile Crane	O	Damage, Packing	
62.	Mobile Pick Up & Carry Crane	O	Damage, Packing	
63.	Motor boats	O	Damage, Packing	
64.	Safety showers	S	Damage, Packing	
65.	Diffusers/dampers	S	Damage, Packing	
Chemicals and consumables (acid, alkali, paints, oils, reagents and special chemicals)				
66.	Hydro Chloric Acid (HCl)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical
67.	Sulphuric acid (H ₂ SO ₄)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
68.	Sodium hydroxide (NaOH)	Store in canes/ storage tank in dyke area	Date of production/ leakage/ fumes/ breather	hazardous chemical ,breather to be checked for air ingress
69.	Sodium hypo chlorite	To be stored under shed	Date of production/ leakage/ fumes	hazardous chemical ,self-life normally 15-30 days after which strength of chemical decays
70.	Ammonia	S	Date of production/ leakage/ fumes	Store in closed storage tanks, hazardous chemical
71.	CW treatment chemicals	S	Date of production , Self-life	Store in closed canes
72.	RO/UF cleaning chemicals	S	Date of production , Self-life	Store in closed canes
73.	Lime	C	Damage to packing , seepage	Prevent moisture, rain
74.	Alum bricks	C	Damage to packing	Prevent moisture, rain
75.	Poly electrolyte	S		Store in closed storage tanks
76.	Laboratory chemicals(powder)	C	Damage, Packing self-life	
77.	Laboratory chemicals(liquid)	C	Damage, Packing self-life	
78.	Lubrication oils	C	Leakage	
79.	Paints	S	Leakage ,air tightness	
80.	Sand	O	Damage of packing	No hooks
81.	Salt (NaCl)	C	Damage of packing, water ingress	Prevent moisture, rain
82.	Anthracite	S	Damage of packing	
83.	Activated carbon	S	Damage of packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
84.	Thermal insulation	S	Damage of packing	
85.	Cement	C	Damage of packing	Prevent moisture, rain
86.	Gravels	O	Damage of packing	
87.	ION exchange resins	C	Damage , packing	Refer manufacturer guidelines
88.	RO membranes	C	Damage , packing	Refer manufacturer guidelines
89.	UF membranes	C	Damage , packing	Refer manufacturer guidelines
90.	Cleaning chemicals	C	Damage , packing	Refer manufacturer guidelines
91.	Chemicals for analysers/calibration	C	Damage , packing	Refer manufacturer guidelines
Electrical and C & I items (motors, cables etc.)				
92.	Motors	C	Damage , packing	
93.	Cable drums	O	Damage	
94.	Control Panel /control desk, UPS ,JB	S	Damage, Packing	
95.	Instruments(gauges/analysers)	C	Damage	
Special items		As per Manufacturer's item, like Hydrogen cylinders, Ozonator, Analyser, Chlorine dioxide generators etc.		

5. CONCLUSION

Concerned storage agency at site should make sure that loss in equipment performance and wear & tear are minimised through proper storage and preservation. The above are broad guidelines and cover major equipment / materials. However specific storage practices shall be followed as per manufacturer recommendation. All the necessary measures even in addition to the ones mentioned above, if found necessary, should be taken to achieve the objective.

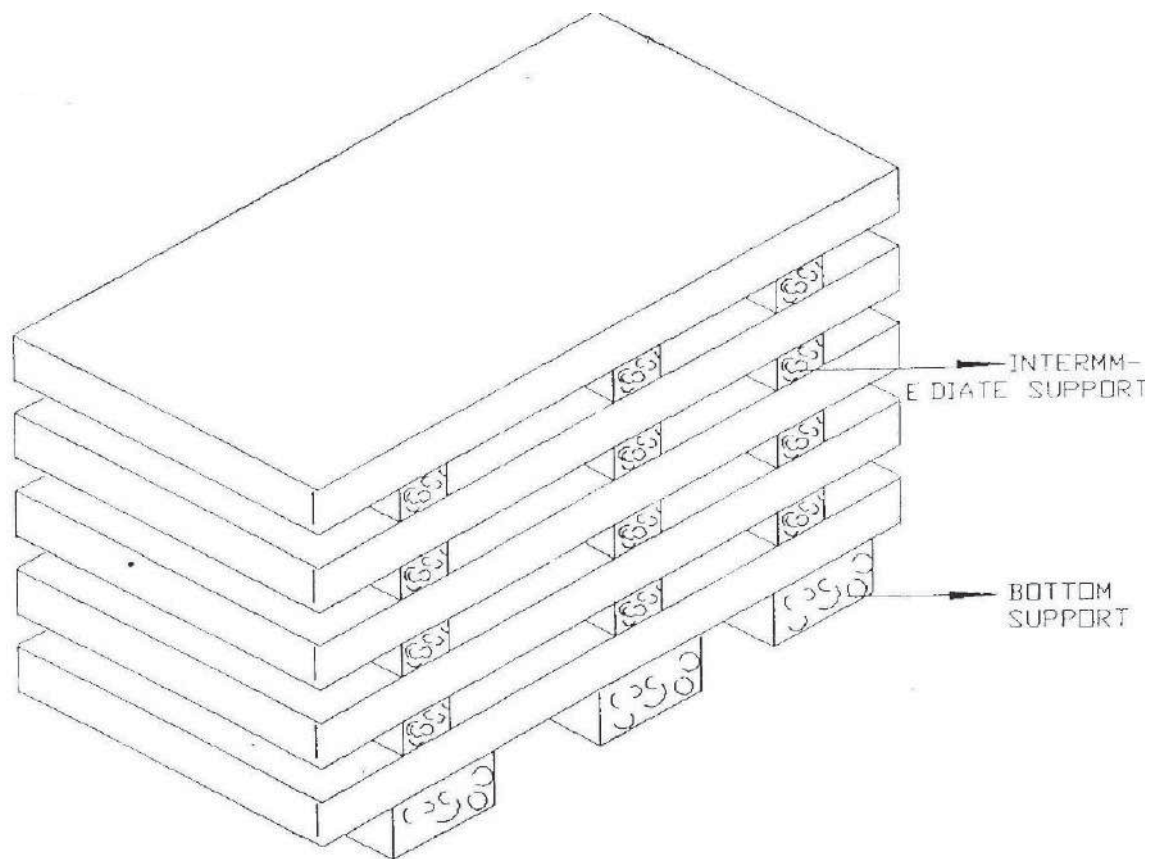


Figure – 1 – PLATE STACKING ARRANGEMENT

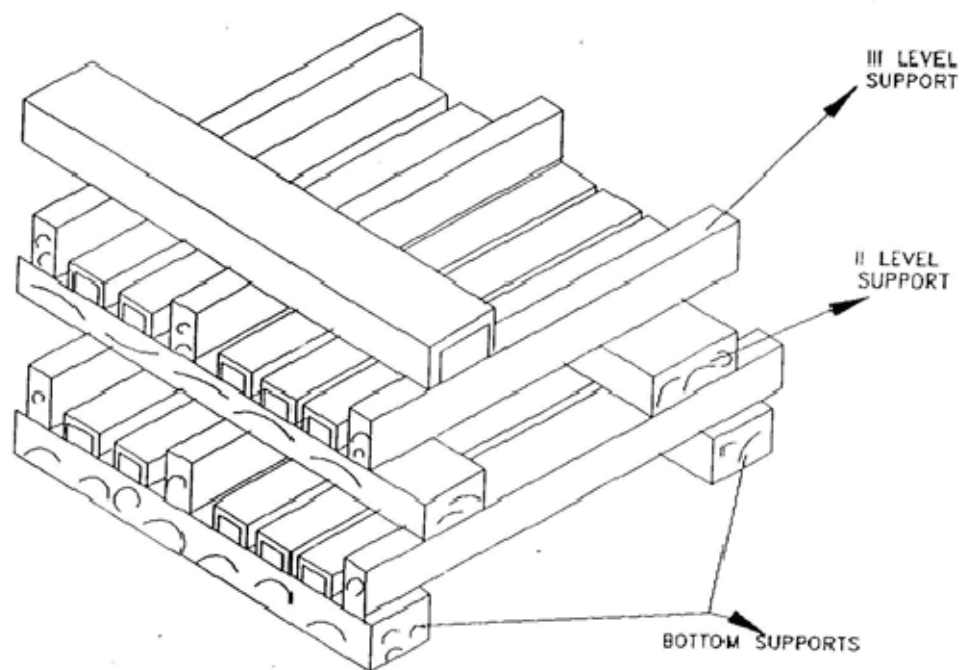


Figure – 2 – STRUCTURAL STEEL STACKING ARRANGEMENT



**1x800 TANGEDCO NORTH CHENNAI TPP
AIR CONDITIONING SYSTEM**

SPECIFICATION No: PE-TS-423-553-A001

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REV. 01

DATE: NOV 2017

SECTION II



**1x800 TANGEDCO NORTH CHENNAI TPP
AIR CONDITIONING SYSTEM
INSPECTION AND TESTING**

SPECIFICATION No: PE-TS-423-553-A001

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**SECTION-II
SUB-SECTION-1
INSPECTION AND TESTING**

	1x800 TANGEDCO NORTH CHENNAI TPP AIR CONDITIONING SYSTEM INSPECTION AND TESTING	SPECIFICATION No: PE-TS-423-553-A001	
		SECTION : II	
		SUB-SECTION : 1	
		REV 01	DATE: NOV 2017
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1.01.00	Inspection and Tests during Manufacture.		
1.01.01	The method and techniques to be used by the Bidder for the control of quality during manufacture of all plant and equipment shall be agreed with the Owner.		
1.01.02	The Owner’s general requirements with respect to quality control and the required shop tests are set out elsewhere in this specification.		
1.01.03	Before any item of plant or equipment leaves its place of manufacture the Owner shall be given the option of witnessing inspections and tests for compliance with the specification and related standards.		
1.01.04	Advance notice shall be given to the Owner as agreed in the Contract, prior to the stage of manufacture being reached, and the piece of plant must be held at this stage until the Owner has inspected the piece, or has advised in writing that inspection is waived. If having consulted the Owner and given reasonable notice in writing of the date on which the piece of plant will be available for inspection, the Owner does not attend the Bidder may proceed with manufacture having forwarded to the Owner duly certified copies of his own inspection and test results. The owner’s representative shall have at all reasonable times access to bidder’s or his sub-vendor’s premises and shall have power to inspect/ examine materials and workmanship or equipment under manufacture. The Bidder shall forthwith forward to the engineer duly certified copies of the Test Certificates in six copies (one to the Purchaser and five to the Consulting Engineer) for approval. Further nine (9) copies of Shop Test Certificates shall be bound with Instruction Manuals referred to elsewhere. For electrical equipment, routine tests as per relevant IS spec are to be carried out on all equipment. Type tests are also to be carried out on selected equipment as detailed in the specs of concerned electrical equipment.		
1.01.05	Under no circumstances any repair or welding of castings be carried out without the consent of the Engineer. Proof of the effectiveness of each repair by radiographic and/or other non-destructive testing technique, shall be provided to the Engineer.		
1.01.06	All the individual and assembled rotating parts shall be statically and dynamically balanced in the works. Where accurate alignment is necessary for component parts of machinery normally assembled on site, the Bidder shall allow for trial assembly prior to despatch from place of manufacture.		
1.01.07	All materials used for the manufacture of equipment covered under this specification shall be of tested quality. Relevant test certificates shall be made available to the Purchaser. The certificates shall include tests for mechanical properties and chemical analysis of representative material. Equipment or parts coming under any statutory		



**1x800 TANGEDCO NORTH CHENNAI TPP
AIR CONDITIONING SYSTEM
INSPECTION AND TESTING**

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Regulations shall be certified by a Competent Authority under the regulations in the specified format.

1.01.08 All pressure parts connected to pumping main shall be subjected to hydraulic testing at a pressure of 150% of shut-off head for a period not less than one hour. Other parts shall be tested for one and half times the maximum operating pressure, for a period not less than one hour.

1.01.09 All necessary non-destructive examinations shall be performed to meet the applicable code requirements.

1.01.10 All welding procedures adopted for performing welding work shall be qualified in accordance with the requirements of Section-IX of ASME code or IBR as applicable. All welded joints for pressure parts shall be tested by liquid penetrant examination according to the method outlined in ASME Boiler and Pressure Vessel code. Radiography, magnetic particle examination magnaflex and ultrasonic testing shall be employed wherever necessary/ recommended by the applicable code. At least 10% of all major but welding joints shall be radiographed unless otherwise stipulated.

Statutory payments in respect of IBR approvals including inspection shall be made by the bidder. Bidder's scope shall include to preparation of all necessary documents, co-ordination and follow-up for above approval. Owner shall only forward assistance/endorsement of documents /design /drawings /reports/records to be submitted for approval as stipulated/ required by Statutory Authorities till registration of the unit and clearance for commercial operation.

1.02.00 Performance Tests at Site

1.02.01 The full requirements for testing the system shall be agreed between the Owner and the Bidder prior to Award of Contract. The completely erected System shall be tested by the Bidder on site under normal operating conditions. The Bidder shall also ensure the correct performance of the System under abnormal conditions, i.e. the correct working of the various emergency and safety devices, interlocks, etc.

1.02.02 The Bidder shall provide complete details of his normal procedures for testing, for the quality of erection and for the performance of the erected plant. These tests shall include site pressure test on all erected pipe work to demonstrate the quality of the piping and the adequacy of joints made at site.

1.02.03 The Bidder shall furnish the quality procedures to be adopted for assuring quality from the receipt of material at site, during storage, erection, pre-commissioning to tests on completion and commissioning of the complete system/equipment.

1.03.00 For details of specific tests required on individual equipment refer to respective section of this specification.

All Statutory testing / clearance is in Bidder's scope including payment of all fees, etc. as required



1x800 TANGEDCO NORTH CHENNAI TPP AIR CONDITIONING SYSTEM INSPECTION AND TESTING

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QAP FORMAT

BHARAT HEAVY ELECTRICALS LIMITED

CORPORATE QUALITY ASSURANCE

PROJECT:

SYSTEM :

VENDOR :

ITEM :

[illegible]

Legend:

1. BHEL

2. Vendor

3. Sub-Vendor

QP No

CQS/SQP/31

Signature

Date _____

Rev

Name _____

Page No

1 of 1

Party

Customer/Consultant

Bhel

Vendor



**1x800 TANGEDCO NORTH CHENNAI TPP
AIR CONDITIONING SYSTEM
LIST OF DOCUMENTS TO BE SUBMITTED WITH
BID**

SPECIFICATION No: PE-TS-423-553-A001

SECTION : II

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

1. Compliance cum confirmation certificate
2. Guaranteed power consumption (In the format attached in the spec mentioning KW rating).
3. Un priced format for main package (mentioning quoted against each item)
4. Un priced format for mandatory spare (mentioning quoted against each item, if applicable)
5. Un priced format for Tools and Tackles (mentioning quoted against each item)
6. Un priced format for Commissioning spare (mentioning quoted against each item)
7. Complete set of technical specification duly signed and stamped.
8. No deviation certificate



1x800 TANGEDCO NORTH CHENNAI TPP

**AIR CONDITIONING SYSTEM
COMPLIANCE CUM CONFIRMATION
CERTIFICATE**

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COMPLIANCE CUM CONFIRMATION CERTIFICATE

The bidder shall confirm compliance with following by signing / stamping this compliance certificate (every sheet) and furnish same with the offer.

- a) The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions, other than those mentioned under "exclusion and those resolved as per 'Schedule of Deviations', with regard to same.
- b) There are no other deviations w.r.t. specifications other than those furnished in the 'Schedule of Deviations'. Any other deviation, stated or implied, taken elsewhere in the offer stands withdrawn unless specifically brought out in the 'Schedule of Deviations'
- c) Bidder shall submit QP in the event of order based on the guidelines given in the specification & QP enclosed therein. QP will be subject to BHEL / CUSTOMER approval & customer hold points for inspection / testing shall be marked in the QP at the contract stage. Inspection / testing shall be witnessed as per same apart from review of various test certificates/ Inspection records etc. This is within the contracted price without any extra implications to BHEL after award of the contract.
- d) All drawings/ data-sheets / calculations etc. submitted along with the offer shall not be taken cognizance off.
- e) The offered materials shall be either equivalent or superior to those specified in the specification & shall meet the specified / intended duty requirements. In case the material specified in the specifications is not compatible for intended duty requirements then same shall be resolved by the bidder with BHEL during the pre-bid discussions, otherwise BHEL / Customer's decision shall be binding on the bidder whenever the deficiency is pointed out.

For components where materials are not specified, same shall be suitable for intended duty, all materials shall be subject to approval in the event of order.

- f) The commissioning spares shall be supplied on 'As Required Basis' & prices for same included in the base price itself.
- g) All sub vendors shall be subject to BHEL / CUSTOMER approval in the event of order.
- h) Guarantee for plant/equipment shall be as per relevant clause of GCC / SCC / Other Commercial Terms & Conditions
- i) In the event of order, all the material required for completing the job at site shall be supplied by the bidder within the ordered price even if the same are additional to approved billing break up, approved drawing or approved Bill of quantities within the scope of work as tender specification. This clause will apply in case during site



1x800 TANGEDCO NORTH CHENNAI TPP

**AIR CONDITIONING SYSTEM
COMPLIANCE CUM CONFIRMATION
CERTIFICATE**

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commissioning, additional requirements emerges due to customer and / or consultant's comments. No extra claims shall be put on this account

- j) Schedule of drawings submissions, comment incorporations & approval shall be as stipulated in the specifications. The successful bidder shall depute his design personnel to BHEL's / Customer's / Consultant's office for across the table resolution of issues and to get documents approved in the stipulated time.
- k) As built drawings shall be submitted as and when required during the project execution.
- l) The bidder has not tempered with this compliance cum confirmation certificate and if at any stage any tempering in the signed copy of this document is noticed then same shall be treated as breach of contract and suitable actions shall be taken against the bidder.
- m) Successful bidder shall furnish detailed erection manual for each of the equipment supplied under this contract at least 3 months before the scheduled erection of the concerned equipment / component or along with supply of concerned equipment / component whichever is earlier.
- n) Document approval by customer under Approval category or information category shall not absolve the vendor of their contractual obligations of completing the work as per specification requirement. Any deviation from specified requirement shall be reported by the vendor in writing and require written approval. Unless any change in specified requirement has been brought out by the vendor during detail engineering in writing while submitting the document to customer for approval, approved document (with implicit deviation) will not be cited as a reason for not following the specification requirement.
- o) In case vendor submits revised drawing after approval of the corresponding drawing, any delay in approval of revised drawing shall be to vendor's account and shall not be used as a reason for extension in contract completion.



1x800 TANGEDCO NORTH CHENNAI TPP

AIR CONDITIONING SYSTEM
PRE-BID CLARIFICATION SCHEDULE

SPECIFICATION No: PE-TS-423-553-A001

SECTION : II

SUB-SECTION : 4

REV. NO. 01

DATE: NOV 2017

SHEET: 1 OF 1

PRE-BID CLARIFICATION SCHEDULE

S. NO.	SECTION/CLAUSE/PAGE NO.	STATEMENT OF THE REFERRED CLAUSE	CLARIFICATION REQUIRED

The bidder hereby clarifies that above mentioned are the only clarifications required on the technical specification for the subject package.

Signature: _____

Name: _____

Designation: _____

Company: _____

Date: _____

Company Seal



1x800 TANGEDCO NORTH CHENNAI TPP

**AIR CONDITIONING SYSTEM
NO DEVIATION CERTIFICATE**

SPECIFICATION No: PE-TS-423-553-A001

SECTION : II

SUB-SECTION : 5

REV: 01

DATE: NOV 2017

SHEET 1 OF 1

NO DEVIATION CERTIFICATE

Refer GCC-6, Annexure-II Deviation sheet (Cost of withdraw)



1x800 TANGEDCO NORTH CHENNAI TPP

**AIR CONDITIONING SYSTEM
GAURANTEE POWE CONSUMPTION**

SPECIFICATION No: PE-TS-423-553-A001

SECTION : II

SUB-SECTION : 6

REV. NO. 01

DATE: NOV 2017

SHEET: 1 OF 1

REFER ANNEXURE-III



**1x800 TANGEDCO NORTH CHENNAI TPP
AIR CONDITIONING SYSTEM
SUGGESTIVE PRICE FORMAT**

SPECIFICATION No: PE-TS-423-553-A001

SECTION : II

SUB-SECTION : 7

REV 01

DATE: NOV 2017

**SECTION-II
SUB-SECTION-7**

SUGGESTIVE PRICE FORMAT

SUGGESTED PRICE FORMAT		Doc No:	PE-PF-423-553-A001		
		Rev No:	1		
		Date of issue	NOV 2017		
NAME OF PROJECT:		1x800 TANGEDCO NORTH CHENNAI TPP			
NAME OF PACKAGE:		AIR CONDITIONING SYSTEM			
TECHNICAL SPECIFICATION No:		PE-TS-423-553-A001			
S. No.	DESCRIPTION	UNIT	QTY	AMOUNT (Ex-Works)	
1	Total lump sum firm price inclusive of all prevailing taxes, duties and other levies for Supply part, Services part and Mandatory spares (if applicable) comprising of design (i.e.preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles (as applicable), fill of lubricants & consumables, mandatory spares alongwith spares for erection, startup and commissioning as required, forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation & storage at site, in-site transportation, assembly, erection & commissioning, final painting at site, minor civil work, trial run at site, preperation of layout drawings 3D (as applicable) and carrying out Performance guarantee / Functional / Demonstration tests at site (As applicable), training of customer/client O&M staff (if applicable) and handover in flawless condition of the package to the end customer complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendment & agreements till placement of order.	1 Lot			
2	MAJOR BREAK-UP OF PRICES GIVEN IN 1.0 ABOVE.				
2.1	Total lump sum firm price inclusive of all prevailing taxes, duties and other levies for Supply part comprising of design (i.e.preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles (as applicable), fill of lubricants & consumables alongwith spares for erection as required, startup and commissioning spares as required, forwarding, proper packing, shipment and delivery at site, preperation of layout drawings 3D (as applicable) for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendment & agreements till placement of order. (Break-up as per Annexure-I)	1 Lot			
2.2	Total lumpsum firm prices inclusive of all prevailing taxes, duties and other levies for Services part comprising of service part for unloading, handling, transportation & storage at site, in-site transportation, assembly, erection & commissioning, final painting at site, minor civil work, trial run at site and carrying out Performance guarantee / Functional / Demonstration tests at site (As applicable), training of customer/client O&M staff (if applicable) and handover in flawless condition of the package to the end customer complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendment & agreements till placement of order. (Break-up as per Annexure-I)	1 Lot			
2.3	Total lumpsum firm price inclusive of all prevailing taxes, duties and other levies for Mandatory spares comprising of manufacture, fabrication, assembly, inspection / testing (as applicable) at vendor's & sub-vendor's works, painting, forwarding, proper packing, shipment, delivery at site & guarantee as per tender technical specification above, amendment & agreements till placement of order. (Price break up of mandatory spares is to be furnished as per Annexure- II)	1 Lot			
Note:					
1.) Bidder to quote Guaranteed Power Consumption for Air Conditinging System as per Annexure-III.					
2.) PG to consider and suitably incorporate taxes, duties and other commercial aspects.					
Particulars of bidder / authorised representative					
	Name	Designation	Signature	Date	Company Seal

SUGGESTED PRICE FORMAT APPENDIX - A Special tools & tackles for maintenance				Doc No:	PE-PF-423-553-A001
				Rev No:	1
				Date of issue	NOV 2017
NAME OF PROJECT:		1x800 TANGEDCO NORTH CHENNAI TPP			
NAME OF PACKAGE:		AIR CONDITIONING SYSTEM			
TECHNICAL SPECIFICATION No:		PE-TS-423-553-A001			
SL NO	DESCRIPTION	UNIT	Qty	AMOUNT (Ex-Works)	
1	FLAT D WRENCH - 6 MM TO 32 MM (12 Pcs)	SET	1		
2	BOX WRENCHES - 6 MM TO 22 MM (14 Pcs)	SET	1		
3	RING SPANNER - 6 MM TO 32 MM (12 Pcs)	SET	1		
4	ALLEN KEYS - 2 MM TO 10 MM	SET	1		
5	CRESCENT SCREW SPANNER	NO.	1		
6	SCREW DRIVER	NO.	1		
7	OFFSET SCREW DRIVER	NO.	1		
8	INSULATED PLIER	NO.	1		
9	TORCH LIGHT (SUITABLE FOR 2 CELL)	NO.	1		
10	HAMMER 1 LB	NO.	1		
11	OIL CAN	NO.	1		
12	POCKET THERMOMETER - 0 TO 50 DEG. C	NO.	1		
13	INSULATION TAPE ROLL	NO.	1		
14	STEEL FOOT RULE - 12"	NO.	1		
15	FEELER GAUGE 9 BLADES	NO.	1		
16	PIPE WRENCH	NO.	1		
17	FLARE NUT (1/4")	NOS.	6		
18	FLARING TOOL	NO.	1		
19	TUBE CUTTER	NO.	1		
20	GAS CHARGING PIPE	NO.	1		
21	NITROGEN CHARGING ADAPTER	NO.	1		
22	PRESSURE GAUGE (2 1/2" DIA DIAL) 0 - 300 PSI	NO.	1		
23	PRESSURE GAUGE (2 1/2" DIA DIAL) 0 - 500 PSI	NO.	1		
24	COMPOUND GAUGE (2 1/2" DIA DIAL) (-)30" to 150 PSI	NO.	1		
25	PSYCHRO METER	NO.	1		
26	LOCK WITH KEY FOR TOOL BOX	NO.	1		
27	RATCHET 1/4"	NO.	1		
28	MS TOOL BOX	NO.	1		
NOTES					
1	ABOVE IS THE MINIMUM LIST. ANY OTHER TOOL / TACKEL REQUIRED FOR THE SYSTEM SHALL ALSO BE PROVIDED BY THE VENDOR WITHOUT ANY COST IMPLICATION.				
Particulars of bidder / authorised representative					
	Name	Designation	Signature	Date	Company Seal

SUGGESTED PRICE FORMAT ANNEXURE - I					Doc No:		PE-PF-423-553-A001	
					Rev No:		1	
					Date of issue		NOV 2017	
NAME OF PROJECT:				1x800 TANGEDCO NORTH CHENNAI TPP				
NAME OF PACKAGE:				AIR CONDITIONING SYSTEM				
TECHNICAL SPECIFICATION No:				PE-TS-423-553-A001				
SL NO	DESCRIPTION	UNIT	Qty	SUPPLY	ERECTION AND COMMISSIONING			
				AMOUNT (Ex-Works)	AMOUNT (Ex-Works)			
A	AC-Plant-1: CENTRAL CHILLED WATER SYSTEM FOR MAIN CCR AREAS							
1	Microprocessor controlled, water cooled chiller package each of minimum capacity 180 TR (ACTUAL) consisting of Hermetic/ semi - Hermetically sealed Screw type refrigerant compressor operating on R134a refrigerant complete with motor, unit mounted starter, complete with suction and discharge shut off valves, HP / LP cutouts, oil pressure failure switch, gauge panel, automatic capacity control; Condenser, relief valve, chiller, controls such as thermostatic/electronic expansion valve, cooling thermostat, antifreeze thermostat, water flow switch, integral refrigerant pipes & fittings, strainer, sight glass, isolating valves, chiller drain valve, chiller insulation, refrigerant piping insulation, first charge of gas and oil, base frames, vibration isolators, integral wiring, unit mounted isolator / fuse switch and other accessories as specified.	2	NO					
2	Sheet metal cabinet type air handling units (double skin as per specification) consisting of chilled water cooling coil, centrifugal blower, TEFC sq cage induction motor, VFD, drive set , filters (pre filter at the inlet), 3 way motorised mixing valve with thermostatic controls and other accessories as per specifications to meet the AC load of the main Control Room areas of power house building at 17.0m and kept at 24.0 M floor level as per specification. Fine filter and HEPA Filters shall be provided as per the specification. Each AHU fan shall be provided with VFD driven motor alongwith VFD and other accessories as required for VFD shall also be included in the price.	3	NO					
3	Sheet metal cabinet type air handling units (double skin as per specification) consisting of chilled water cooling coil, centrifugal blower, TEFC sq cage induction motor, VFD, drive set , filters (pre filter at the inlet), 3 way motorised mixing valve with thermostatic controls and other accessories as per specifications to meet the AC load of the UPS & Battery charger areas at 8.5m. Fine filter and HEPA Filters shall be provided as per the specification. Each AHU fan shall be provided with VFD driven motor alongwith VFD and other accessories as required for VFD shall also be included in the price.	2	NO					
4	Fibreglass reinforced plastic (FRP) construction cooling towers of adequate capacity, complete with fan, motor, FRP basin, nozzles, make-up water & quick fill water connection, drains, piping, valves, strainers, ladder & all accessories as specified.	2	NO					
5	Centrifugal pump sets for condenser water recirculation complete with TEFC motor & all accessories as specified.	2	NO					
6	Centrifugal pump sets for chilled water recirculation complete with TEFC motor & all accessories, as specified.	2	NO					
7	Make up water cum storage tank, for cooling towers Make up, of HDPE/MS (spray galvanised from inside) with accessories as required. Capacity of each tank 8 m3 .	2	NO					
8	Expansion Tank HDPE/MS (spray galvanised from inside) (insulated) for chilled water with all accessories as required, capacity 1 m3.	1	NO					
9	Online Non chemical scale preventer, with all accessories as required to meet system requirements	1	NO					
10	Condenser water piping with necessary fittings, strainers, valves including piping from make up water storage tank to humidifiers of AHU room as per specification. This shall include make up water piping with valves and fitting from terminal point upto the make up water tank.	1	LOT					
11	Insulated chilled water piping from AC plant to AHU rooms within power house building complete with valves supports, fittings, strainers, insulation with finish as per specification.	1	LOT					
12	Monsoon reheating/ winter heating kit comprising strip heaters, safety controls, air-stat, contactors, frame work, thermostat & humidistat/ sensors etc.	1	LOT					

SUGGESTED PRICE FORMAT ANNEXURE - I					Doc No:		PE-PF-423-553-A001	
					Rev No:		1	
					Date of issue		NOV 2017	
NAME OF PROJECT:				1x800 TANGEDCO NORTH CHENNAI TPP				
NAME OF PACKAGE:				AIR CONDITIONING SYSTEM				
TECHNICAL SPECIFICATION No:				PE-TS-423-553-A001				
SL NO	DESCRIPTION	UNIT	Qty	SUPPLY	ERECTION AND COMMISSIONING			
				AMOUNT (Ex-Works)	AMOUNT (Ex-Works)			
13	Pan type humidifier for each AHU room.	1	LOT					
14	Fresh air fan (axial flow type), complete with motor, inlet cone, air filters as per the specificalton, dampers etc.	1	LOT					
B	AC Plant -2 (ESP building)							
1	DX type, water cooled condensing unit of 40 TR (ACTUAL) capacity. The refrigerant compressor shall be Srew / Scroll, Open / Semi-hermetic type suitable for Refrigerant R-134a / R-407c / R-410a environment friendly HFC refrigerants with drive package (for open type compressor only), Suction and discharge valves, capacity control system, expansion valve, crank case heater etc. A control panel shall be provided to house all gauges and controls. The panel shall contain all necessary terminal strips to facilitate external wiring. The unit shall be complete with expansion valve, all necessary fittings, accessories, insulated refrigerent piping to and from AHUs, foundation bolts, nuts, washers etc complete in all respect.	2	NOs					
2	Sheet metal cabinet type air handling units (double skin as per specification) The draw through horizontal AHUs shall comprise of , Dampers, Filters (pre filter at the inlet), DX- cooling coil, Electric heating coil, Electric steam humidifier and Fan section with fan & TEFC sq cage induction motor, VFD, drive set, face and bypass damper with modulating motor, condensate drain pan, thermostatic controls and other accessories to meet the AC load of control room area. Fine filter and HEPA Filters shall be provided as per the specification. Each AHU fan shall be provided with VFD driven motor alongwith VFD and other accessories as required for VFD shall also be included in the price.	2	NOs					
3	Fibreglass reinforced plastic (FRP) construction cooling towers of adequate capacity, complete with fan, motor, FRP basin, nozzles, make-up water & quick fill water connection, drains, piping, valves, strainers, ladder & all accessories as specified.	2	NOs					
4	Centrifugal pump sets for condenser water recirculation complete with TEFC motor & all accessories as specified.	2	NOs					
5	Make up cum Storage water tank HDPE/MS (spray galvanised from inside) to cooling towers with accessories as required. Capacity of each tank 8 m3 .	1	NOs					
6	Online non - chemical scale preventer, with all accessories as required to meet system requirements	1	NOs					
7	Condenser water piping with necessary fittings, strainers, valves including piping from make up water storage tank to humidifiers of AHU room as per specification. This shall include make up water piping with valves and fitting from terminal point upto the make up water tank.	1	LOT					
8	Monsoon reheating/ winter heating kit comprising strip heaters, safety controls, air-stat, contactors, frame work, thermostat & humidistat/ sensors etc.	1	LOT					
9	Pan type humidifier for each AHU room.	1	LOT					
10	Fresh air fan (axial flow type), complete with motor, inlet cone, air filters (pre and fine), dampers etc.	1	LOT					
C	AC Plant -3 : WATER COOLED PACKAGE UNIT (Service building building)							
1	Water Cooled PAC-Unit complete with all accessories as specified The package unit shall be complete with all accessories like duct hetaers, pan humidifier, filters, acoustic insulation of duct for 5m from PU, drain piping with insulation upto nearest drain, required instrumentation etc							
a*	15TR	8	NO*					
b*	20TR	32	NO*					
2	Fibreglass reinforced plastic (FRP) construction cooling towers of adequate capacity, complete with fan, motor, FRP basin, nozzles, make-up water & quick fill water connection, drains, piping, valves, strainers, ladder & all accessories as specified.(Minimum 400 TR)	2	NOs					
3	Centrifugal pump sets for condenser water recirculation complete with TEFC motor & all accessories as specified.	2	NOs					

SUGGESTED PRICE FORMAT ANNEXURE - I						Doc No:		PE-PF-423-553-A001	
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NAME OF PROJECT:				1x800 TANGEDCO NORTH CHENNAI TPP					
NAME OF PACKAGE:				AIR CONDITIONING SYSTEM					
TECHNICAL SPECIFICATION No:				PE-TS-423-553-A001					
SL NO	DESCRIPTION	UNIT	Qty	SUPPLY	ERECTION AND COMMISSIONING				
				AMOUNT (Ex-Works)	AMOUNT (Ex-Works)				
4	Make up water cum storage tank, for cooling towers Make up, of HDPE/MS (spray galvanised from inside) with accessories as required. Capacity of each tank 8 m3 .	2	NOs						
5	Online non - chemical scale preventer, with all accessories as required to meet system requirements	1	NOs						
6	Condenser water piping with necessary fittings, strainers, valves including piping from make up water storage tank to humidifiers of AHU room as per specification. This shall include make up water piping with valves and fitting from terminal point upto the make up water tank.	1	LOT						
7	Monsoon reheating/ winter heating kit comprising strip heaters, safety controls, air-stat, contactors, frame work, thermostat & humidistat/ sensors etc.	1	LOT						
8	Pan type humidifier for each AHU room.	1	LOT						
9	Fresh air fan (axial flow type), complete with motor, inlet cone, air filters (pre and fine), dampers etc.	1	LOT						
D	ITEMS COMMON TO ALL AC PLANTS								
1*	Fan coil unit (FCU) consisting of chilled water cooling coil, blower, motor, drive set, filters (pre filter), 3 way motorised mixing valve with thermostatic controls and other accessories. All accessories like vibration isolation pads, hanger rods, supporting arrangement, canvass connection, nuts, bolts, washers and other items required to make the installation complete in all respect shall be supplied in adequate quantity along with the FCUs.								
a*	3 TR	5	NO*						
b*	2 TR	1	NO*						
c*	1.5 TR	1	NO*						
2*	Fire damper.								
a*	Fire damper with auto resetting, limit switches, indication lamps etc.	30	SQM*						
b*	Motorized actuator with single phase power supply for the above fire damper.	40	NO*						
3*	GSS zinc coating 275 gms/ m ² ducting complete with hangers/ supports, dampers, grilles, diffusers (with & without VCD) etc.								
a*	18G.	500	SQM*						
b*	20G.	1500	SQM*						
c*	22G.	2000	SQM*						
d*	24G.	2500	SQM*						
e*	Supply air diffuser with VCD (Extruded Aluminium).	55	SQM*						
f*	Return air diffuser without VCD (Extruded Aluminium).	90	SQM*						
g*	VOLUME CONTROL DAMPERS in GI construction as per specifications complete with fixing arrangement.	20	SQM*						
4	Acoustic insulation of the first 6 of ducting from AHU outlets.	1	LOT						
4.1*	Acoustic lining AHU / PU room as per specifications.	2000	SQM*						
5*	Thermal insulation of supply air duct & return air duct with finish as specified.	6500	SQM*						
6	Cable tray, conduites, junction box, Local control panel and Field instruments like pressure gauge, temperature gauge, temperature and pressure transmitters, DP transmitters, flow transmitters, flow indicator, etc. as required for the complete system	1	LOT						
7	Fiber optic cable	400	Rmt*						
8*	Insulated MS medium class drain piping upto nearest drain point with and without insulation								
a*	50mm	400	M						
b*	40mm	250	M						
E	Air conditioning system for aux control rooms as specified.								
1*	Air Cooled PAC-Unit complete with all accessories as specified The package unit shall be complete with all accessories like duct heaters, pan humidifier, filters, acoustic insulation of duct for 6m from PU, drain piping with insulation upto nearest drain, required instrumentation etc								
(a)*	15 TR net capacity	2	No*						
(b)*	10 TR net capacity	2	No*						
2*	Air-cooled split type AC units consisting of condensing unit & evaporating unit including refrigerant pipes & fittings with insulation etc. (Minimum BEE Rating 5 Star for non ductable units).								

SUGGESTED PRICE FORMAT ANNEXURE - I						Doc No:	PE-PF-423-553-A001
						Rev No:	1
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NAME OF PROJECT:				1x800 TANGEDCO NORTH CHENNAI TPP			
NAME OF PACKAGE:				AIR CONDITIONING SYSTEM			
TECHNICAL SPECIFICATION No:				PE-TS-423-553-A001			
SL NO	DESCRIPTION	UNIT	Qty	SUPPLY AMOUNT (Ex-Works)	ERECTION AND COMMISSIONING AMOUNT (Ex-Works)		
(a)*	5.0 TR capacity (ductable type, 415 V, 3 phase with isolation switch).	2	NO*				
(b)*	2.0 TR capacity (non-ductable type, 240 V, 1 phase) with isolation switch , i.e MCB of suitable rating as specified, voltage stabilizer, cabling, all supporting structure and refrigerent piping to suite actual site condition, drain piping upto nearest drain etc.	35	NO*				
(c)*	1.5 TR capacity (non-ductable type, 240 V, 1 phase) with isolation switch , i.e MCB of suitable rating as specified, voltage stabilizer, cabling, all supporting structure and refrigerent piping to suite actual site condition, drain piping upto nearest drain etc..	25	NO*				
3*	Water Cooled precision-Unit complete with all accessories as specified. The precision package unit shall be complete with all accessories like duct heaters, pan humidifier, filters, acoustic insulation of duct for 6 m from PU, drain piping with insulation upto nearest drain, required instrumentation etc.						
(a)*	20 TR net capacity	2	No*				
(b)*	15 TR net capacity	2	No*				
F*	Handling arrangement as per specification						
a*	Electric Hoist with traveling trolley of 3T capacity	1	No*				
b*	Manual trolley (Manually operated, platform trolley of 1.5 Ton capacity with base area 2m x 1.5m)	2	No*				
c*	1T Chain pulley block	2	No*				
d*	1T Chain pulley block with travelling trolley	2	No*				
G*	Venetian blinds	100	SQM*				
H*	Air curtain along with instruments as per the specification. (for minimum door height 3 m and width 3 feet)	2	No*				
I	Total lumpsum price for special tools & tackles for maintenance inclusive of packing forwarding, transportation up to site, etc. (Bidder shall submit item-wise price break-up as per appendix-A).	1	LOT		NA		
J	Total lumpsum price for commissioning spares inclusive of packing forwarding, transportation up to site, etc. (Bidder shall submit item-wise price break-up as per appendix-B).	1	LOT		NA		
K	Any other item not indicated above, but required to make the system complete in all respects.	1	LOT				
NOTES							
1	The bidder shall furnish unit rates for variable item (marked *) for necessary adjustment (plus or minus) variation during detailed engg. stage. The unit rates quoted above shall be considered and no separate unit rates shall be quoted. Unit rates shall be valid throughout the contract.						
Particulars of bidder / authorised representative							
	Name	Designation	Signature	Date	Company Seal		

SUGGESTED PRICE FORMAT APPENDIX - B Commissioning spares				Doc No:	PE-PF-423-553-A001
				Rev No:	1
				Date of issue	NOV 2017
NAME OF PROJECT:		1x800 TANGEDCO NORTH CHENNAI TPP			
NAME OF PACKAGE:		AIR CONDITIONING SYSTEM			
TECHNICAL SPECIFICATION No:		PE-TS-423-553-A001			
SL NO	DESCRIPTION	UNIT	Qty	AMOUNT (Ex-Works)	
1	AHU FAN BELTS	SET	1		
2	PRESSURE GAUGE	NO.	1		
3	TEMPERATURE GAUGE	NO.	1		
4	FILTER	SET	1		
5	COMPRESSOR OIL	Ltr.	1 Lot		
6	REFRIGERANT	Kg	1 Lot		
NOTES					
1	ABOVE IS THE MINIMUM LIST. ANY OTHER COMMISSIONING SPARE REQUIRED FOR THE SYSTEM SHALL ALSO BE PROVIDED BY THE VENDOR WITHOUT ANY COST IMPLICATION.				
Particulars of bidder / authorised representative					
	Name	Designation	Signature	Date	Company Seal

SUGGESTED PRICE FORMAT ANNEXURE-II LIST OF MANDATORY SPARES		Doc No:	PE-PF-423-553-A001	
		Rev No:	1	
		Date of issue	NOV 2017	
NAME OF PROJECT:		1x800 TANGEDCO NORTH CHENNAI TPP		
NAME OF PACKAGE: AIR CONDITIONING SYSTEM		AIR CONDITIONING SYSTEM		
TECHNICAL SPECIFICATION: PE-TS-423-553-A001		PE-TS-423-553-A001		
S. No.	DESCRIPTION	UNIT	Qty	AMOUNT (Ex-Works)
A	C&I portion			
	The quantity of following spares includes a minimum of 20 % spares for replacement of each type of lamps, PBs, ILPBs, fuse, MCB, MCCB used in the equipment/system offered by him even if this is not detailed below.			
i)	Measuring Instruments and Skid Mounted Instruments	Lot	1	
1	10% of the number of indicators, recorders and meters offered from each model for the project or a minimum of one number per model, whichever is more. These instruments shall be supplied with three sets of blank scales.			
2	For skid mounted instruments (if any) - 10% of total number of instruments for each model and type for the project or a minimum of one number for each model and type, whichever is more.			
ii)	Temperature Elements and Thermowells	Lot	1	
1	10% spare thermocouple/RTD elements,suitable for replacement for each type and length of element furnished with thermocouple/RTD assemblies, or a minimum of one number of each type & length, whichever is more.	%	10%	
2	10% thermo wells for each type of temperature sensors or a minimum of one for each type, whichever is more	%	10%	
3	Temperature Transmitters and Electronic Transmitters (For Pressure, DP, Temp, Flow, Level), Temperature, Pressure, Flow & Level Switch, safety switches, Gauges, meters, Transducer or any other instrument etc.			
	10% of total number of instruments/transducers offered for each model and type for the project or a minimum of one number, whichever is more.	Lot	1	
iv)	Distributed Control System and Other Electronic Systems/Sub- Systems/ VMS / MIS /LAN / Simulator / WAN / CAAQMS and any other system as supplied as per Tender Specification etc.	Lot	1	
1	Electronic modules - 10% of number for each type or minimum of 2 number for each type whichever is high.	%	10%	
2	Auto/Manual stations, setpoint/ bias stations etc.: - 10% of the number of stations offered for the project from each type or a minimum of 2 number from each model, whichever is more.			
3	Twenty percent spare replacement for each type of control logic power supply fuses, MCB, MCCB, at each current rating required for the project.	%	20%	
4	Ten (10) percent or 2 no. (Whichever is more) Electronic cards of each type used for Servers supplied with any control system.			
5	10% of electric to pneumatic converters of each type utilized with automatic control system using pneumatic drives or a minimum of one of each type, whichever is more.			

6	Ten (10) percent or five no. (Whichever is more) of cubicle power supply power supply modules of each type and rating.	Nos.	5	
7	Ten (10) percent of the total quantity of each type of interposing/coupling relays.	Sets	1	
8	Twenty (20) percent or 2 no. (Whichever is more) RJ 45 connector with box of each type.	Nos.	2	
9	Ten (10) percent or 2 no. (Whichever is more) Hooters, Buzzers, Cooling fans of each type.	%	10%	
10	Interface cables 2 sets of each type/model	Sets	1	
11	Power supply modules (AC to DC convertors) 10% or Five no. (Whichever is more) of each type/model	Nos.	5	
v)	Relay Based Control Panels	Sets	1	
1	10% LEDs for indicating lights shall be furnished.			
2	Three times, the one hundred percent (300% of installed) spare replacement control circuit fuses/MCB/MCCB of each current rating required shall be furnished.			
3	20% spare replacement relays modules & contactors of each type.			
vi)	Alarm Annunciation System	Sets	1	
1	20% spares of each type installed shall be provided for logic modules, group card modules, power supply modules, Hooters and any other electronic module.			
2	5% spares of each size shall be provided for un-engraved window boxes complete with LED etc.			
3	20% of installed LEDs for annunciation facia windows and LEDs box assemblies offered for the project shall be provided as mandatory spares.			
4	One (1) spare annunciator hooter of each type.			
vii)	Erection hardware	Sets	1	
1	Ten (10) percent of each type & Size installed instrument valve, manifold for each type, rating, model number and size of devices supplied for the project.			
2	Ten (10) percent of total number of condensate pots or four numbers whichever is higher of each type & Size installed.			
3	Ten (10) percent of each type & Size installed Fittings			
viii)	Mandatory Spares for Control valves, Power Cylinder, Control Dampers, Actuators and Accessories			
a)	Following spares shall be furnished for control valves, Power Cylinder, Control Dampers as applicable.	Lot	1	
1	One set of spare control valve stem packing for each control valve.			
2	Two moulded rubber diaphragms for each control valve.			
3	One sets of each of O-rings and rubber gaskets for each control valve.			
4	100 percent qty. of lubricants for gaskets for each control valve on one year consumption basis.			
5	2 sets of limit switches and 1 set of valve positioner for each control valve.			
6	20 percent of position transmitter (4-20mA) for total qty. of control valve.			
7	One (1) set of valve trims (such as plug, stem, seat ring / cage, guide bushing, stem lock pin, packing retaining ring, etc.) for each control valve.			
8	One completes actuator of each type or min 10% for each type and size whichever is more.			
9	20 percent of Solenoid valves or min 2 no. of each type for total qty. of control valves.			
10	20% of I to P converters, Pressure regulators.			

ix)	Mandatory spares not covered above	Lot	1	
	Bidder to supply 10% or 1 no. (whichever is more) of each type of sensor/instrument, analyzers /special instruments/Electronic card, instrumentation/mechanical fittings etc. for any other electronic system, feeder control cabinets, hydra step (EWLI), Vibration Monitoring System, CCTV, C&I Lab Instruments, On line Carbon in Ash analyzer system, On line Coal mass flow/speed measurement system, On line secondary air flow measurement system Mass Flow meter, Solid flow meter, 3 D Acoustic type level transmitters, Nucleonic & non nucleonic density transmitter etc.			
B	Electrical portion			
1	415V Motors			
1.1	Terminal plates	Nos.	10 Nos. each for small motors upto 30 KW & 4 Nos. each for more than 30 KW	
1.2	Heaters	Set	2 sets	
1.3	Greasing arrangements	Set	4 sets each type of motor	
1.4	Motor of each type and rating	Nos.	10% of the installed quantity or minimum 1 number whichever more	
1.5	Bearings (DE and NDE) for each type and rating of motor	Set	4 set	
Note: Mandatory spares listed above is bare minimum requirement. In case any additional mandatory spares requirement is covered elsewhere in the tender specification apart from specified above, same shall be deemed to have been covered in bidders scope of supply.				
Particulars of bidder / authorised representative				
	Name	Designation	Signature	Date
				Company Seal

SUGGESTED PRICE FORMAT ANNEXURE - III Guaranteed Power Consumption For Air Conditioning System					Doc No:	PE-PF-423-553-A001
					Rev No:	1
					Date of issue	NOV 2017
NAME OF PROJECT:			1x800 TANGEDCO NORTH CHENNAI TPP			
NAME OF PACKAGE:			AIR CONDITIONING SYSTEM			
TECHNICAL SPECIFICATION No:			PE-TS-423-553-A001			
S.NO.	DESCRIPTION OF EQUIPMENT	NO OF EQUIPMENT		TOTAL GUARANTEED POWER CONSUMPTION FOR EACH EQUIPMENT AT MOTOR INPUT TERMINAL AND CONTROL PANEL (IN KW)	DUTY FACTOR	TOTAL KW
		WORKIN	STANDBY			
		3A	3B	4	5	6=3Ax4x5
1	AC PLANT FOR COMMON CONTROL ROOM AREAS, CER ROOM, UPS ROOM, COMPUTER ROOM					
1.1	Water chilling machine	1	1			
1.2	Chilled water pumps for AC plant	1	1			
1.3	Condenser water pumps for AC plant	1	1			
1.4	Cooling tower fans for AC plant	1	1			
1.5	AHUs for Common control room areas, CER, computer room etc at EL 24 M.	2	1			
1.6	Fresh air fans for above AHUs room	2	0			
1.7	AHUs for UPS room area at EL 8.5 M.	1	1			
1.8	Fresh air fans for above AHUs room	2	0			
2	ESP					
2.1	Water cooled condensing unit	1	1			
2.2	FRP Cooling Tower	1	1			
2.3	Condenser water pumps	1	1			
2.4	AHU for above condensing unit	1	1			
2.5	Fresh air fans for above AHU room.	2	0			
				TOTAL (KW)		
Note:	Estimated power consumption (EPC) figure for the system (for working drives only) has been considered as 336 KW. So long bidder's quoted guaranteed power consumption (GPC) above remains within this EPC, there will be no technical loading of bid on power consumption for evaluation. However, if bidder's quoted GPC exceeds EPC, there shall be technical loading of bid for evaluation @ Rs 588401/- per KW of additional power over EPC. Bidder's guaranteed power consumption at motor input terminals (not shaft power) as furnished in relevant schedule shall be demonstrated by the successful bidder during performance testing at works/ site. In case power consumption is noted higher than EPC / bidder's quoted GPC whichever is higher, during inspection/ PG test, penalty @ Rs 588401/- per KW shall be levied on vendor.					
Particulars of bidder / authorised representative						
Name	Designation	Signature	DATE	Company Seal		

