

**TAMILNADU GENERATION & DISTRIBUTION CORPORATION
LIMITED**

1x800 MW TANGEDCO NORTH CHENNAI TPP

TECHNICAL SPECIFICATION

FOR

VENTILATION SYSTEM

SPECIFICATION NO.: - PE-TS-423-554-A001 (REV 01)



**BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR**

**PROJECT ENGINEERING MANAGEMENT
PROJECT ENGINEERING INSTITUTE BUILDING
SECTOR-16A, PLOT NO.-25, NOIDA, INDIA**



TITLE: TECHNICAL SPECIFICATINS FOR VENTILATION SYSTEM	SPECIFICATION No: PE-TS-423-554-A001	
	SECTION	
	REV. 01	DATE: NOV 2017
	SHEET : 1 OF 2	

CONTENTS

This Technical specification consists of two sections:

SECTION - I

SUB- SECTIONS	TITLE		Page No
Sub-Section-A	INTENT OF SPECIFICATION		5
Sub-Section-B	PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA		8
Sub-Section-C	TECHNICAL SPECIFICATIONS		
	Sub Section-C1	SPECIFIC TECHNICAL REQUIREMENT	18
	Sub Section-C2	CUSTOMER SPECIFICATION	35
		C2 - A TECHNICAL REQUIREMENT	36
		C2 - B PROJECT SPECIFIC GENERAL REQUIREMENTS INCLUDING:	69
		GENERAL TECHNICAL REQUIREMENT	70
		FUNCTIONAL / PERFROMANCE / DEMONSTRATION / GUARANTEE TESTS	123
		QUALITY ASSURANCE	154
		DRAWINGS / DOCUMENTS SUBMISSION PROCEDURE (Refer ANNEXURE-VI)	
		PACKING PROCEDURE	296
		PROJECT MANAGEMENT AND SITE SERVICES	300
		C2 - C PAINTING SPECIFICATIONS	316
	Sub Section-C3	TECHNICAL SPECIFICATION (ELECTRICAL PORTION)	329
	Sub Section-C4	TECHNICAL SPECIFICATION (C&I PORTION)	441
	Sub Section-C5	TECHNICAL SPECIFICATION (MATERIAL HANDLING PORTION)	528
Sub Section-D	STANDARD TECHNICAL SPECIFICATIONS		558
Sub Section-E	ANNEXURE-I	LIST OF MAKES OF SUB-VENDOR ITEMS	608
	ANNEXURE-II	MANDATORY SPARE LIST	617
	ANNEXURE-III	PAINTING & COLOUR SCHEME	618
	ANNEXURE-IV	LIST OF TOOLS & TACKLES	619
	ANNEXURE-V	SERVICE WATER ANALYSIS	621
	ANNEXURE-VI	DRAWINGS / DOCUMENTS SUBMISSION PROCEDURE	623
	ANNEXURE-VII	MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION	625
	ANNEXURE-VIII	FORMAT FOR OPERATION AND MAINTENANCE MANUAL	628
	ANNEXURE-IX	SITE STORAGE AND PRESERVATION	632
	ANNEXURE-X	PACKING PROCEDURE(Refer SECTION C2-B)	



TITLE:
**TECHNICAL SPECIFICATINS FOR
VENTILATION SYSTEM**

SPECIFICATION No: PE-TS-423-554-A001

SECTION

REV. 01

DATE: NOV 2017

SHEET : 2 OF 2

SECTION - II

SUB SECTIONS	TITLE		Page No
Sub Section-1	INSPECION AND TESTING WITH STANDARD QUALITY PLAN		649
Sub Section-2	LIST OF DOCUMENTS TO BE SUBMITTED WITH BID		653
Sub Section-3	COMPLIANCE CUM CONFIRMATION CERTIFICATE		654
Sub Section-4	PRE BID CLARIFICATION SCHEDULE		656
Sub Section-5	NO DEVIATION CERTIFICATE		657
Sub Section-6	GUARANTEED POWER CONSUMPTION		658
Sub Section-7	SUGGESTIVE PRICE FORMAT INCLUDING MANDATORY SPARES.		659
Sub Section-8	DRAWINGS (ONLY FOR TENDER PURPOSE)		
	DRG TITLE	DRG NO	
a	MECHANICAL LAYOUT DRAWINGS SHOWING LOCATION OF EQUIPMENT		670
b	ESP CONTROL ROOM DRWAING		676
c	PID		677
d	MAKE UP WATER SCHEME		679



1X800 TANGEDCO NORTH CHENNAI TPP
VENTILATION SYSTEM

SPECIFICATION No: PE-TS-423-554-A001

SECTION: I

REV. 01

DATE: NOV 2017

SECTION - I



1x800 TANGEDCO NORTH CHENNAI TPP

**VENTILATION SYSTEM
INTENT OF SPECIFICATION**

SPECIFICATION No: PE-TS-423-554-A001

SECTION : I

Sub Section: A

REV. 01

DATE: NOV 2017

SHEET 1 OF 3

SECTION-I

SUB-SECTION-A

INTENT OF SPECIFICATION

**1x800 TANGEDCO NORTH CHENNAI TPP****VENTILATION SYSTEM
INTENT OF SPECIFICATION****SPECIFICATION No: PE-TS-423-554-A001****SECTION : I****Sub Section: A****REV. 01****DATE: NOV 2017****SHEET 1 OF 3****1.0 INTENT OF SPECIFICATION**

- 1.1 The specification covers design, engineering, manufacture, supply / procurement, inspection and testing at vendor's / sub vendor's / manufacturer's works, painting, forwarding, proper packing and shipment and delivery at site, unloading, handling & transportation, storage, preservation , security / safety at site , Erection & Commissioning, minor civil & structural (as applicable) works as required on FOR site basis, Performance and guarantee testing / demonstration testing and handing over to BHEL's customer of **VENTILATION SYSTEM** as per details in different sections / volumes of this specification and various pre award agreements for **1x800 TANGEDCO NORTH CHENNAI TPP , Chennai, Tamil Nadu.**
- 1.2 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve the contractor of the responsibility of providing such facilities to complete the supply, erection and commissioning, performance and guarantee/demonstration testing of **VENTILATION SYSTEM.**
- 1.3 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to highest standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgement is not in full accordance herewith.
- 1.4 The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing. Similarly, the extent of supply also includes all items required for completion of the system and not withstanding that they may have been omitted in drawings / specifications or schedules.
- 1.5 The general term and conditions, instructions to tenderers and other attachment referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification is subject to compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.
- 1.6 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under Vol-III of the specification **within 10 days of receipt of tender documents.** In absence of any such clarifications, in case of any contradictory requirement, the more stringent



1x800 TANGEDCO NORTH CHENNAI TPP

**VENTILATION SYSTEM
INTENT OF SPECIFICATION**

SPECIFICATION No: PE-TS-423-554-A001

SECTION : I

Sub Section: A

REV. 01

DATE: NOV 2017

SHEET 1 OF 3

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



1X800 TANGEDCO NORTH CHENNAI TPP

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

SPECIFICATION No: PE-TS-423-554-A001

SECTION : I

Sub Section : B

REV. 01

DATE: NOV 2017

SECTION: I

SUB-SECTION: B

**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)



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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)



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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
POWER PROJECT STAGE III



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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



1x800 TANGEDCO NORTH CHENNAI TPP

**VENTILATION SYSTEM
TECHNICAL SPECIFICATION**

SPECIFICATION No: PE-TS-423-554-A001

SECTION : I

Sub Section : C

REV. 01

DATE: NOV 2017

SECTION: I

SUB SECTION: C

TECHNICAL SPECIFICATIONS



1X800 TANGEDCO NORTH CHENNAI TPP

**VENTILATION SYSTEM
SPECIFIC TECHNICAL REQUIREMENT**

SPECIFICATION No: PE-TS-423-554-A001

SECTION : I

SUB-SECTION : C 1

REV. 01

DATE: NOV 2017

SHEET 1 OF 17

SECTION: I

SUB-SECTION: C 1

SPECIFIC TECHNICAL REQUIREMENT

**1X800 TANGEDCO NORTH CHENNAI TPP****VENTILATION SYSTEM
SPECIFIC TECHNICAL REQUIREMENT****SPECIFICATION No: PE-TS-423-554-A001****SECTION : I****SUB-SECTION : C 1****REV. 01****DATE: NOV 2017****SHEET 2 OF 17****1. FUNCTION**

The purpose of the system is to provide Ventilation System for different areas of **1x800 MW, NORTH CHENNAI STAGE-III** under the scope of BHEL.

2. SYSTEM DESCRIPTION**VENTILATION SYSTEM-1**

- 2.1.** The Ventilation System is provided in the following locations within the Power House by Air washers.

Ventilation system shall be comprise of four (4) nos. (All working) Air washer. Each air washer shall be consisting of 2 nos. (2x50%) of fans and 2 nos. (2x100 %) of pumps. Coursing of air in desired direction / areas shall be made by using roof extractors (70% of total air supplied) and wall mounted exhaust fans.

VENTILATION SYSTEM-2

- 2.2.** The Ventilation System is provided in the following locations for ESP-control room building by UAF.

Ventilation system shall be comprise of One (1) number of UAF. Each UAF shall be consisting of 1 number (1x100%) of fans and 2 number (2x100 %) of pumps. UAF shall have 90% saturation efficiency.

VENTILATION SYSTEM-3

- 2.3.** Ventilation provision for Auxiliary Buildings in various location (offsite area) is envisaged as follows.

a)	Switchgear Room, MCC room,	Wall mounted supply fans (with pre and fine filters) with gravity operated backdraft dampers.
b)	Battery room, hazardous area and fumes generating area, Oil rooms	Wall mounted exhaust fans (spark proof with flame proof motor).
c)	AC Plant Room, CPU / CPU Regeneration, SWAS room (Non-AC Area), Various pump houses under BHEL scope	Wall mounted exhaust fans
d)	Toilet / pantries	Wall mounted exhaust fans propeller type

**1X800 TANGEDCO NORTH CHENNAI TPP****VENTILATION SYSTEM
SPECIFIC TECHNICAL REQUIREMENT****SPECIFICATION No: PE-TS-423-554-A001****SECTION : I****SUB-SECTION : C 1****REV. 01****DATE: NOV 2017****SHEET 3 OF 17**

2.4. Please refer to clause 2.1.10.4 and other relevant clauses of customer technical specifications **section C-2** for other detail of system description.

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

3. DESIGN CRITERIA**3.1. System Design Criteria**

The outside design conditions considered are as follows:

	Summer	Monsoon	Winter
DBT (°C)	47.0	28.3	18.3
WBT (°C)	27.8	26.7	13.9
RH (%)	41	88	60

The inside design conditions:-

Evaporative Cooled Areas:

Inside temperature shall be kept 5°C below the design ambient temperature during summer.

Mechanically ventilated areas:

Temperature rise above outside ambient shall be maximum 3°C during summer.

Higher number of air changes/higher quantity of air in either of condition shall be selected.

The ventilation philosophy in various areas shall be as under:

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

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



1X800 TANGEDCO NORTH CHENNAI TPP

**VENTILATION SYSTEM
SPECIFIC TECHNICAL REQUIREMENT**

SPECIFICATION No: PE-TS-423-554-A001

SECTION : I

SUB-SECTION : C 1

REV. 01

DATE: NOV 2017

SHEET 4 OF 17

All equipment shall be designed for continuous duty.

The ducting shall be sized to have constant friction drop along its length.

The air washer and UAF shall be designed for maximum face velocity of 2.0 M/Sec.

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

The UAF shall be designed for minimum 90% saturation efficiency.

Insulation for the duct exposed to atmosphere 50 mm thick fiber glass rigid board (density 48 Kg/m³ and TF quality) finished with 26 swg aluminium cladding.

Please also refer to clause no. 2.1.10.4 and other relevant clauses of Customer technical specification section C-2 for design criteria.

4. LAYOUT CONSIDERATIONS

Evaporative cooling system by adopting Air Washer Unit (AWU) shall be provided for the ventilation of turbine building. Cooled and filtered air from Air Washer Unit shall be distributed by means of ducting to the TG building near various heat sources like turbo-generator, condenser, Boiler feed pump HP & LP heaters etc. The hot air from the hall shall than be exhausted by means of roof extractors. The quantity of air exhausted shall be kept lower than the quantity of air supplied in such a way that a little overpressure is maintained inside the hall. This will reduce infiltration of outside hot and dusty air.

The supply air quantity for each unit is supplied from four (4) AWU - two (2) nos. being placed at 0.0 M level outside A-Row TG building and two (2) nos. shall be placed in B-C bay at 29.5 M floor level. Such division and location is decided to achieve effective air distribution with less amount of ductwork and less pressure drop in fans with no crossover of ducting along A-B bay.

The Air Washer Units primarily serve TG hall and the electrical areas like MCC Room, Switchgear Room, and Cable Spreader Room. Fire dampers are provided in the supply air ducting leading to all electrical rooms (Switch Gear Room, cable galleries). The operation of these automatic dampers shall be interlocked suitably with fire alarm system

5. EQUIPMENT AND SERVICES TO BE PROVIDED FOR VENTILATION SYSTEM

5.1. Air washer

Air-washers for TG hall:

Four (4) Nos. sheet metal type Air washer units (AWU) having capacity 250000 M³/Hr each having minimum 95 mmWC static pressure for T.G.Hall.

Each air washer comprises of:

- Two (2) no. (2x50% duty) Centrifugal fan backward inclined, DIDW Type, complete with electric drive motor, drive Pulleys, V-belt, belt guards, slide rails and other accessories etc.



1X800 TANGEDCO NORTH CHENNAI TPP

**VENTILATION SYSTEM
SPECIFIC TECHNICAL REQUIREMENT**

SPECIFICATION No: PE-TS-423-554-A001

SECTION : I

SUB-SECTION : C 1

REV. 01

DATE: NOV 2017

SHEET 5 OF 17

- Two (2) nos. (2 x 100 % duty) Horizontal split casing type centrifugal pumps for circulation of water shall be considered. Pump suction shall be provided with pot strainer with by-pass valves.
- Capacity of pump shall be 250 m³/hr and head 30 mmWC (approx.).
- A spray nozzle system consisting of double banks spray system each connected to individual headers, flow regulating valves for controlling flow to spray header. Nozzles shall be of brass or bronze with chrome plating and self-cleaning type. Pressure drop across nozzle shall be 1.4 - 2.4 Kg./sq.cm (g).
- Distribution plate and moisture eliminators.
- Air washer chamber shall be fabricated from 3.15 mm black MS sheet.
- Air washer shall be of double bank construction (One uni-flow and the other cross flow).
- Water tank shall be fabricated from 6 mm MS sheet. Inside & outside surface shall be spray galvanized.
- Air filters (water repellent type nylon filter) complete with fixing frame.
- Intake louver with frame & screen.
- All valves, pipes, nuts & bolts, pipe hangers, supports, internal fittings and supports including ball float valves for makeup water connection.
- Inspection door with ladder and cat walk in the spray chamber.
- Drain pipe with siphon, marine light in each section.
- Necessary controls and instrumentation.
- Sand trap louvers shall be provided in the fresh air intake side.
- Other details shall be as per clause numbers 2.1.10.8.10 of section C-2.

5.2. UAF for ESP building:

One (1) Nos. Sheet metal type Unitary Air Filtration system (UAF) having cap. 1,10,000 CMH at minimum 80 mmWC static pressure shall be placed at roof of the ESP bldg..

Each UAF comprises of:

- One (1) No. (100% duty) Centrifugal fan backward inclined, SISW type, complete with electric drive motor, drive Pulleys, V-belt, belt guards, slide rails and other accessories etc.
- Two (2) Number (2 x 100 % duty) Centrifugal split casing type pumps for circulation of water. Pump system shall be provided with pot strainer with by-pass valves.
- Capacity of pump shall be 110 m³/hr and head 25 mwc (approx.)
- A spray nozzle system consisting of single bank spray system, flow regulating valves for controlling flow to spray header. Nozzles shall be of brass or bronze with



1X800 TANGEDCO NORTH CHENNAI TPP

**VENTILATION SYSTEM
SPECIFIC TECHNICAL REQUIREMENT**

SPECIFICATION No: PE-TS-423-554-A001

SECTION : I

SUB-SECTION : C 1

REV. 01

DATE: NOV 2017

SHEET 6 OF 17

chrome plating and self-cleaning type. Pressure drop across nozzle shall be 1.4 - 2.4 Kg./sq.cm (g).

- Distribution plate and moisture eliminators.
- UAF chamber shall be fabricated from 3.15 mm black MS sheet.
- UAF shall be of single bank construction
- Water tank shall be fabricated from 6 mm MS sheet. Inside & outside surface shall be spray galvanized.
- Air filters (water repellent type nylon filter) complete with fixing frame.
- Intake louver with frame & screen.
- All valves, pipes, nuts & bolts, pipe hangers, supports, internal fittings and supports including ball float valves for makeup water connection.
- Inspection door with ladder and cat walk in the spray chamber.
- Drain pipe with siphon, marine light in each section.
- Necessary controls and instrumentation.
- Sand trap louvers shall be provided in the fresh air intake side.
- Other details shall be as per clause numbers 2.1.10.8.10 of section C-2.

Please refer to clauses no 2.1.10.8.10 with other relevant clauses of Customer technical specification section C-2 for Air washer construction.

5.3. Centrifugal flow fan units

Efficiency of centrifugal fan shall not be less than 75%.

Please refer to clauses no 2.1.10.8.13 with other relevant clauses of Customer technical specification section C-2 for detail construction of centrifugal fan.

5.4. Wall mounted axial flow fan

Each wall mounted axial flow fan shall be complete with

Fan impeller & casing.

Electric drive motor with coupling if any, including motor brackets.

Inlet cone and grouting framework, if any.

Rain protection cowl with bird-screen and back draft damper.

Vibration isolator.

All supply air axial flow fans shall be provided with pre-filters (and also with fine filters for MCC/switchgear room).



1X800 TANGEDCO NORTH CHENNAI TPP

**VENTILATION SYSTEM
SPECIFIC TECHNICAL REQUIREMENT**

SPECIFICATION No: PE-TS-423-554-A001

SECTION : I

SUB-SECTION : C 1

REV. 01

DATE: NOV 2017

SHEET 7 OF 17

Please refer to clauses no 2.1.10.8.15 with other relevant clauses of Customer technical specification section C-2 for detail construction of axial flow fan.

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

5.5. ROOF EXTRACTOR UNIT:

Each wall roof extractor unit is complete with

Fan wheel, electric drive motor with motor coupling if any and motor bracket.

Short duct mounting/axial fan casing having inspection door and base

Grouting framework & foundation bolts including screen at bottom.

Rain protection cowl with bird-screen (provided with roof – hood with limit switch)

Foundation bolts including screen at bottom.

Please refer to clauses no 2.1.10.8.14 with other relevant clauses of Customer technical specification section C-2 for detail construction of RE Unit.

5.6. All supply / Exhaust Air ducting

Air distribution from Air Washers and UAF would be done through ducting system, grilles and diffusers. Ducts shall be made Galvanized steel sheet (hot dip or spray) (class 275 gm/ m² as per IS: 277). All ducting shall be designed on equal friction method and fabricated as per IS: 655.

Please also refer to clauses no 2.1.10.8.7 with other relevant clauses of Customer technical specification section C-2 for detail construction of ducting.

Thickness of duct shall be as follows. :

Rectangular duct Size (mm)	Gauge	Thickness (mm)
Up to 750	24	0.63
751 - 1500	22	0.80
1501 - 2250	20	1.00
> 2250	18	1.25
Plenum	18	1.25

- All grilles, diffuser, high velocity air outlet nozzles.
- Volume control dampers
- Supports and hangers including anchor bolts as required.
- Manually adjustable/back draft type/Gravity type exhaust air dampers.
- Fire Dampers (Motorised type electrically operated) shall be provided with open and close status limit switches) of fire rating 2 hours.



1X800 TANGEDCO NORTH CHENNAI TPP

**VENTILATION SYSTEM
SPECIFIC TECHNICAL REQUIREMENT**

SPECIFICATION No: PE-TS-423-554-A001

SECTION : I

SUB-SECTION : C 1

REV. 01

DATE: NOV 2017

SHEET 8 OF 17

5.7. WATER PUMP SETS

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

Each circulating water pump set for air washer/UAF shall comprise of the following

- Centrifugal pump Horizontal split casing type, adequate capacity to match the system requirement for Air washer & UAF.
- One no. adequately sized TEFC sq. cage induction motor suitable for 415V, 3 phase, 50 Hz AC supply.
- One no. Pot type strainer at inlet complete with screen, drain arrangement etc.
- Gate valve, one each at suction and Globe valve, one each at discharge side of the pump set.
- One no. non-return (check) valve at discharge side of each pump set.
- One set of base plate, coupling, coupling guard, anti-vibration mountings, foundation bolts etc.
- Efficiency of centrifugal pump shall not be less than 70%.

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

Please also refer to clauses no 2.1.10.8.4 with other relevant clauses of Customer technical specification section C-2 for detail construction of water pump.

5.8. Filters:-

- Pre filter with efficiency of 90% down to 10 micron.
- Fine filter with efficiency 99.5% down to 5 micron.

Please also refer to clauses no 2.1.10.8.5 with other relevant clauses of Customer technical specification section C-2.

5.9. Online non chemical type scale preventer:-

Online non chemical type scale preventer shall be provide at common make up line for air washer and UAF.

5.10. Air washer and UAF fan shall be provided with VFD and velocity/static pressure sensor in supply air path.

5.11. Lifting arrangement for maintenance:

Manually operated Chain pulley block of 1 T capacity shall be provided for Maintenance purpose in each Air-washer room.



1X800 TANGEDCO NORTH CHENNAI TPP

**VENTILATION SYSTEM
SPECIFIC TECHNICAL REQUIREMENT**

SPECIFICATION No: PE-TS-423-554-A001

SECTION : I

SUB-SECTION : C 1

REV. 01

DATE: NOV 2017

SHEET 9 OF 17

5.12. CONTROL PHILOSOPHY

The Control system shall comprise of DDCMIS, common for both AC & Ventilation system, with remote I/O panel, hook-up with serial link to main plant DDCMIS for monitoring only.

Following Audio-Visual Annunciations are to be provided for Air-washers and UAFs.

Air Washers and UAF pumps shall be interlocked with low level of water in sump and high level of pressure drop across the strainer.

High level of sump shall be alarmed in OWS.

5.13. OTHER CONTROLS - VENTILATION SYSTEM

Emergency stop push button shall be provided for all drives in air washer rooms. All other drives associated with ventilation system like fresh air supply fans, exhaust fans, roof extractor etc. shall be fed from respective MCC.

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

5.14. Fire damper

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

6. SPECIFIC REQUIREMENTS:-

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

All ventilation system shall operate on 100% fresh air.

Valves with rising stem shall have position indicator.

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

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

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

For pumps, fans blower, continuous motor rating (at 50° C ambient) shall be at 15% above the demand of equipment at duty point or 10% above the maximum load demand



1X800 TANGEDCO NORTH CHENNAI TPP

VENTILATION SYSTEM SPECIFIC TECHNICAL REQUIREMENT

SPECIFICATION No: PE-TS-423-554-A001

SECTION : I

SUB-SECTION : C 1

REV. 01

DATE: NOV 2017

SHEET 10 OF 17

whichever is higher. Whenever belt drives are used the belts shall be sized for 150% of the rated power and there shall be minimum of two belts per drive.

A margin of 10% shall be considered while sizing the equipment (Air washer, UAF and Pumps).

Design margin shall be maintained as follows:

For fan a) Head-20% b) Flow-20%

For Pump a) Head-20% b) Flow-15%

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

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



1X800 TANGEDCO NORTH CHENNAI TPP

VENTILATION SYSTEM SPECIFIC TECHNICAL REQUIREMENT

SPECIFICATION No: PE-TS-423-554-A001

SECTION : I

SUB-SECTION : C 1

REV. 01

DATE: NOV 2017

SHEET 11 OF 17

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



1X800 TANGEDCO NORTH CHENNAI TPP

**VENTILATION SYSTEM
SPECIFIC TECHNICAL REQUIREMENT**

SPECIFICATION No: PE-TS-423-554-A001

SECTION : I

SUB-SECTION : C 1

REV. 01

DATE: NOV 2017

SHEET 12 OF 17

7. MATERIALS OF CONSTRUCTION

7.1. CENTRIFUGAL FAN

Please refer to clauses no 2.1.10.8.13 with other relevant clauses of Customer technical specification section C-2 for MOC of centrifugal fan.

Fan Casing (side plates & stiffeners): Mild Steel Sheets/plate to IS: 2062 Gr.B / IS: 1079 /Eq.

The minimum thickness of casing shall be 3.15 mm.

Impeller hub: Mild Steel

Impeller back plate blade & shroud: Mild Steel to IS: 2062 Gr.B.

Shaft: EN - 8 or eqv.

Shaft sleeve: EN - 8 or eqv.

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

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

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

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

7.2. AXIAL FAN

Please refer to clauses no 2.1.10.8.15 with other relevant clauses of Customer technical specification section C-2 for MOC of axial flow fan.

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

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

Neoprene rubber pads: As required.

Supporting frame for mounting: Required.

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

Mounting flange on casing: At inlet and outlet.

Painting / protecting coating – All the MS parts shall be galvanised or protected with three coats of epoxy paint.

7.3. ROOF EXTRACTOR UNIT

Please refer to clauses no 2.1.10.8.14 with other relevant clauses of Customer technical specification section C-2 for MOC of RE Unit.

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

7.4. AIR WASHER and UAF

Please refer to clauses no 2.01.1004, with other relevant clauses of Customer technical specification section C-2 for MOC of Air washer.



1X800 TANGEDCO NORTH CHENNAI TPP

**VENTILATION SYSTEM
SPECIFIC TECHNICAL REQUIREMENT**

SPECIFICATION No: PE-TS-423-554-A001

SECTION : I

SUB-SECTION : C 1

REV. 01

DATE: NOV 2017

SHEET 13 OF 17

Moisture Eliminators plates: 100% virgin PVC die-extruded construction of minimum finished thickness of 2 mm.

Moisture Eliminator Frame: 22 SWG GI sheets and GI angle of adequate strength.

Piping: MS Heavy class (Galvanized) to IS: 1239 Part I or IS: 3589 depending on size.

Suction Screen for Water: Brass

7.5. Air Filters

Please refer to clauses no 2.1.10.8.5 with other relevant clauses of Customer technical specification section C-2 for dry filter.

7.6. Valves:

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

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

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

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

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

All valves with rising stem shall have position indicators.

All valves shall be provided with locking arrangement.

All water line valves shall be of cast iron body for sizes 65 NB and above conforming to IS: 780 and Gun metal construction for sizes less than 65 NB conforming to IS : 778. Cast iron parts shall conform to IS : 210 Gr. FG 220.

Please refer to clauses no 2.1.10.8.9 with other relevant clauses of Customer technical specification section C-2.

7.7. CENTRIFUGAL PUMP

Please refer to clauses no 2.1.10.8.4 with other relevant clauses of Customer technical specification section C-2 for MOC of pump.

8. GENERAL

- 1) Basis of design, all calculations including heat load calculations for summer seasons, equipment selection criterion, layout drawings/ schemes/G.A. dwg and documents like data sheet/ technical particulars etc. Are subject to Customer approval during detail engineering stage.
- 2) Vendor to furnish characteristic curves for all major equipment offered indicating duty point during detailed engineering.



1X800 TANGEDCO NORTH CHENNAI TPP

**VENTILATION SYSTEM
SPECIFIC TECHNICAL REQUIREMENT**

SPECIFICATION No: PE-TS-423-554-A001

SECTION : I

SUB-SECTION : C 1

REV. 01

DATE: NOV 2017

SHEET 14 OF 17

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



1X800 TANGEDCO NORTH CHENNAI TPP

VENTILATION SYSTEM SPECIFIC TECHNICAL REQUIREMENT

SPECIFICATION No: PE-TS-423-554-A001

SECTION : I

SUB-SECTION : C 1

REV. 01

DATE: NOV 2017

SHEET 15 OF 17

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



1X800 TANGEDCO NORTH CHENNAI TPP

VENTILATION SYSTEM SPECIFIC TECHNICAL REQUIREMENT

SPECIFICATION No: PE-TS-423-554-A001

SECTION : I

SUB-SECTION : C 1

REV. 01

DATE: NOV 2017

SHEET 16 OF 17

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



1X800 TANGEDCO NORTH CHENNAI TPP

**VENTILATION SYSTEM
SPECIFIC TECHNICAL REQUIREMENT**

SPECIFICATION No: PE-TS-423-554-A001

SECTION : I

SUB-SECTION : C 1

REV. 01

DATE: NOV 2017

SHEET 17 OF 17

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

9.0 EXCLUSIONS

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



1X800 TANGEDCO NORTH CHENNAI TPP

**VENTILATION SYSTEM
CUSTOMER SPECIFICATIONS**

SPECIFICATION No: PE-TS-423-554-A001

SECTION : I

SUB-SECTION : C 2

REV. 01

DATE: NOV 2017

SECTION: I

SUB-SECTION: C 2

CUSTOMER SPECIFICATIONS



1X800 TANGEDCO NORTH CHENNAI TPP

**VENTILATION SYSTEM
CUSTOMER SPECIFICATIONS
TECHNICAL REQUIREMENT**

SPECIFICATION No: PE-TS-423-554-A001

SECTION : I

SUB-SECTION : C 2A

REV. 01

DATE: NOV 2017

SECTION: I

SUB-SECTION: C 2A

**CUSTOMER SPECIFICATIONS
TECHNICAL REQUIREMENT**



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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



- 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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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,



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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	



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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



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



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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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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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SPECIFICATION No: PE-TS-423-554-A001

SECTION : I

SUB-SECTION : C 2B

REV. 01

DATE: NOV 2017

**VENTILATION SYSTEM
PROJECT SPECIFIC GENERAL
REQUIREMENTS**

SECTION: I

SUB-SECTION: C 2B

**CUSTOMER SPECIFICATIONS
PROJECT SPECIFIC GENERAL REQUIREMENTS**

Chapter 6

General Technical Requirement



VOLUME II SECTION 1

CHAPTER 6

CONTENTS

1.0	INTRODUCTION	2
2.0	BRAND NAME	2
3.0	BASE OFFER & ALTERNATE PROPOSALS	2
4.0	COMPLETENESS OF FACILITIES	2
5.0	CODES & STANDARDS	2
6.0	EQUIPMENT FUNCTIONAL GUARANTEE	4
7.0	DESIGN OF FACILITIES/ MAINTENANCE & AVAILABILITY CONSIDERATIONS	4
8.0	DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY BIDDER	5
9.0	CENTRAL DOCUMENTATION FACILITY	17
10.0	QUALITY ASSURANCE PROGRAMME	18
11.0	PRE-COMMISSIONING AND COMMISSIONING FACILITIES	25
12.0	TAKING OVER	28
13.0	TRAINING OF OWNER'S PERSONNEL	28
14.0	SAFETY ASPECTS DURING CONSTRUCTION AND ERECTION	29
15.0	NOISE LEVEL	29
16.0	PACKAGING AND TRANSPORTATION	29
17.0	ELECTRICAL ENCLOSURE	30
18.0	INSTRUMENTATION AND CONTROL	30
19.0	ELECTRICAL NOISE CONTROL	31
20.0	INSTRUMENT AIR SYSTEM	31
21.0	TAPPING POINTS FOR MEASUREMENTS	31
22.0	ELECTRONIC MODULE/COMPONENT DETAILS	31
23.0	ENVIRONMENTAL MONITORING & CONTROL MEASURES	31



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.



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

EPC TENDER SPECIFICATION FOR BTG PACKAGE



- 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.



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

EPC TENDER SPECIFICATION FOR BTG PACKAGE



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



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

8.3.1 Instruction Manuals

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

8.3.2 Erection Manuals

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

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



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

8.3.3 Operation & Maintenance Manuals

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

8.3.4 Plant Handbook

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

1. Design and performance data.



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

8.3.5 Project Completion Report

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

8.3.6 Drawings

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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



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



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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



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

EPC TENDER SPECIFICATION FOR BTG PACKAGE



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



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

EPC TENDER SPECIFICATION FOR BTG PACKAGE



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.			



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.			



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

EPC TENDER SPECIFICATION FOR BTG PACKAGE



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	



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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	



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.			



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

EPC TENDER SPECIFICATION FOR BTG PACKAGE



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			



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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		



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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				



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

EPC TENDER SPECIFICATION FOR BTG PACKAGE



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			



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

EPC TENDER SPECIFICATION FOR BTG PACKAGE



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 Familiarisation with different sub-systems	(a) Manufacturing process for	
	Insulation system		Core	
	Cooling medium & arrangement		Winding bars	
	Winding & core support systems		Assembly	
	b) Design aspects of other auxiliary systems		Testing facilities	
MANDAYS	30	15	15	
Generator Excitation System including AVR.	Design features of various sub-systems	Operational feed back Familiarisation with various equipment functioning at reference plants	Manufacturing process& testing facilities for various equipment of excitation system	
	Excitor			
	PMG			
	Controllers & different limiters etc.			
	PSS & associated system studies			
MANDAYS	30	15	15	



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

EPC TENDER SPECIFICATION FOR BTG PACKAGE



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	



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

EPC TENDER SPECIFICATION FOR BTG PACKAGE



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		



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

EPC TENDER SPECIFICATION FOR BTG PACKAGE



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]



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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																



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

EPC TENDER SPECIFICATION FOR BTG PACKAGE



ANNEXURE-VI

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

ANNEXURE-VII

MFGR.'s LOGO		SUPPLIER'S NAME AND ADDRESS		FIELD QUALITY PLAN				PROJECT:		
				ITEM :		QP NO.:		PACKAGE:		
						REV.NO.:				
				SUB-SYSTEM:		DATE:		CONTRACT NO.:		
PAGE: OF....		MAIN-SUPPLIER:								
SL. NO	ACTIVITY & OPERATIONS	CHARACTERISTICS/ INSTRUMENTS	CLASS# OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		REMARKS
1	2	3	4	5	6	7	8	9	D*	10
			LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (v) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. LEGEND TO BE USED: CLASS #: A = CRITICAL, B=MAJOR, C=MINOR; 'A' SHALL BE WITNESSED BY THE OWNER FQA, 'B' SHALL BE WITNESSED BY OWNER'S ERECTION / CONSTRUCTION DEPTT. AND 'C' SHALL BE WITNESSED BY ERECTION SUPPLIER (A & B CHECK SHALL BE OWNER CHP STAGE)						DOC. NO.: REV..... CAT.....	
MANUFACTURER/ SUB-SUPPLIER	MAIN- SUPPLIER									
SIGNATURE										
						FOR THE OWNER USE	REVIEWED BY	APPROVED BY	APPROVAL SEAL	

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:



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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).	
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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 (VWO 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:



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.:
- $$(V_{m1} \times D_{i1}) + (V_{m2} \times D_{i2}) + (V_{m3} \times D_{i3}) + (V_{m4} \times D_{i4}) + (V_{m5} \times D_{i5}) + (V_{m6} \times D_{i6})$$

$$D_i = \frac{\text{Sum of } (V_{m_i} \times D_{i_i})}{V_{m1} + V_{m2} + V_{m3} + V_{m4} + V_{m5} + V_{m6}}$$

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.

$$Z = C \cdot \ln(1 - E_g)$$

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

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:
- Guarantee Turbine Cycle Heat rate test at 800MW corresponding to the heat balance diagram specified in the tender specification.
 - Guarantee Output test of 105% rated load corresponding to the heat balance diagram specified in the tender specification.
 - 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

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CONTENTS



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

S. NO	VOLUME NO.	DESCRIPTION
1	VOLUME I	SECTION 1 – INSTRUCTION TO BIDDER'S SECTION 2 – GENERAL CONDITIONS OF CONTRACT SECTION 3 – ERECTION CONDITIONS OF CONTRACT SECTION 4 – SPECIAL CONDITIONS OF CONTRACT SECTION 5 – FORMATS & SCHEDULES
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

Part 2.5 Quality Assurance Plan

Quality Assurance Plan

Part 2.5.1 Mechanical Works



VOLUME II-SECTION 2
PART 2.5- QUALITY ASSURANCE PLAN
CONTENTS

2.5.1	QUALITY ASSURANCE PLAN-MECHANICAL WORKS	2
2.5.1.1	GENERAL REQUIREMENTS.....	2
2.5.1.2	SHOP TESTS FOR STEAM GENERATOR	2
2.5.1.3	ROTATING AND OTHER EQUIPMENTS/ITEMS FOR STEAM GENERATOR	7
2.5.1.4	FIELD /ERECTION CHECKS FOR STEAM GENERATOR & AUXILIARIES.....	12
2.5.1.5	POWER CYCLE PIPING.....	12
2.5.1.6	STEAM TURBINE AND ASSOCIATED EQUIPMENT.....	20
2.5.1.7	AUXILIARIES OF STEAM TURBINE.....	27
2.5.1.8	LUBRICATING OIL, JACKING OIL AND CONTROL OIL SYSTEMS.....	27
2.5.1.9	STEAM SURFACE CONDENSERS FOR MAIN TURBINE CONDENSER AND DRIVE TURBINE CONDENSER (IF OFFERED)	28
2.5.1.10	CONDENSER AIR EVACUATION SYSTEM FOR MAIN TURBINE CONDENSER AND DRIVE TURBINE CONDENSER (IF OFFERED)	29
2.5.1.11	FEED WATER HEATER, DRAIN COOLERS, GLAND STEAM CONDNSER, HEAT EXCHANGERS & PRESSURE VESSELS / STORAGE TANKS	30
2.5.1.12	PIPING, BELLOWS AND THERMAL INSULATION FOR TURBINE & AUX SYSTEMS	30
2.5.1.13	VALVES	33
2.5.1.14	MISC. ITEMS / EQUIPMENTS	35
2.5.1.15	ELECTRICAL AND CONTROL & INSTRUMENTATION:	36
2.5.1.16	SITE TEST:	36
2.5.1.17	CONDENSER ON LOAD TUBE CLEANING SYSTEM/DEBRIS FILTER FOR MAIN TURBINE CONDENSER AND DRIVE TURBINE CONDENSER (IF OFFERED)	37
2.5.1.18	CONDENSATE EXTRACTION PUMPS AND DRIP PUMPS (IF OFFERED)	39
2.5.1.19	POWER CYCLE HEATERS & DEAERATOR	42
2.5.1.20	BOILER FEED PUMPS & DRIVE TURBINE	46
2.5.1.21	LOW PRESSURE PIPING.....	50



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- (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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- (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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- (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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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:



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- (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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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:



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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)



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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			



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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 requirement



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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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:



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

**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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

**** 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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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		



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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																			



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- (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.



**1X800 MW COAL BASED NORTH CHENNAI THERMAL
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	-	-	-	-	-	



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



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														



**1X800 MW COAL BASED NORTH CHENNAI THERMAL
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												



**1X800 MW COAL BASED NORTH CHENNAI THERMAL
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



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



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



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



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



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



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											



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



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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

**VOLUME II – SECTION 2
PART 2.5 QUALITY ASSURANCE PLAN
CONTENTS**

2.5.2	QUALITY ASSURANCE PLAN FOR ELECTRICAL ITEMS	2
2.5.2.1	GENERATOR & AUXILIARIES	2
2.5.2.2	GENERATOR BUSDUCTS AND NEUTRAL GROUNDING EQUIPMENTS	13
2.5.2.3	GENERATOR CIRCUIT BREAKER	15
2.5.2.4	GENERATOR TRANSFORMERS	17
2.5.2.5	UNIT & STATION TRANSFORMERS	19
2.5.2.6	AUXILIARY TRANSFORMERS	21
2.5.2.7	HT SWITCHGEAR	23
2.5.2.8	HT BUSDUCT	25
2.5.2.9	LT INDOOR TRANSFORMERS	26
2.5.2.10	LT SWITCHGEAR & BUSDUCT	27
2.5.2.11	MOTORS	31
2.5.2.12	VARIABLE FREQUENCY DRIVE	35
2.5.2.13	HT CABLES	36
2.5.2.14	LT POWER CABLES	38
2.5.2.15	LT CONTROL CABLES	40
2.5.2.16	DC SYSTEM	41
2.5.2.17	DIESEL GENERATORS	46
2.5.2.18	CABLING, EARTHING & LIGHTNING PROTECTION	50
2.5.2.19	ILLUMINATION	51



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		



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



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



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



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
POWER PROJECT STAGE III**



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



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



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	



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



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										



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



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



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



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	



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



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
POWER PROJECT STAGE III**



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



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



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.											



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.											



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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
Raw materials	Y	Y									Y												
Factory acceptance test	Y	Y									Y												
Appearance inspect	Y	Y	Y				Y																
System tests	Y	Y	Y			Y	Y	Y															
Circuit breaker	Y	Y	Y				Y	Y	Y														
Disconnecting and earthing switch	Y	Y																					Y



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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			



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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 / Characteristics 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																		



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



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	



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.								



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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		



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

Attributes / Characteristics	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
Items/Components Sub Systems															
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.															



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



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				



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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				



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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 & Disconnector 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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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				



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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							



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.														



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.															



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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	



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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						



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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									



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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	



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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														



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.																		



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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			



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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									



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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											



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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														



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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			



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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											



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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									



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

ALTERNATOR																		
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	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
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	Y	Y1
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																		



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.										



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



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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

Notes:

- 1This 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	



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

VOLUME II-SECTION 2
PART 2.5- QUALITY ASSURANCE PLAN
CONTENTS

2.5	Quality Assurance Plan.....	2
2.5.3	General Requirement.....	2
2.5.3.1	Testing Method	2
2.5.3.2	Response time for Turbine Control System.	5
2.5.3.3	Factory Acceptance Tests for DDCMIS, DCS & Simulator	6
2.5.3.4	Factory Acceptance Test for Simulator	8
2.5.3.5	FAT Procedure	10
2.5.3.6	Calibration of Instruments	12
2.5.3.7	Tests to be performed for Field Instruments	12
2.5.3.8	Measurement System	24
2.5.3.9	Control System	24
2.5.3.10	Availability Guarantee Test	27
2.5.3.11	Test Dates	27
2.5.3.12	Test Duration and Definition	27
2.5.3.13	Test Duration Time	28
2.5.3.14	Conditions	29
2.5.3.15	Training.....	29
2.5.3.16	Warranty	30
2.5.3.17	Remote Service Centre for DDCMIS & DCS	30



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.



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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	



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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**



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

- 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.



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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 :



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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:



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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:-



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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.



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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



EPC TENDER SPECIFICATION FOR BTG PACKAGE

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