

**TANILNADU GENERATION AND DISTRIBUTION
CORPORATION (TENGEDCO)**

**2X660 MW ENNORE SEZ STPP
AT ASH DYKE OF NCTPS, CHENNAI.**

**TECHNICAL SPECIFICATION
FOR
COMPRESSED AIR SYSTEM
VOLUME – II B & III**

SPECIFICATION NO.: PE- TS- 412- 555- A001, Rev 01



**BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA, INDIA**



**2x660 MW ENNORE SEZ
COMPRESSED AIR SYSTEM**

INDEX

SPECIFICATION NO: PE-TS-412-555-A001

VOLUME: II B & III

REV: 01

DATE: 15.12.2016

SHEET: 1 OF 2

VOLUME – II B

SECTIONS	TITLE	Page No
SECTION-A	INTENT OF SPECIFICATION	4
SECTION-B	PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA	7
SECTION-C	TECHNICAL SPECIFICATIONS	20
	SECTION-C1	21
	C1-A SCOPE OF SUPPLY,TERMINAL POINTS AND EXCLUSIONS	22
	C1-B SPECIFIC TECHNICAL REQUIREMENT	29
	SECTION-C2 CUSTOMER SPECIFICATION	36
	C2 - A TECHNICAL REQUIREMENT	37
	C2 - B PROJECT SPECIFIC GENERAL REQUIREMENTS INCLUDING LAYOUT, LP PIPING & VALVES.	45
	C2 - C PERFROMANCE GUARANTEE TESTS	141
	C2 - D QUALITY ASSURANCE	145
	SECTION-C3 TECHNICAL SPECIFICATION (ELECTRICAL PORTION)	161
	SECTION-C4 TECHNICAL SPECIFICATION (C&I PORTION)	193
SECTION-D	STANDARD TECHNICAL SPECIFICATIONS	487

SECTION-E	ANNEXURE-I	LIST OF MAKES OF SUB-VENDOR ITEMS	515
	ANNEXURE-II	MANDATORY SPARE LIST	539
	ANNEXURE-III	PAINTING & COLOUR SCHEME	546
	ANNEXURE-IV	LIST OF TOOLS & TACKLES	562
	ANNEXURE-V	DM WATER ANALYSIS	566
	ANNEXURE-VI	DRAWINGS / DOCUMENTS SUBMISSION PROCEDURE	568
	ANNEXURE-VII	INSPECTION AND TESTING	569
	ANNEXURE-VIII	MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION	573
	ANNEXURE-IX	FORMAT FOR OPERATION AND MAINTENANCE MANUAL	576
	ANNEXURE-X	SITE STORAGE AND PRESERVATION	580
	ANNEXURE-XI	PACKING PROCEDURE	595
	ANNEXURE-XII	LIST OF COMMISSIONING SPARES	597



**2x660 MW ENNORE SEZ
COMPRESSED AIR SYSTEM**

INDEX

SPECIFICATION NO: PE-TS-412-555-A001

VOLUME: II B & III

REV: 01

DATE: 15.12.2016

SHEET: 2 OF 2

VOLUME-III

SECTIONS	TITLE	Page No
1	LIST OF DOCUMENTS TO BE SUBMITTED WITH BID	600
2	COMPLIANCE CUM CONFIRMATION CERTIFICATE	602
3	PRE BID CLARIFICATION SCHEDULE	605
4	SCHEDULE OF TECHNICAL DEVIATION	607
5	ELECTRICAL LOAD DATA	609
6	DRAWINGS	612
	DRG TITLE	
a	PLOT PLAN	
b	P & I DIAGRAM OF COMPRESSED AIR SYSTEM WITH REF TYPE AIR DRIER	
c	COMPRESSOR HOUSE LAYOUT	
7	INDICATIVE BILLING BREAK-UP	616



2x660 MW ENNORE SEZ

**COMPRESSED AIR SYSTEM
INTENT OF SPECIFICATION**

SPECIFICATION NO: PE-TS-412-555-A001

VOLUME: II B

SECTION: A

REV: 00

Date: 15.12.2016

Sheet: 1 OF 3

SECTION-A

INTENT OF SPECIFICATION



2x660 MW ENNORE SEZ

COMPRESSED AIR SYSTEM INTENT OF SPECIFICATION

SPECIFICATION NO: PE-TS-412-555-A001

VOLUME: II B

SECTION: A

REV: 00

Date: 15.12.2016

Sheet: 2 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, proper packing and shipment and delivery at site, as required on FOR site basis, ,unloading, handling, transportation & storage at site, in site transportation, assembly, erection & commissioning, final painting, trial run & carrying out acceptance tests at site of compressed air system of as per details in different sections / volumes of this specification and various pre award agreements for 2X660 MW ENNORE SEZ STPP.
- 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 and handing over within quoted price.
- 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



2x660 MW ENNORE SEZ

**COMPRESSED AIR SYSTEM
INTENT OF SPECIFICATION**

SPECIFICATION NO: PE-TS-412-555-A001

VOLUME: II B

SECTION: A

REV: 00

Date: 15.12.2016

Sheet: 3 OF 3

to seek any clarification on specification requirement in the format enclosed under Vol-III of the specification **within 10 days of receipt of tender documents**. In absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of Purchaser / Customer shall prevail and shall be complied by the bidder without any commercial implication on account of the same. Further in case of any missing information in the specification not brought out by the prospective bidders as part of pre-bid clarification, the same shall be furnished by Purchaser/ Customer as and when brought to their notice either by the bidder or by purchaser/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.

- 1.7 The bidder's offer shall not carry any sections like clarification, interpretations and /or assumptions.
- 1.8 Deviations, if any, should be very clearly brought out clause by clause along with cost of withdrawal in the enclosed schedule (in Vol – III); otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification. If no cost of withdrawal is given against the deviation, it will be presumed that deviation can be withdrawn without any cost to BHEL/its customer.
- 1.9 In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, Section - C shall prevail over section – D, however more stringent requirement as per the interpretation of the owner shall apply.
- 1.10 In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.
- 1.11 For definition of word like Contractor, bidder, supplier, vendor, Customer/ Purchaser / Employer, consultant, please referred relevant clause(s) of GCC.

	2x660 MW ENNORE SEZ COMPRESSED AIR SYSTEM		SPECIFICATION No: PE-TS-412-555-A001	
			VOLUME: II B	
	PROJECT INFORMATION		SECTION : B	
			REV. 00	DATE:15.12.2016
			SHEET : 1 OF 1	

SECTION: B

PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA

CHAPTER 1

PROJECT SYNOPSIS

1.0 GENERAL BACKGROUND AND SALIENT FEATURES

1.1 Introduction

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

1.2 Location

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

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

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

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

1.3 Type of Plant

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

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

1.4 PROJECT INFORMATION

Project Title : **2 x 660 M W E nnore S EZ C oal B ased
Supercritical T hermal P ower Project at Ash
Dyke of NCTPS**

Owner : **TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION (TANGEDCO)**

LOCATION

The site is located near Vayalur Village, Ennore

Latitude : 13°17' N to 13°18' N

Longitude : 80°18' E to 80°19' E

Distance from Chennai City : 35 km

Nearest Airport is at Chennai at a

Distance of : 60 km

Nearest Seaport is : Ennore

Nearest Railway Station is : Athipattu Pudunagar (approx 5 kms)

Meteorological Condition

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

Climatological data : Ambient temp. (°C)
Annual Maximum Mean Temp 41.5(°C)
Annual Minimum Mean Temp 24(°C)
Design Ambient temperature 35(°C)

Relative Humidity

Maximum 100%
Minimum 36%
Design 75%

Annual Rainfall

Maximum 2540 mm
Average 1600 mm
Minimum 1175 mm

Prevailing Wind Direction

Nov to Jan – From NW & NE

Feb to Mar – From East & SE
Apr to May – From South & SE
June – From SW
July to Aug – From NW
Sept to Oct – From SE & SW
Wind Speed 11.8 kmph (avg)
50 kmph (max)
Seismic Zone III as per
IS:1893-2002

1.5 Access to Site

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

1.6 Plant Rating, Capacity, Availability, PLF

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

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

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

The capacity of the unit is selected so as to deliver the rated output even after ageing that will occur between overhauls, as a result of deposition of salts in turbine blades, wear and tear etc.

The plant load factor (PLF) being considered is 85%.

1.7 Power Evacuation

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

1.8 Site Selection

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

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

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

1.9 Fuel

1.9.1 Source of Fuel

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

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

The steam generator shall be designed for the following conditions :

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

The analysis of fuel is given below :

1.9.2 Coal Analysis:

Coal Quality Parameters

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

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

DOMESTIC COAL

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

Sr. No.	Particulars	Units	Parameters
6.	K ₂ O	%	-
7.	TiO ₂	%	1.60
8.	SO ₃	%	0.25
9.	P ₂ O ₅	%	0.51
10.	MgO	%	0.50
11.	Others	%	0.60
12.	Total		100.00
E	Resistivity of fly ash	Ohm - cm	1.73x 10 ¹²

IMPORTED COAL

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

Sr. No.	Particulars	Units	Parameters
8.	SO ₃	%	10.60
9.	P ₂ O ₅	%	0.20
10.	MgO	%	8.60
11.	Others	%	-
12.	Total	%	100.00

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

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

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

1.9.3 Specification of LDO

Specific gravity @ 15° C	0.8348
Gross calorific value, Kcal/kg	10400
Pour point “°C” max.	12
Flash point “°C” min.	66
Sulphur % “T” max.	0.5
K. Viscosity in Centistokes @ 50° C max.	7.5
Ash by wt. %	0.01
Water & sediment Vol. Max. %	0.25

1.9.4 Specification of HFO

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

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

1.9.5 Fuel Linkage

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

The coal requirement has been worked as under:-

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

Per day 20928 tonnes.

Annual 6.5 MTPA for 85% PLF

1.9.6 Fuel Transportation

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

1.10 Source Of Water

1.10.1 Source

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

1.10.2 Chemical analysis of Sea Water:

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

1.10.3 Requirement

The requirement of water for the plant will be for meeting the requirement of make up for the re-circulating cooling water system, dust suppression system in coal handling plants, ash disposal system and the RO/ D.M. water plant which will be supplying the power cycle make up requirements, etc. In addition the water requirements will be for drinking and service purposes. Water requirement is estimated as approx. 15523 m³/hr.

1.11 Source of Equipment

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

1.12 Power Evacuation Plan

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

1.13 400 KV GIS Switchyard

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

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

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

1.14 Average Yearly Generation

The average yearly generation is calculated considering the following.

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

1.15 INFORMATION FOR ENVIRONMENTAL APPRAISAL

1.0 GENERAL INFORMATION ABOUT THE PROJECT

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

- 1.3 Location of the Project : Near Vayalur Village, Ennore, Tamil Nadu
- 1.4 Site where proposed plant is to be located : Ash dyke of NCTPS
- 1.5 Capacity of the project under consideration : 2x 660MW
- 1.5.1 Govt. land / Private land / others : TANGEDCO land
- 1.5.2 Topographical feature, demographic profile & physiography : Site has differential levels and require filling to maintain the desired grade level of +10.00 meter above MSL
- 1.5.3 Nature of soil : Clayey soil
- 1.5.4 Distance from the nearest town / city / major human settlements : Chennai -35 km
- 1.5.5 Population to be displaced : Nil
- 1.5.6 Distance from water source : Approx. 5 km (from Cooling Water Forebay of NCTPS Stage II)
- 1.5.7 Area of forest land, if involved : Nil
- 1.5.8 Distance of forest from the site : N.A
- 1.6 Is this an extension?
If so indicate capacity of existing plant : No

- 1.7 What is the ultimate capacity envisaged : 2x660 MW

2.0 GENERAL ENVIRONMENTAL INFORMATION

- 2.1 Area of the land proposed to be acquired : Refer Plot Plan Land already acquired
- i. Area required for plant : 500 Acres
- ii. Ash disposal : 100 % dry fly ash disposal and

100% wet bottom ash disposal is envisaged to existing ash pond.

- iii. Plant facilities : The area is adequate for locating all the required systems for 2x660 MW.
- 2.2 Area proposed to be built-up or developed : Power station will be built-up in the proposed site as indicated in the plot plan.
- 2.3 Specify site characteristics River basin/ estuarine / coastal / others : Site is close to Buckingham Canal
- 2.4 Is the site situated in the forest area? Give following details : No
 - 2.4.1 Area : N.A
 - 2.4.2 Type of forests : N.A
- 2.5 Is site situated near to the forests? Give the distance from the site. : N.A.
- 2.6 Give a description of the flora within 25 km of your plant site under the following heads :
 - a. Crops :
 - b. Forest :
 - c. Grass land :
 - d. Endangered species :
 - e. Others (Specify) :

} Refer details in the specification elsewhere.
- 2.6.2 Give details of the following features, if they exist, within a radius of 25 km of the proposed site? :
 - i. Fisheries :
 - ii. Sanctuary / natural park biosphere reserve :
 - iii. Lakes / ponds / reservoir :
 - iv. Stream / river : Buckingham canal is close to the site
 - v. Estuary / sea : Bay of Bengal is 5 km from site

- vi. Hills / mountains :
- vii. Historic / cultural / :
 tourist /
 archaeological scenic
 sites / defence
 installations

2.7 Human settlement :

2.7.1 Total number of persons :
 proposed to be employed

i. During construction : 2500

450(0.75person/MW) TANGEDCO

ii. During operation : direct employees



**TECHNICAL SPECIFICATION
2x660 MW ENNORE SEZ
COMPRESSED AIR SYSTEM**

SPECIFICATION No: PE-TS-412-555-A001

VOLUME: II B

SECTION : C

REV. 00

DATE: 15.12.2016

Sheet: 1 of 1

SECTION: C

TECHNICAL SPECIFICATIONS



**TECHNICAL SPECIFICATION
2x660 MW ENNORE SEZ
COMPRESSED AIR SYSTEM**

SPECIFICATION No: PE-TS-412-555-A001

VOLUME: II B

SECTION : C1

REV. 00

DATE:15.12.2016

Sheet: 1 OF 1

SECTION: C1

SPECIFIC TECHNICAL REQUIREMENT



**TECHNICAL SPECIFICATION
2x660 MW ENNORE SEZ
COMPRESSED AIR SYSTEM**

SPECIFICATION No: PE-TS-412-555-A001

VOLUME: II B

SECTION : C1A

REV. 00

DATE: 05.11.2016

SHEET 1 OF 1

VOLUME - II B

SECTION: C1A

**SCOPE OF SUPPLY, TERMINAL POINTS
AND EXCLUSIONS**



COMPRESSED AIR SYSTEM

2X 660MW ENNORE SEZ STPP

DOCUMENT NO.: PE-TS-412-555-A001

VOLUME- IIB

SECTION-C1-A

REV. 0

DATE: 15.12.2016

1. SCOPE OF SUPPLY AND SERVICES:

The scope of work under this specification shall be as below.

Items not specifically mentioned but deemed necessary by the Tenderer for making the system completely reliable and efficient shall also be considered as if included.

- 1.1 Total lump sum for Equipment & Services as specified, comprising of design & engineering, manufacture, inspection & testing at manufacturer's works, painting at manufacturer's works, duly packed for transportation, delivery to site, unloading storage & handling at site, erection & commissioning, carrying out performance/acceptance tests at site & final painting of complete Compressed Air System consisting of following equipment:
 - 1.1.1 Three (3) Nos. Instrument Air Compressors (Oil Free Screw) each of minimum 40 NM³/Min capacity at 8.5 Kg/sqcm (g) discharge pressure with suction filter with silencer, inter cooler and after cooler with moisture separators, automatic drain traps, instruments, control system and other accessories.
 - 1.1.2 Three (3) Nos. Air Drying Plants refrigerant Type of capacity matching with individual IA compressor with all instruments, control panels and other accessories as specified.
 - 1.1.3 Three (3) Nos. Service Air Compressors (Oil Free Screw) each of minimum 40 NM³/Min capacity at 8.5 Kg/sqcm (g) discharge pressure with suction filter with silencer, inter cooler and after cooler with moisture separators, automatic drain traps, instruments, control system and other accessories.
 - 1.1.4 Six (6) Nos. Air Receivers of 10 cum capacity each adjacent to compressor house with instruments, relief valve, drain connection with automatic trap stations and other accessories as specified.
 - 1.1.5 Three (3) Nos. Electronic Dew point meters.
 - 1.1.6 Pipes and fittings for compressed air line & interconnecting airline, cooling water line including hanger/supports, auxiliary structural members etc. inclusive of all cu-tubing for control air piping, fittings, valves, Counter flanges, bolts, nuts, gaskets etc. at all piping terminals, base plates, support plates, anchor bolts, nuts, sleeves, inserts, lifting lugs, eye bolts etc and other accessories as required including drain piping - Lot.
 - 1.1.7 All airline and water line valves – Lot.
 - 1.1.8 Field instruments, including portable vibration analyzer and tachometer, as specified in technical specification, all instruments necessary for performance testing of compressors as well as air drying plants – Lot.
 - 1.1.9 Microprocessor/PLC based integrated control system for each compressor and dryer and one PLC based control system for overall control of the compressed air system.– Lot.
 - 1.1.10 Cables as specified – Lot.

The Bidder to provide provisions for Vibration monitoring system for all compressors and their motors as mentioned in different sections of this specification. Other critical parameters monitoring as specified in specification is also in bidder's scope.

 - 1.1.11 Maintenance and erection tools and tackles, start up and commissioning spares, consumables, first fill of lubricants inclusive of packing – Lot
 - 1.1.12 Any other item not included above or in specification but required for Compressed Air System.
 - 1.1.13 All commissioning spares & consumables for trouble free operation shall be in scope of bidder.



COMPRESSED AIR SYSTEM

2X 660MW ENNORE SEZ STPP

DOCUMENT NO.: PE-TS-412-555-A001

VOLUME- IIB

SECTION-C1-A

REV. 0

DATE: 15.12.2016

- 1.1.14 Civil works:-Minor dressings of foundation blocks, equipment grouting, supply and fixing of supports etc. on walls, foundations; floor and trenches will be done by successful bidder.
- 1.1.15 Erection and commissioning of compressed air system.
- 1.1.16 UPS, battery and battery charger for the PLC and the OWS / OEWS as specified in the specification.

2.0 TERMINAL POINTS :

- 2.1 Bidder will terminate compressed air piping at common IA header and common SA header downstream of air receiver with isolation valve as per enclosed tender drawing.
- 2.2 250 Nb Cooling water supply pipeline connection will be provided by the purchaser outside the compressor house (at 10.0 m from compressor house building).The return hot water shall be terminated by the contractor at the same location. Further interconnection from these terminal points shall be in bidder's scope. Refer enclosed tender drawing.

3.0 EXCLUSIONS:

- 3.1 HT motors for Air compressors. HT motors are not in bidder's scope of supply, bare motors only shall be supplied as free issue by BHEL to successful bidder based on motor inputs furnished by bidder, like motor rating and TS (Torque - Speed) curve. The responsibility for satisfactory operation for combined performance of compressors & motors shall rest with the bidder only as if, the drive motors also have been supplied by the bidder. Couplings, base plate, foundation bolts, any other fittings, etc. as required shall be supplied by the bidder only. BHEL shall supply motors to successful bidder works for shop testing of compressors with job motors. All other motors (mandatory spare) shall be dispatched by BHEL directly to project sites.
- 3.2 MCC/Switchgear for power supply to Air Compressors and other drives and panels.
- 3.3 Civil works including construction of compressor house, foundation of all compressor, air dryer and air receiver, pipe / cable trenches.
- 3.4 Lighting and ventilation of compressor house.
- 3.5 Monorail hoists/Cranes as necessary for handling of equipment after erection.
- 3.6 Compressed Air Distribution Piping running from isolation valve of the IA & SA header after the air receivers outside the compressor house.

4. SUB-VENDOR ITEMS

The tentative make of Sub-vendor items shall be generally as per Annexure-I, Section E, Vol.-II B enclosed which is subject to customer approval during detail engineering.

5. DRAWINGS AND DOCUMENTS TO BE SUBMITTED WITH THE BID

The drawings and documents to be submitted with the bid shall strictly be as mentioned under Volume III. Any documents other than those indicated in Volume III will not be reviewed and will not form part of contract.

6. DRAWINGS/ DOCUMENTS REQUIRED DURING DETAIL ENGINEERING



COMPRESSED AIR SYSTEM

2X 660MW ENNORE SEZ STPP

DOCUMENT NO.: PE-TS-412-555-A001

VOLUME- IIB

SECTION-C1-A

REV. 0

DATE: 15.12.2016

List of drawing / document required to be submitted during detail engineering is attached in **Annexure-VIII, Section E, Vol.-II B**. Any other drawings and documents as required by BHEL / Customer / Consultant shall be furnished by the successful bidder during detail engineering stage for which no implication shall be entertained by BHEL.

7. DRAWINGS DISTRIBUTION SCHEDULE

Vendor needs to submit 2 sets of hard copies of each drawing/document during detail engineering along with editable soft copy of the same. However, exact no. of drawings / documents and submission/distribution procedure for the same shall be intimated to the successful bidder after award of contract and the same shall be complied by the successful bidder without any commercial implication.

8. DRAWINGS ENCLOSED WITH THE SPECIFICATION

Drawings as per Vol III enclosed will form part of the specification.

The P&I diagrams are indicative and show the minimum requirement to be followed including minimum requirement of instruments. Any other item and instruments required (within the terminal points) to make the system complete in all respect and for satisfactory operation of the system shall also deemed to have been included by the bidder in their scope. The detailed P&I diagrams for compressed air system in line with specification requirement shall be developed by the vendor during detail engineering for customer's approval and without any commercial implication to customer. Bidder to note that the while preparing PIDs after placement of order, successful bidder shall incorporate line numbers Instrument tag nos., KKS Numbering, equipment no, Line Spec, Line MOCs, legend / symbol chart, equipment capacity, relief valve capacity and set pressure, control valve capacity, range, fail position etc. in these drawing and same are subject to the customer approval.

9. MANDATORY SPARES

General requirement of mandatory spares will be as per the list enclosed under **Annexure – II, Section E, Vol.-IIB**. The successful bidder immediately after approval of PID, Layout & equipment/ instrument data sheets /GA will prepare detailed list of mandatory spares with regard to their exact quantities, applicability/ non applicability; supply of alternate items against non-applicable items etc. This list will be submitted to customer for getting their approval. The successful bidder will proceed for ordering only after approval of the list.

10. OTHER REQUIREMENTS

- Detailed erection manual for each of the equipment as well as complete system supplied under this contract at least 2 months before the scheduled erection of the concerned equipment / component or along with supply of concerned equipment / component whichever is earlier.
- The O&M Manual to be submitted by the successful bidder will necessarily address the following:
 - a. Complete System Description along with PIDs, write up on electrical philosophy and safety/process interlocks etc.
 - b. Instructions for plant operation
 - c. Commissioning procedure of the system
 - d. Chapter on precautions to be taken during:
 - Operation
 - Idle time
 - Long shutdown



COMPRESSED AIR SYSTEM

2X 660MW ENNORE SEZ STPP

DOCUMENT NO.: PE-TS-412-555-A001

VOLUME- IIB

SECTION-C1-A

REV. 0

DATE: 15.12.2016

e. Chapter on trouble shooting during plant operation covering:

- Safely aspects
- Do's and do not's
- Maintenance schedule
- Schedule of lubricants & consumables

f. O & M instruction for all individual equipment which shall invariably contain but not necessarily limited to the following:

- Equipment description/interdiction
- Data sheet, Equipment GA & Cross Section Drawing
- Catalogue of each equipment
- DO's & DON'T's
- Duty Conditions
- Installation & Safety Recommendation
- Start-up & shut down procedure
- Instructions for testing and adjustment of system parameters
- Disassembly & Assembly Instructions giving sequence no. of each component
- List of Replacement/ Spare parts along with their drawing and catalogues and procedure for ordering spares.
- Reason & Remedy Chart for any problem
- Maintenance Schedules- Daily, Weekly, Monthly, Half Yearly and Annual indicating clearly the spares part and man-hour requirement for each stage.
- Detailed specification/ Schedule of all the consumables including lubricant oils, greases, chemicals etc. required for the complete system
- Commission procedure for equipment.

- Document approval by customer under Approval category or information category shall not absolve the vendor of their contractual obligations of completing the work as per specification requirement. Any deviation from specified requirement shall be reported by the vendor in writing and require written approval. Unless any change in specified requirement has been brought out by the vendor during detail engineering in writing while submitting the document to customer for approval, approved document (with implicit deviation) will not be cited as a reason for not following the specification requirement.
- In case vendor submits revised drawing/doc after approval of the corresponding drawing/doc, any delay in approval of revised drawing shall be to vendor's account and shall not be used as a reason for extension in contract completion. However, in case changes are necessitated due to any constraints at customer end, delay in review/ approval of such revised drawing beyond one month will be to customer's account.
- Bidder to note that during detail engineering, successful bidder to submit the drg/doc through web based Document Management System in addition to hard copies to be submitted as per dwg/ document distribution schedule. Bidder would be provided access to the DMS for drg/doc approval and adequate training for the same. Detailed methodology would be finalized during the kick-off meeting. Bidder to ensure following at their end.



COMPRESSED AIR SYSTEM

2X 660MW ENNORE SEZ STPP

DOCUMENT NO.: PE-TS-412-555-A001

VOLUME- IIB

SECTION-C1-A

REV. 0

DATE: 15.12.2016

- Internet explorer version – Minimum Internet Explorer 7
- Internet speed – 2 mbps (Minimum preferred)
- Pop ups from our external DMS IP (124.124.36.198) should not be blocked
- Vendor's Internal proxy setting should not block DMS application's link (<http://124.124.36.198/wrenchwebaccess/login.aspx>)

DMS user manuals to be used by BHEL PEM vendors for uploading, viewing, revising, commenting and tracking documents on PEM's DMS have been uploaded on PEM internet website (www.bhelpem.com) under the Vendor session.

For quick access bidder may refer the link <http://bhelpem.com/DMSManuals/DMSManuals.html>

- Final Electrical Load list will be submitted by the successful bidder as per agreed drawing/ doc submission schedule. Thereafter any change in the electrical load list shall be entertained only subject to its feasibility, and BHEL reserves the right to debit the vendor cost of any changes necessitated in the switch gear /MCC on account of changed loads.
- Wherever CIVIL works is excluded from the bidder's scope, successful bidder shall furnish civil assignment drawings. The corresponding CIVIL drawing prepared by BHEL / CIVIL agency, based on civil assignment drawing of bidder will be furnished to the successful bidder for concurrence. In case any modification is required in the civil work already carried out based on final civil inputs given by vendor, BHEL reserves the right to debit cost of such rework to vendor".
- If any deviation is there then same to be indicated separately under the heading "Schedule of Technical Deviation" enclosed as per Volume III of the Technical Specification along with Cost of Withdrawal. In case nothing is mentioned under the column Cost of withdrawal then during bid evaluation no price implication will be admissible for withdrawal of deviations. Bidders shall also note that the deviation in any other form except above is not acceptable (i.e. in data sheet or other Annexure or elsewhere in the offer) and same shall not be considered for review/evaluation purpose/comments and it would be assumed that the system/material/equipment has been offered strictly in line with specifications/requirements.

11 BIDDER TO NOTE THE FOLLOWING INFORMATION:

- 11.1 Bidders to indicate offered model in their offer and to submit backup document (e.g. performance test, etc.) matching FAD calculation along with the catalogue of the offered model to justify selection.
- 11.2 Compressor and air dryer shall be designed for cooling water (from passivated DM water) with inlet temp of thermal 38 deg C and terminal pressure 10 kg/sqcm(g). Bidder to restrict the temperature rise to 10 deg C and pressure drop across Compressed Air System within terminal points to 10 MWC. Qty of cooling water shall be 350 cum/hr (Maximum) considering working equipment only.
- 11.3 Design Inlet conditions for Compressor
- a) Temp : 50.0 Deg C
 - b) Relative humidity : 100%
 - c) Altitude : 10.0 m above MSL
- 11.4 Design, all calculations, equipment selection criterion, layout drawings/schemes/G.A. drg and documents like data sheet/Technical particulars etc. shall be prepared by successful bidder and shall be subjected to Customer & BHEL approval during detail engineering stage.



COMPRESSED AIR SYSTEM
2X 660MW ENNORE SEZ STPP

DOCUMENT NO.: PE-TS-412-555-A001

VOLUME- IIB

SECTION-C1-A

REV. 0

DATE: 15.12.2016

- 11.5 The maximum velocity to be considered in compressed air shall be 10.0 m/s (under Average pr. & Temp. Conditions).
- 11.6 All drawings and documents shall be computer based.
- 11.7 All commissioning spares & consumables for trouble free operation shall be provided, with minimum to what specified elsewhere in the specification.
- 11.8 Bidder to clearly note that the instruments, valves etc as shown in the P&I Diagram is the bare minimum and any additional instruments/valves required to complete the system in terms of safety, trouble free operation of equipment's & system as a whole and isolation of individual equipment for maintenance, then same shall be supplied by the bidder without any commercial implication to BHEL.
- 11.9 Grouting of equipment's, like Air receiver, Air dryer & foundation bolts etc. are in the scope of the bidder.
- 11.10 Performance test for compressors shall be carried out at shops with job motor only.
- 11.11 All the instruments as required for performance testing shall be arrange by bidder. Instrument for testing shall be calibrated from government certified labs & this is in the bidder scope. Bidder to ensure validity of such reports before the performance tests.
- 11.12 Height of Air receivers shall be limited to 5M for all air receivers except unit air receiver. The height of unit air receiver shall be limited to 4M.
- 11.13 Access platform required for the maintenance of instruments/valves on the towers of HOC type air drier shall be in bidder's scope of work.
- 11.14 Only KKS tagging shall be used in all document/drawings and in the field for all items/equipment/signals etc. No other tagging method is acceptable. The successful bidder shall provide detailed drawing with KKS only. Operational write up of the system should strictly contain KKS code for identification and description.



TECHNICAL SPECIFICATION
2X 660MW ENNORE SEZ STPP
COMPRESSED AIR SYSTEM

SPECIFICATION No: PE-TS-412-555-A001

VOLUME: II B

SECTION : C1-B

REV. 00

DATE: 15.12.2016

SHEET: 1 OF 1

VOLUME - II B
SECTION: C1-B
SPECIFIC TECHNICAL REQUIREMENT



**2X660 MW ENnore SEZ STPP AT
ASH DYKE OF NCTPS, CHENNAI**

COMPRESSED AIR SYSTEM

BHEL Doc. No: **PE-TS-412-555-A001**

REV 00

DATE 15.12.2016

Volume IIB, Section C1-B

1. SYSTEM DESCRIPTION

- 1.1.1** Compressed air system is provided in the power plant to supply compressed air through the distribution network to various user points.
- 1.1.2** The compressed air system is comprised of the instrument air system and the plant/service air system. Instrument air is required for the various pneumatically operated valves and instruments in the power plant, while plant air is required for general plant services.
- 1.2** Compressed Air System includes the following
- 1.2.1** Three (3) nos. (2 working + 1 standby) Instrument air compressors and three (3) nos. Plant air compressor (2 working + 1 standby), including drives, intercoolers, after coolers, step up gearbox, silencer and other accessories.
- 1.2.2** Three (3) nos. (2 working + 1 standby) air-drying plants (ADP) each suitable for connecting to individual instrument air compressor.
- 1.2.3** Intake air filters.
- 1.2.4** Six (6) nos. air receivers, (3 nos. for instrument air service and 3 nos. for plant air service) near compressor house.
- 1.2.5** Interconnecting piping, valves, fittings, supports/hangers, control air tubing (complete with valves and fittings between air receivers, compressor and local panel for each compressor), cooling water piping & valves for safe and satisfactory operation of air compressors.
- 1.2.6** Instruments including the electronic on line dew point meter with suitable sampling connection and isolation valve at the outlet of each Air Drying Plant shall be provided.

2. DESIGN INPUTS/ CRITERIA

2.1 AIR COMPRESSORS

- 2.1.1** The capacity of each instrument air compressor shall be 45 NM³/min. Delivery pressure will be 8.5 Kg/cm² (g) at compressor outlet while 8.0 Kg/cm² (g) at ADP outlet. Each compressor will be designed to deliver the nominal capacity at the required delivery pressure.
- 2.1.2** The capacity of each plant air compressor shall be 45 NM³/Min. Delivery pressure will be 8.5 Kg/cm² (g) at outlet of SA compressor.
- 2.1.3** Air compressors will be multi stage oil free, screw type.
- 2.1.4** The compressors' capacity will be designed for 50° C DBT and 100% RH at atmospheric pressure at site & at 10.0m above mean sea level (MSL).
- 2.1.5** Testing of compressor shall be as per ISO 1217.
- 2.1.6** Air compressors will be designed for continuous operation with high efficiency to satisfy the performance requirement.
- 2.1.7** The maximum continuous motor ratings shall be arrived at considering 15% margin over the duty point input or 10% over the maximum demand of the driven equipment, whichever is higher, considering highest system frequency. When the driver is not directly coupled to the compressor, due consideration will be made for losses in power transmission, in addition to the above margin.
- 2.1.8** Satisfactory operation in parallel will be ensured without any uneven load sharing, undue vibration, noise etc.

	2X660 MW ENNORE SEZ STPP AT ASH DYKE OF NCTPS, CHENNAI		BHEL Doc. No: PE-TS-412-555-A001	
	COMPRESSED AIR SYSTEM		REV	00
			DATE	15.12.2016
			Volume IIB, Section C1-B	
2.1.9	Noise level shall not exceed 85 dBA plus tolerances as per ISO standard when measured at a distance of 1.5 meter above the floor and 1.0 meter from the compressor under free field conditions. Acoustic enclosure, if required, shall be provided to meet the above condition. The discharge blow off silencer and intake silencers shall be designed to meet the above noise limitation levels.			
2.1.10	The compressed air velocity shall be limited to 10 m/s for sizing the compressed air pipes.			
2.1.11	The material of construction for the Air Compressor shall be as per the reputed manufacturer's standard.			
2.2	ROTOR.			
2.2.1	Rotors will be one-piece construction with a suitable forged carbon steel or stainless steel coated with corrosion resistant material to minimise leakage and wear.			
2.2.2	The rotors will have an asymmetric profile, so as to keep leakage losses to a minimum and ensure high efficiency.			
2.2.3	Highly precise timing gears will be mounted on the rotor shafts to maintain the rotors in correct relative position.			
2.2.4	These gears will be designed to counteract the axial forces incurred in compression.			
2.2.5	Rotors shall be dynamically balanced.			
2.3	AIR DRYING PLANT.			
2.3.1	The air drying plant shall be refrigerant type. The capacity of ADP shall be 40 NM ³ /Min each.			
2.3.2	Atmospheric pressure dew point shall (–) 20 deg C.			
2.3.3	Line pressure dew point shall be (+) 4 deg C.			
2.3.4	The material of construction for the Air drying plant shall be as per the reputed manufacturer's standard.			
2.4	AIR RECEIVER.			
2.4.1	The capacity of 06 nos. air receivers provided near to compressor house shall be 10 m ³ (nominal).			
2.4.2	The air receivers shall be vertical self-supporting cylindrical vessels with supporting legs for resting on their foundation.			
2.4.3	Design Pressure & Temperature for the air receiver shall be 12.75 kg/cm ² (g) & 50 ⁰ C respectively. Air receivers shall be designed as per ASME Section VIII or IS: 2825.			
2.4.4	The material of construction of shell, dished ends, flanges etc. of the air receivers shall be of carbon steel as per IS: 2062 / SA 516 Gr 70 / equivalent.			
2.4.5	Air receiver shall be provided with nozzles, air release vents, safety valve, pressure gauge, temperature gauge, minimum 500 mm dia. manhole for inspection.			
2.5	INTAKE FILTER			
2.5.1	Dry type suction air filters will be provided at the compressor inlet to prevent dust and dirt from entering the compression chambers of compressors. The filtering efficiency shall be 99 %, down to 10 microns. Sound suppressing characteristics will be considered in the filter design.			
2.6	PIPING AND VALVES (WITHIN COMPRESSOR HOUSE)			
2.6.1	All interconnecting compressed air piping shall conform to ASTM A-53 type E grade B / IS 1239 heavy grade /IS 3589 Gr 410 and shall be galvanised as per IS- 4736 or equivalent. All cooling water piping will be IS-3589 Gr.410/ IS-1239 Heavy grade. Oil Piping shall be API 5L. The fittings shall be conforming to relevant BIS standard and			



2X660 MW ENnore SEZ STPP AT ASH DYKE OF NCTPS, CHENNAI

COMPRESSED AIR SYSTEM

BHEL Doc. No: PE-TS-412-555-A001

REV 00

DATE 15.12.2016

Volume IIB, Section C1-B

Grade equivalent that of parent pipe Grade. Compressed air piping handling hot air will be suitably insulated so as to restrict surface temperature to 60 deg. C. The galvanised pipe joints will be screwed coupling type for sizes up to 50 NB and above 50 NB the same will be flanged. Cooling water lines of 65 Nb and above shall be joined by butt welding and 50 Nb and below by socket welding.

2.6.2 Necessary auto drain shall also be provided at strategic points in compressed air line.

2.6.3 VALVES

2.6.3.1 Compressed Air service.

a) All airline valves shall be ball valve type. For compressed air application, valve material shall be galvanized cast carbon steel or forged carbon steel for sizes 65 mm NB & above and Gun metal for sizes 50 NB and below.

3.6.3.2 Water service

a) Cooling water / drain water application valve shall be gate / globe / ball valve type. Valve material shall be Cast iron for size 65 Nb and above; gun metal / forged carbon steel for sizes 50 Nb and below.

2.6.3.3 End connections shall be screwed or flanged as required.

2.7 LAYOUT CONSIDERATION

2.7.1 Air compressors will be located indoor in a separate compressor room.

2.7.2 The air receivers will be located outdoors and adjacent to the compressor room.

2.7.3 Complete ADP equipment shall be preferably mounted on a skid and located indoor.

2.8 C&I ITEMS

C&I items design criteria shall be as per C&I Specification.

4. BRIEF SCOPE

4.1 SCOPE OF SUPPLY

Scope of supply shall comprise of the following:

4.1.1 Multistage oil free, screw type 45 Nm³/min capacity air compressors, six (6) nos. (03 for IA and 03 for SA) complete with including drives, intercoolers, after coolers, step up gearbox, silencer and other accessories.

4.1.2 Refrigerant type air drying plant of capacity 45 Nm³/min, 03 nos.

4.1.3 Six (06) nos. air receivers of 10 m³ capacity each.

4.1.4 All interconnecting piping, valves, fittings, supports/hangers, cooling water piping & valves for safe and satisfactory operation of system – 01 Lot.

4.1.5 All instruments including the electronic on line dew point meter. – 01 Lot.

4.1.6 Microprocessor based integrated control system for each compressor in line with the specification requirements indicated in volume III and volume V (except OEM limitations very particular to the equipment design subjected to customer's approval) and one PLC based control system for overall control of the compressors.

4.2 SCOPE OF SERVICES.

4.2.1 Erection and Commissioning of Compressed Air System.

5. OPERATION & CONTROL PHILOSOPHY

5.1 The necessary instrumentation and control has been provided for safe and trouble free operation of compressed air system.

	2X660 MW ENNORE SEZ STPP AT ASH DYKE OF NCTPS, CHENNAI COMPRESSED AIR SYSTEM	BHEL Doc. No: PE-TS-412-555-A001	
		REV	00
		DATE	15.12.2016
		Volume IIB, Section C1-B	

5.2	Individual compressor control shall be through microprocessor based control system in line with the specification requirements indicated in C&I Specification (except OEM limitations very particular to the equipment design subjected to customer's approval).
5.3	For overall controls of the Compressors, one PLC based control system with Hot redundant processor shall be provided. One number OWS & one number OEWS, one number B/W Laser Jet Printer and one number A3 sized Dot Matrix Printer shall also be provided. "Salient features of the control system are briefed in this document, for detailed description separate documents i.e. write-up on operations / interlocks, PLC configuration & I/O list shall be furnished after finalisation of system supplier.
5.4	Depending upon operational requirement each compressor can be selected and operated in following mode:
5.4.1	Local mode: Individual compressor is operated from Local Integral Control System. This mode of operation shall be selected through individual microprocessor. During this mode the individual compressor start / stop command shall be executed by respective microprocessor through facia MMI. Required application / operational software with logic for start permissive / start / stop / run etc. are pre-loaded in the microprocessor, which in turn control the compressor as the case may be. Loading & unloading of the compressor shall be as per the operating pressure band setting in the individual microprocessor. Logic built in compressor's individual microprocessor based control system shall take care the signals from transducers with in the compressor.
5.4.2	Remote mode: Individual compressor is operated through PLC OEWS. This mode of operation shall be selected through individual microprocessor. However during this mode individual compressor start / stop command shall be executed by common PLC, before giving start / stop command from OWS the compressor "Remote selected" shall be ensured from the compressor room. As in local mode microprocessor with pre-loaded application / operational software consisting of logic for start permissive / start / stop / run etc. will control the individual compressor. During this mode also loading & unloading of the compressor shall be as per the operating pressure band setting in the individual microprocessor.
5.4.3	Logics for the external signals out of the compressor shall be taken care by PLC for overall control, operation and monitoring of complete compressor plant.
5.5	Operation of Compressed Air System.
5.5.1	Instrument air system consists of 3 numbers of Compressors (02 working + 01 standby), 03 numbers of Air Drying Plant (02 working + 01 standby), air receivers and distribution network of piping and valves.
5.5.2	The compressors are operated in cascade mode of operation. The operation of compressors is carried out as under, say of IA compressors: ➤ Initially, the pressure setting in all 03 numbers compressors is set in cascading mode, with higher pressure settings (say for Compressor No.01 - 8.5 kg/cm² for unloading & 8.1 kg/cm² for loading, For Compressor No.02- 8.3 kg/cm² for unloading & 7.9 kg/cm² for loading) for working and lower pressure settings (say 8.0 kg/cm² for unloading & 7.4 kg/cm² for loading) for the standby compressor. ➤ To ensure auto start-up of standby compressor, all the three compressors are started together. ➤ The pressure starts building up in the system. Once the header pressure crosses the unloading pressure of standby compressor, the standby compressor unloads and then subsequently goes into idle / standby mode. ➤ Then the header pressure is maintained by unloading / loading of working compressors. ➤ In case of trip/failure of working compressor, the header pressure starts dropping.

	2X660 MW ENnore SEZ STPP AT ASH DYKE OF NCTPS, CHENNAI	BHEL Doc. No: PE-TS-412-555-A001	
		REV	00
		DATE	15.12.2016
		Volume IIB, Section C1-B	
COMPRESSED AIR SYSTEM			

➤ As soon as the header pressure reaches the loading pressure of standby compressor (say 7.4 kg/cm²), the standby compressor automatically starts by sensing the header pressure.

5.5.3 Operating procedure of plant air compressors is same as IA compressors described in 5.5.2 above.

5.5.4 For ensuring IA at all the time, intermediate IA and plant air headers are connected through check valve and a pneumatically operated valve such that compressed air can flow from plant air to IA intermediate header. For this purpose, an analogue signal from PT mounted on IA header shall be taken to common PLC and from PLC pneumatic valve would be operated. In case of low pressure in IA header, pneumatic valve shall be opened to ensure availability of IA upstream of air drying plant. For actuating pneumatic valve, following pressure setting may be done: less than or equal to 7.0 kg/cm² – pneumatic valve to open, & pressure greater than or equal to 7.5 kg/cm² – pneumatic valve to close.

5.5.5 All the process inputs (digital or analog), other than specific to compressors are taken directly to compressed air system common PLC for monitoring the system.

5.5.6 Common PLC panel shall be connected to main plant DCS through redundant soft and hard link for monitoring purpose. Major equipment status and abnormal conditions shall be hardwired from common system PLC to main plant DCS for monitoring i.e. instrument air pressure, instrument air flow, dew point, service air pressure and service air flow.

5.5.7 Common PLC shall have redundant softlink interfacing (not in daisy serial link) with each individual compressor’s microprocessor based control system, and HW signals required for start / stop, load / unload commands, local / remote operation, general warning and shut down. Logics for interlock and protection of compressor are inbuilt in their own microprocessor based control system.

5.5.8 PLC Control panel shall house PLC Hardware, Alarm Annunciator driven by PLC programmed sequence, Indicators, Indication lamps, Switches, local / remote selector switch, Start / Stop push buttons, Auxiliary Relays, Motor current meter etc.. Selector switch shall be provided in the control panel to achieve three positions for “Base duty”, “Stand by duty” and “Stop”.

5.5.9 The latest proven PLC system shall be provided. PLC should be sourced from original manufacturers. PLC system shall be complete with hot standby redundant CPU of word length of 32bits minimum, Input / Output modules, dual serial link interface module for connecting Input / Output Modules, dual Communication Processors, dual Memory modules and redundant Power supply units. Power supply unit shall be redundant for each CPU & I/O rack. PLC system will be interfaced with DDCMIS through OPC dual redundant communication interfacing (to be provided at PLC & DDCMIS end) for important process parameters. PLC shall confirm to IEC – 61131.”

5.5.10 The compressor automatic or local operation, general warning / alarm, compressor loading /unloading will be hardwired to PLC as a general philosophy. RTD and BTd temperature signals of compressor motor shall be wired to individual compressor microprocessor panel for tripping of compressor in case of high temperature. Control signals from compressor switchgear shall be wired to individual compressor microprocessor panel for interlock. RTD and BTd temperature signals of compressor motor shall be hooked to PLC for monitoring purpose. The running status of air driers will also be available in the PLC.

5.5.11 Control of moisture separator circuit shall be implemented in PLC. Auto drain valves and solenoid operated valves through timers of PLC are to be paralleled at the bottom of reservoir tank.

5.5.12 PLC system shall be supplied as per C&I Specification only.

a) Redundancy of I/O cards shall be provided as per C&I Specification.

	2X660 MW ENNORE SEZ STPP AT ASH DYKE OF NCTPS, CHENNAI COMPRESSED AIR SYSTEM	BHEL Doc. No: PE-TS-412-555-A001	
		REV	00
		DATE	15.12.2016
		Volume IIB, Section C1-B	
		b) PLC shall be provided with necessary redundant ports & complete hardware for Auto time synchronization from Master clock time as per C&I Specification. c) Design and functional requirements as detailed out for DDCMIS / DCS in C&I Specification shall also be applicable for CAS common PLC. d) UPS shall be parallel redundant with battery and ACDB.	
5.5.13	Vibration monitoring system (VMS) shall be provided for compressor motor. VMS for compressor motor (at both end or at single end) shall be as per compressor OEM. These VMS signals shall be connected to common PLC from field / VMS panel. Apart from this one number portable vibration analysed shall also be provided inline with C&I Specification.		
5.5.14	Compressors individual microprocessor panel shall have feature meeting the functional requirements of technical specification.		
5.5.15	One number Tachometer in line with C&I Specification for speed measurement shall be provided.		
5.5.16	Codes for Design, inspection and service for C&I items shall be as per C&I Specification.		
5.5.17	All the instruments/equipment/electrical items shall be provided & designed with maximum star rating as available in line with energy conservation policies notified by BEE, GOI at the time of supply.		
5.5.18	Complete Control & Instrumentation cables shall be provided as per technical specification only.		
5.5.19	Erection Hardware shall be provided as per C&I Specification and Installation drawings only.		
5.5.20	Quality assurance and testing of PLC shall be provided as per C&I Specification.		
5.5.21	UPS details for Compressed Air system shall be as per C&I Specification.		
5.5.22	Tools and tackles shall be provided as per Technical Specification Vol. III, CI no 24.2.21, Pg. no 739.		
5.5.23	Field instruments shall be provided as per Technical Specification Vol. V. chapter 3, chapter-9 & Annexure C.		
5.5.24	Junction Boxes shall be provided as per technical specification.		
5.5.25	Details of control panels shall be as per C&I Specification.		



**TECHNICAL SPECIFICATION
2X660 MW ENNORE SEZ
COMPRESSED AIR SYSTEM**

SPECIFICATION No: PE-TS-412-555-A001

VOLUME: II B

SECTION : C2

REV. 00

DATE:15.12.2016

SHEET: 1 OF 1

SECTION: C2

CUSTOMER SPECIFICATIONS



**TECHNICAL SPECIFICATION
2X660 MW ENNORE SEZ
COMPRESSED AIR SYSTEM**

SPECIFICATION No: PE-TS-412-555-A001

VOLUME: II B

SECTION : C2-A

REV. 00

DATE: 15.12.2016

SHEET: 1 OF 1

SECTION: C2-A

TECHNICAL REQUIREMENT

CHAPTER 18

18.0 COMPRESSED AIR SYSTEM

18.1 Description

18.1.1 The compressed air system shall comprises of Instrument Air (IA) System and Service Air (SA) system.

18.1.2 The IA system shall supply required quality air to various pneumatically operated valves and instruments of SG, TG and all BOP systems envisaged excluding Ash Handling Plant. SA system shall meet the service air requirement of the proposed Units.

18.1.3 Service Air Compressor may be used for Instrument Air System connecting with Air Drying Plant in case of non availability of Instrument Air Compressors. The valves and piping arrangement for such interconnection shall also be provided

18.1.4 The service & instruiument air compressors alongwith air driers shall be located in a separate building.

18.2 The scope of supply for Instrument Air System shall include but not limited to the following:

- i. Three (3), oil free multistage rotary screw compressors for providing IA air for facilities in Ennore SEZ area. Out of these two (2) shall be working and one (1) shall be on standby duty
- ii. Shell and tube type water cooled Inter cooler and After cooler with moisture separators and drain traps for each compressor.
- iii. Suction filter along with blow off valve and silencer for each compressor.
- iv. Three (3) refrigerant type Air Drying Plants for compressors in Ennore SEZ area. Capacity of each drier shall be equal to capacity of compressor. Out of these two (2) shall be working and one (1) shall be on standby duty.
- v. All instruments as required including pressure switches, temperature switches, pressure gauges, temperature gauges, control panels
- vi. Three (3) vertical Air Receivers in Ennore SEZ area complete with supporting structure, pressure gauges and switches, safety valves, drain traps.
- vii. PLC based control panel for control and monitoring of the Compressed air system, field instruments, control cables, etc. Refer clause 3 of Annexure 'C' volume V Instrumentation and Control works.
- viii. Smaller air receivers, each of capacity 2 cum shall be provided as required in areas located away from the compressor house to maintain pressure.

18.3 The scope of supply for Service Air System shall include but not limited to the following:

- i. Three (3), oil free multistage rotary screw compressors. Out of these two (2) shall be working and one (1) shall be on standby duty.
- ii. Shell and tube type water cooled Inter cooler and After cooler with moisture separators and drain traps for each compressor.
- iii. Suction filter along with blow off valves and silencer for each compressor.
- iv. All instruments as required including pressure switches, temperature switches, pressure gauges, temperature gauges, control panels
- v. Three (3) nos. vertical Air Receivers [of capacity 10 M³ (min)] complete with welded supporting stand and foundation bolt, pressure gauge and switch, safety valves, drain cock as minimum. Two air receivers shall be for each unit.
- vi. PLC based control panel for control and monitoring of the Compressed air system, field instruments, control cables, etc. Refer clause 3 of Annexure 'C' volume V Instrumentation and Control works.
- vii. Smaller air receivers, each of capacity 2 cum shall be provided as required in areas located away from the compressor house to maintain pressure.
- viii. Moisture trap to be provided at boiler end and turbine end and wherever necessary.

18.4 **Design Requirements**

18.4.1 All equipment shall be designed for continuous operation.

18.4.2 The capacity of each IA compressor and SA compressor in Ennore SEZ Area shall be as per requirement..The discharge pressure at the outlet shall not be less than 8.5 Kg/cm² (g).

18.4.3 Noise level shall not exceed 85 dBA when measured at a distance of 1.0 meter from the compressor. Acoustic enclosures as required, shall be provided to meet the above condition. The discharge blow-off silencer and intake silencers shall be designed to meet the above noise limitation level.

18.5 **Air Compressors**

18.5.1 Service air compressors and instrument air compressors shall be interconnected for flexibility in operation, designed for continuous operation with high efficiency to satisfy the system requirements. The compressors shall be of indoor duty complete with air coolers necessary valves with vent pipe work ducted to a safe discharge outlet. The air pipe work shall be of GI pipes of heavy quality construction.

18.5.2 Compressors shall be identical oil free, rotary, screw type. Each compressor shall have an inlet filter and silencer unit having inlet area large enough to ensure that frequent filter changes are not required. The silencer unit shall comply with the statutory noise requirements specified for which necessary acoustic enclosure shall be provided for housing the compressors. Drive motor shall comply with standard specification for induction motors enclosed with the specification and shall be connected directly to the compressor.

18.5.3 Each air compressor shall have its own control panel with indication lights for power on; service hour-run meter; load hour-run meter; inlet air filter differential pressure high; outlet air pressure & temperature (analogue gauge); oil filter differential pressure high; separator element differential high; motor overload; low oil level; compressor temperature high; oil temperature before and after oil cooler (analog gauge). The compressor should trip on motor overload; low oil level; and compressor temperature high.

18.5.4 Compressed air piping shall be sized for minimum pressure drops and considering velocity range of 6-10 m/sec as per IS: 6206. All pipelines shall have butt welded connections with minimum flange joints for connection to vessels and equipment. All pipelines shall be suitably supported and routed such that there shall be minimum hindrance for the operating personnel.

18.6 Air Receivers

18.6.1 Air receivers shall be provided for service air and instrument air separately as shown in the flow diagram.

18.6.2 Air receivers shall be designed in accordance with ASME Section-VIII or IS: 2825. Corrosion allowance of minimum 3 mm shall be considered for the design. The air receiver shall be of vertical cylindrical design with dished ends.

18.6.3 Air receivers shall be designed for minimum 1.5 times compressor discharge pressure. The water capacity of air receiver shall be 10 M³.

18.6.4 The air receiver shall have inlet/outlet connections, safety relief valves, fusible plugs, pressure gauges, pressure switches, temperature gauges, flanged pipe connections, inspection manholes with automatic drain traps. The air receiver shall have access platforms for maintenance of safety relief valves and instruments.

18.7 Air Drying Plants

20

The capacity of air drying plant shall be equal to the capacity of the individual air compressors. The Air drying plant, at its rated capacity, shall be designed to deliver continuously air at dew point of minus (-) 40 deg C at atmospheric pressure and the Quality of dry outlet air to conform to Instrument Society of American Standard S7.3 "Quality Standard for Instrument Air". ~~Air Driers shall be HOC type.~~

Air Drying Plants (REFRIGERANT TYPE)

18.7.1 Codes And Standards

The design, manufacture, testing and performance of the various components of Air Drying Plant shall comply with at least the requirements of one or more of the following codes, as applicable :

- | | | | |
|------|----------|---|---|
| i) | IS-11989 | : | Specification for Air Dryers. |
| ii) | IS-2825 | : | Code for Unfired Pressure Vessels. |
| iii) | IS-11327 | : | Requirement for refrigerant condensing type units |
| iv) | IS-5111 | : | Testing of refrigerant compressor |

v) ISO 8753.1 : Filter quality classes

Technical requirements

The capacity of air drying plant shall be equal to the capacity of the individual air compressors. The Air drying plant, at its rated capacity, shall be designed to deliver continuously air at dew point of minus (-) 40 deg C at atmospheric pressure and the Quality of dry outlet air to conform to Instrument Society of American Standard S7.3 "Quality Standard for Instrument Air".

Discharge pressure available at the outlet of Air drying Plant shall be minimum 7.5 Kg/cm² (g) or more as per the requirement of Contractor

The compressors and Air Drying plants shall operate under the following ambient conditions.

- | | | |
|-------|--|-------------------------------|
| (i) | Minimum temperature | 10 deg.C |
| (ii) | Maximum temperature | 50 deg. C |
| (iii) | Design condition (temperature & Relative humidity) | 50 deg.C & 100% RH |
| (iv) | Height above MSL (m) | As given in Plant information |

- (A) One number Air drying plant shall be provided for each Instrument air compressor. The air driers shall be refrigerant type.

Wet Compressed air undermines efficiency of smallest to the largest pneumatic system. Therefore, moisture removal in compressed air system installation is a must. The incoming saturated, moist air shall be precooled in the Air - to - Air Heat Exchanger by the outgoing dry chilled air to ensure that a greater part of Water Vapour gets condensed into liquid moisture. Further moisture separation shall take place in the Freon -to- Air Heat Exchanger where air is chilled to a temperature of +2 Deg. C. and moisture condenses. This temperature is termed as pressure 'Dew Point'. The Moisture Separator removes the condensate by an Automatic Condensate Trap i.e. auto drain.

The compressed dry air shall be reheated in Air -to- Air Heat Exchanger and fed to the point of application. As long as compressed air temperature remains above the +2 Deg. C., no further condensation shall occur. The refrigeration circuit shall be conventional circuit comprising refrigerant Compressor, air and water cooled Condenser, Expansion Valve etc. using Freon R-22 as refrigerant gas. Ecofriendly Refrigerant like R-134 A, R-404 A, R-407C shall be used. ADP shall be water cooled

- (B) The compressor shall be hermetically sealed.

- (D) The material of Construction for various components of ADP shall be as follows:-

ADP Vessel	Carbon Steel
All internals of adsorber vessels	SS-304
Cooler shells, channels and covers,	Same as that in intercooler /
Cooler tube sheet & tubes	after coolers
• Relief Valves	Brass or SS
• Desiccant	Silica gel or activated alumina
• Air Piping	Galvanized Steel
• Valves in air line	CI or Cast steel or Forged Steel body with SS trim
• Valves in water pipe lines	SS/ Bronze / Gunmetal

(F) Control Philosophy

Sequential operation of the ADP & air compressors shall be controlled automatically with a provision for manual take over.

~~Change over of tower from drying mode to standby mode shall happen automatically if the dew point is high at the outlet of ADP sensed by the dew point (using aluminium oxide probe) meter/sensor.~~

The control system shall provide the (as minimum) alarms, "Low cooling water flow", "Low air pressure at the outlet of ADP" and "High dew point at the outlet of ADP". Adequate number of temperature elements etc. shall be provided for measurement and monitoring of the same.

DATA SHEET FOR COMPRESSED AIR SYSTEM (ENNORE SEZ)

1.0 Air Compressors

			Service Air	Instrument Air
1.1	Quantity (Working and Standby)	:	3 (2W+1S)	3 (2W+1S)
1.2	Type	:	Oil free, multistage, rotary, screw type	
1.3	Capacity	:	min 40 NM ³ / min @	8.5 kg/cm ² (g)
1.4	Material of Construction			
a.	Compressor chamber	:	Cast iron coated with corrosion resistant material	
b.	Rotor	:	Forged carbon steel coated with corrosion resistant material; 2 nd stage stainless steel	
c.	Timing gears	:	Low alloy steel	
d.	Inlet throttle valve & housing	:	Aluminium/stainless steel	
e.	Shaft seals	:	High alloy steel	
f.	Unloading cylinder header	:	Aluminium	
g.	Water separator	:	Cast iron	
h.	Non return valves	:	Stainless steel spring loaded type	
i.	Blow off valve	:	Stainless steel	
j.	Safety valve	:	Brass	
k.	Tube of blow off cooler	:	Stainless steel type 304	
l.	Cooler casing	:	Carbon steel/SG iron	
m.	Gear box casing	:	Cast iron/SG iron	
n.	Gears	:	Alloy steel	
p.	Bearings	:	Oil lubricated antifriction type suitable for at least 40,000 running hours	
q.	Shaft seals	:	Floating restrictive ring type design	

2.0 Air Receiver

			Service Air	Instrument Air
2.1	Quantity	:	3	3
2.2	Type	:	Vertical cylinder type	

2.3	Water Capacity	:	10 M ³	10 M ³
2.4	Material of construction	:	MS to IS 2062	
2.5	Safety relief valves	:	Required	
2.6	Automatic drain trap	:	Required	
2.7	Standard	:	ASME Sec-VIII or IS 2825	

3.0 **Air Drying Plant**

3.1	Quantity	:	3 (2W+1S)	
3.2	Capacity	:	40 Nm ³ / min (Min)	
3.3	Type	:	Refrigerant type	
3.4	Dew Point of air at drier outlet	:	(-) 20 Deg C	

	TECHNICAL SPECIFICATION 2X660 MW ENNORE SEZ COMPRESSED AIR SYSTEM	SPECIFICATION No: PE-TS-412-555-A001	
		VOLUME: II B	
		SECTION : C2-B	
		REV. 00	DATE:15.12.2016
		SHEET: 1 OF 1	

SECTION: C2-B

PROJECT SPECIFIC GENERAL REQUIREMENTS

CHAPTER – 3

GENERAL TECHNICAL REQUIREMENTS

1.00.00 INTRODUCTION

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

2.00.00 BRAND NAME

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

3.00.00 BASE OFFER & ALTERNATE PROPOSALS

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

4.00.00 COMPLETENESS OF FACILITIES

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

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

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

5.00.00 CODES & STANDARDS

5.01.00 In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment / plant / system, all equipment parts, systems and works covered under this specification shall comply with all currently applicable statutory regulations and safety codes of the Republic of India as well as of the locality where they will be installed, including the following:

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

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

- (a.) Japanese Industrial Standards (JIS)
- (b.) American National Standards Institute (ANSI)
- (c.) American Society of Testing and Materials (ASTM)
- (d.) American Society of Mechanical Engineers (ASME)

- (e.) American Petroleum Institute (API)
- (f.) Standards of the Hydraulic Institute, U.S.A.
- (g.) International Organisation for Standardization (ISO)
- (h.) Tubular Exchanger Manufacturer's Association (TEMA)
- (i.) American Welding Society (AWS)
- (j.) National Electrical Manufacturers Association (NEMA)
- (k.) National Fire Protection Association (NFPA)
- (l.) International Electro-Technical Commission (IEC)
- (m.) Expansion Joint Manufacturers Association (EJMA)
- (n.) Heat Exchange Institute (HEI)

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

5.04.00 As regards highly standardized equipment such as Steam Turbine and Generator, National /International standards such as JIS, DIN, VDI, ISO, SEL, SEW, VDE, IEC & VGB shall also be considered as far as applicable for Design, Manufacturing and Testing of the respective equipment. In addition, these standards shall be referred for the design of machine foundations, wherever specifically mentioned in the specifications. However, for those of the above equipment not covered by these National / International standards, established and proven standards of manufacturers shall also be considered.

5.05.00 In the event of any conflict between the codes and standards referred to in the above clauses and the requirement of this specification, the requirement of Technical Specification shall govern.

5.06.00 Two (2) English language copies of all-national and international codes and/or standards used in the design of the plant, equipment, civil and structural works shall be provided by the Bidder to the Owner within two calendar months from the date of the Notification of Award.

5.07.00 In case of any change in codes, standards & regulations between the date of bid opening and the date when vendors proceed with fabrication, the Owner shall have the option to incorporate the changed requirements or to retain the original standard. It shall be the responsibility of the Bidder to bring to the notice of the Owner such changes and advise Owner of the resulting effect.

6.00.00 EQUIPMENT FUNCTIONAL GUARANTEE

- 6.01.00 The Equipment and Auxiliaries shall be capable of continuous operation in frequency range of 47.5 to 51.5 Hz.
- 6.02.00 The functional guarantees of the equipment under the scope of the Contract is given elsewhere in the technical specification. These guarantees shall supplement the general functional guarantee provisions covered under General Conditions of Contract.
- 6.03.00 Liquidated damages for shortfall in meeting functional guarantee(s) during the performance and guarantee tests shall be assessed and recovered from the Bidder as specified elsewhere in this specification.
- 7.00.00 DESIGN OF FACILITIES/ MAINTENANCE & AVAILABILITY CONSIDERATIONS**
- 7.01.00 Design of Facilities**
- All the design procedures, systems and components proposed shall have already been adequately developed and shall have demonstrated good reliability under similar conditions elsewhere.
- The Bidder shall be responsible for the selection and design of appropriate equipment to provide the best co-ordinate performance of the entire system. The basic requirements are detailed out in various clauses of the Technical Specifications. The design of various components, assemblies and subassemblies shall be done so that it facilitates easy field assembly and dismantling. All the rotating components shall be so selected that the natural frequency of the complete unit is not critical or close to the operating range of the unit.
- 7.02.00 Maintenance and Availability Considerations**
- Equipment/facilities offered shall be designed for high availability, low maintenance and ease of maintenance. The Bidder shall specifically state the design features incorporated to achieve high degree of reliability/ availability and ease of maintenance. The Bidder shall also furnish details of availability records in the reference plants stated in his experience list.
- Bidder shall state in his offer the various maintenance intervals, spare parts and man-hour requirement during such operation. The intervals for each type of maintenance namely inspection of the furnace, inspection of the entire hot gas path and the minor and major overhauls shall be specified in terms of fired hours, clearly defining the spare parts and man-hour requirement for each stage.
- Lifting devices i.e. hoists and chain pulley jacks, etc. shall be provided by the Bidder for handling of any equipment or any of its part having weight in excess of 500 Kgs during erection and maintenance activities.

Lifting devices like lifting tackles, slings, etc. to be connected to hook of the hoist / crane shall be provided by the Bidder for lifting the equipment and accessories covered under the specification.

8.00.00 DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY BIDDER

8.01.00 Each of the plant and equipment shall be fully integrated, engineered and designed to perform in accordance with the technical specification. All engineering and technical services required ensuring a completely engineered plant shall be provided in respect of mechanical, electrical, control & instrumentation, civil & structural works as per the scope.

The Bidder shall furnish engineering data/drgs. in accordance with the schedule of information as specified in Technical Specification and data sheets.

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

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

Basic Engineering Documentation

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

- i. System description of all the mechanical, electrical, control & instrumentation & civil systems.
- ii. Technology scan for each system / sub-system & equipment.
- iii. Selection of appropriate technology / schemes for various systems/ subsystems including techno-economic studies between various options.
- iv. Optimization studies including thermal cycle optimization.
- v. Sizing criteria of all the systems, sub-systems including various piping systems/ equipment/ structures/ equipment foundations along with all calculations justifying and identifying the sizing and the design margins.
- vi. Schemes and Process & Instrumentation diagrams for the various systems/ sub-system with functional write-ups.
- vii. Operation Philosophy and the control philosophy of the Main Plant and other plants.

- viii. General Layout plan of the power station incorporating all facilities in Bidder's as well as those in the Owner's scope. This drawing shall also be furnished in the form of floppy discs to the Owner for engineering of areas not included in Bidder's scope.
- ix. Basic layouts and cross sections of the main plant building (various floor elevations), boiler, fuel oil area and other areas included in the scope of the Bidder.
- x. Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.
- xi. The successful bidder shall furnish within three (3) weeks from the date of Notification of Award, a list of contents of the Plant Definition Manual (PDMs) including techno-economic studies, which shall then be mutually discussed & finalised with the Owner.
- xii. After approval of Plant Definition Manual / Design Basis Report, Bidder shall furnish detailed technical specification of all system / packages of the Plant.
 - i. Layouts, general arrangements, elevations and cross-sections drawings for all the equipment and facilities of the plant.
 - ii. Flow diagrams, Process & Instrumentation Diagrams alongwith write-up and system description.
 - iii. Start-up curves for turbine, boiler and both turbine and boiler combined together as a unit for various start-ups, viz. cold, warm and hot start-up.
 - iv. Piping isometric, composite layout and fabrication drawings.
 - v. Piping engineering diagrams, pipe and fittings schedules, valve schedules, hanger and support schedules, insulation schedules.
 - vi. Technical data sheets for all bought out and manufactured items. Bidder shall use the specifications as a base for placement of orders on their sub-vendors.
 - vii. Detailed design calculations for components, system/sub-system,, piping etc., wherever applicable including sizing calculations for all auxiliaries as per criteria specified elsewhere in specification.
 - viii. Boiler pressure part schedule and sizing calculations. Boiler performance data and boiler design dossier.
 - ix. Transient, hydraulic and thermal stress analysis of piping and system wherever applicable & input and output data alongwith stress analysis isometrics showing nodes.

- x. Thermal cycle information (heat balance diagrams, boiler performance calculations, condenser and heat exchanger thermal calculations etc.).
- xi. Characteristic Curves/ Performance Correction Curves. Hydraulic & Mechanical design calculations for condensers & heaters.
- xii. Comprehensive list of all terminal points which interface with Owner's facilities giving details of location, terminal pressure, temperature, fluid handled & end connection details, forces, moments etc.
- xiii. Power supply single line diagram, block logics, control schematics, electrical schematics, etc.
- xiv. Protection system diagrams and relay settings.
- xv. Interconnection diagrams.
- xvi. Cable routing plan.
- xvii. Instrument schedule, measuring point list, I/O list, Interconnection & wiring diagram, functional write-ups, installation drawings for field mounted instruments, logic diagrams, control schematics, wiring and tubing diagrams of panels and enclosures etc. Drawings for open loop and close loop controls (both hardware and software). Motor list and valve schedule including type of actuator etc.
- xviii. Alarm and annunciation list and alarms & trip set points.
- xix. Sequence and protection interlock schemes.
- xx. Type test reports and power system stability study report.
- xxi. Control system configuration diagrams and card circuit diagrams and maintenance details.
- xxii. Detailed software manuals & source software listing.
- xxiii. Detailed flow chart for digital control system.
- xxiv. Mimic diagram layout.
- xxv. Civil Task drawings(for the Engineering by Owner),Design and Drawings for the Civil & Structural works in the scope of the Bidder.
- xxvi. Model study reports wherever applicable.
- xxvii. Functional & guarantee test procedures and test reports.

- xxviii. Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.
- xxix. Documentation in respect of commissioning as listed out elsewhere in this specification.
- xxx. The Bidder while submitting the above documents / drawings for approval / reference as the case may be, shall mark on each copy of submission the reference letter alongwith the date vide which the submissions are made.

8.03.01

Instruction Manuals

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

Erection Manuals

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

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

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

Operation & Maintenance Manuals

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

8.03.02

Plant Handbook

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

1. Design and performance data.
2. Process & Instrumentation diagrams.
3. Single line diagrams.
4. Sequence & Protection Interlock Schemes.
5. Alarm and trip values.
6. Performance Curves.
7. General layout plan and layout of main plant building and auxiliary buildings.
8. Important Do's & Don't's

The plant handbook shall be submitted within twelve (12) months from the date of award of contract. After the incorporation of Owner's comments, the final plant handbook complete in all respects shall be submitted three (3) months before start-up and commissioning activities.

8.03.03 **Project Completion Report**

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

8.03.04 **Drawings**

- (a.) All documents submitted by the Bidder for Owner's review shall be in electronic form (soft copies) along with the desired number of hard copies as per Annexure-I. The soft copies to be supplied shall be either in CDs, or through direct transfer via E-mail, etc. depending upon the nature/volume/size of the document. The drawings submitted for approval could be in the Image form.
- (b.) Final copies of the approved drawings shall be submitted on CD-ROM along with the requisite number of hard copies as per Annexure-I.
- (c.) The completed plant documentation with equipment drawings, data sheets, P&ID, BOQ, schematics, logic diagrams, test reports and quality plan, etc. shall be furnished to Owner.
- (d.) All documents/text information shall be in latest version of MS Office.

- (e.) All drawings submitted by the Bidder including those submitted at the time of bid shall be in sufficient detail indicating the type, size, arrangement, weight of each component for packing and shipment, the external connection, fixing arrangement required, the dimensions required for installation and interconnections with other equipment and materials, clearance and spaces required between various portions of equipment and any other information specifically requested in the drawing schedules.
- (f.) Each drawing submitted by the Bidder (including those of sub-vendors) shall bear a title block at the right hand bottom corner with clear mention of the name of the Owner, Consultant, name of the Project, system designation, the specifications title, the specification number, drawing/document number and revisions. If standard catalogue pages are submitted the applicable items shall be indicated therein. All titles, notings, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.
- (g.) The Bidder shall also furnish a "Master Drawing List" which shall be a comprehensive list of all drawings/ documents/ calculations envisaged to be furnished by him during the detailed engineering to the Owner. Such list should clearly indicate the purpose of submission of these drawings i.e. "FOR APPROVAL" or "FOR INFORMATION ONLY".
- (h.) Similarly, all the drawings/ documents submitted by the Bidder during detailed engineering stage shall be stamped "FOR APPROVAL" or "FOR INFORMATION" prior to submission.
- (i.) The furnishing of detailed engineering data and drawings by the Bidder shall be in accordance with the time schedule for the project. The review of these documents/ data/ drawings by the Owner will cover only general conformance of the data/ drawings/ documents to the specifications and contract, interfaces with the equipment provided by others and external connections & dimensions which might affect plant layout. The review by the Owner should not be construed to be a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. The review and/ or approval by the Owner / Project Manager shall not relieve the Bidder of any of his responsibilities and liabilities under this contract.
- (j.) After the approval of the drawings, further work by the Bidder shall be in strict accordance with these approved drawings and no deviation shall be permitted without the written approval of the Owner.
- (k.) All manufacturing, fabrication and execution of work in connection with the equipment / system, prior to the approval of the drawings, shall be at the Bidder's risk. The Bidder is expected not to make any changes in the design of the equipment /system, once they are approved by the Owner. However, if some changes are necessitated in the design of the equipment/system at a later date, the Bidder may do so, but such

changes shall promptly be brought to the notice of the Owner indicating the reasons for the change and get the revised drawing approved again in strict conformance to the provisions of the Technical Specification.

- (l.) Drawings shall include all installations and detailed piping layout drawings. Layout drawings for all piping of 65 mm and larger diameter shall be submitted for review/ approval of Owner prior to erection. Small diameter pipes shall however be routed as per site conditions in consultation with site authority/representative of Owner based on requirements of such piping indicated in approved / finalized Flow Scheme / Process & Instrumentation Diagrams and/or the requirements cropping up for draining & venting of larger diameter piping or otherwise after their erection as per actual physical condition for the entire scope of work of this package.
- (m.) Assessing & anticipating the requirement and supply of all piping and equipment shall be done by the Bidder well in advance so as not to hinder the progress of piping & equipment erection, subsequent system charging and its effective draining & venting arrangement as per site suitability.
- (n.) As Built Drawings

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

- (o.) Drawings must be checked by the Bidder in terms of its completeness, data adequacy and relevance with respect to Engineering schedule prior to submission to the Owner. In case drawings are found to be submitted without proper endorsement for checking by the Bidder, the same shall not be reviewed and returned to the Bidder for re-submission. The Bidder shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data/drawings at site which are needed as an input to the engineering. The Bidder shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Owner’s scope and submit all necessary drawings/ documents for the same.
- (p.) The Bidder shall submit adequate prints of drawing/data/document for Owner’s review and approval. The Owner shall review the drawings and return one (1) copy to the Bidder authorizing either to proceed with manufacture or fabrication, or marked to show changes desired. When changes are required, drawings shall be re-submitted promptly, with revisions clearly marked, for final review. Any delays arising out of the failure of the Bidder to submit/rectify and resubmit in time shall not be accepted as a reason for delay in the contract schedule.

- (q.) All engineering data submitted by the Bidder after final process including review and approval by the Owner shall form part of the contract documents and the entire works covered under these specification shall be performed in strict conformity with technical specifications unless otherwise expressly requested by the Owner in writing.

8.04.00 **Engineering Information Submission Schedule**

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

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

The Engineering Information Schedule shall be updated monthwise.

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

8.05.00 **Engineering Progress and Exception Report**

8.05.01 Report giving the status of each engineering information including

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

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

8.06.00 **Co-Ordination Meetings**

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

- fully co-operate with such persons and agencies involved during the discussions.
- 8.06.02 The Bidder should note that Time is the essence of the contract. In order to expedite the early completion of engineering activities, the Bidder shall submit all drawings as per the agreed Engineering Information Submission Schedule. The drawings submitted by the Bidder will be reviewed by the Owner as far as practicable within three (3) weeks from the date of receipt of the drawing. The comments of the Owner shall then be discussed across the table during the above co-ordination Meetings wherein best efforts shall be made by both sides to ensure the approval of the drawing.
- 8.06.03 The Bidder shall ensure availability of the concerned experts / consultants/ personnel who are empowered to take necessary decisions during these meetings. The Bidder shall be equipped with necessary tools and facilities so that the drawings/documents can be resubmitted after incorporating necessary changes and approved during the meeting itself.
- 8.06.04 Should any drawing remain unapproved for more than six (6) weeks after it's first submission, this shall be brought out in the monthly Engineering Progress and Exception Report with reasons thereof.
- 8.06.05 Any delays arising out of failure by the Bidder to incorporate Owner's comments and resubmit the same during the TCM shall be considered as a default and in no case shall entitle the Bidder to alter the Contract completion date.
- 8.07.00 **Design Improvements**
- The Owner or the Bidder may propose changes in the specification of the equipment or quality thereof and if the parties agree upon any such changes the specification shall be modified accordingly.
- If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any changing the price and/or schedule of completion before the Bidder proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.
- 8.08.00 **Equipment Bases**
- A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base, unless otherwise specifically agreed to by the Owner. Each base plate which support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.
- 8.09.00 **Protective Guards**
- Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards shall be designed for easy installation and removal for maintenance purpose.

- 8.10.00 **Lubricants, Servo Fluids and Chemicals**
- 8.10.01 The Bidder's scope includes all the first fill and one year's topping, requirements of consumables such as oils, lubricants including grease, servo fluids, gases and essential chemicals etc. Consumption of all these consumables during the initial operation and final filling after the initial operation shall also be included in the scope of the Bidder. Bidder shall also supply a quantity not less than 10% of the full charge of each variety of lubricants, servo fluids, gases, chemicals etc. used which is expected to be utilised during the first year of operation. This additional quantity shall be supplied in separate Containers.
- 8.10.02 As far as possible lubricants marketed by the Indian Oil Corporation shall be used. The variety of lubricants shall be kept to a minimum possible.
- Detailed specifications for the lubricating oil, grease, gases, servo fluids, control fluids, chemicals etc. required for the complete plant covered herein shall be furnished. On completion of erection, a complete list of bearings/ equipment giving their location and identification marks shall be furnished to the Owner along with lubrication requirements.
- 8.11.00 **Lubrication**
- 8.11.01 Equipment shall be lubricated by systems designed for continuous operation. Lubricant level indicators shall be furnished and marked to indicate proper levels under both standstill and operating conditions.
- 8.12.00 **Material of Construction**
- 8.12.01 All materials used for the construction of the equipment shall be new and shall be in accordance with the requirements of this specification. Materials utilized for various components shall be those which have established themselves for use in such applications.
- 8.13.00 **Rating Plates, Name Plates & Labels**
- 8.13.01 Each main and auxiliary item of plant including instruments shall have permanently attached to it in a conspicuous position, a rating plate of non-corrosive material upon which shall be engraved manufacturer's name, equipment, type or serial number together with details of the ratings, service conditions under which the item of plant in question has been designed to operate, and such diagram plates as may be required by the Owner.
- 8.13.02 Each item of plant shall be provided with nameplate or label designating the service of the particular equipment. The inscriptions shall be approved by the Owner or as detailed in appropriate section of the technical specifications.
- 8.13.03 Such nameplates or labels shall be of white non-hygroscopic material with engraved black lettering or alternately, in the case of indoor circuit breakers, starters, etc. of transparent plastic material with suitably coloured lettering

engraved on the back. The name plates shall be suitably fixed on both front and rear sides.

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

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

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

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

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

8.13.08 All such plates, instruction plates, etc. shall be bilingual with Hindi inscription first, followed by English. Alternatively, two separate plates one with Hindi and the other with English inscriptions may be provided.

8.13.09 All segregated phases of conductors or bus ducts, indoor or outdoor, shall be provided with coloured phase plates to clearly identify the phase of the system

8.14.00 **Tools and Tackles**

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

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

8.15.00 **Welding**

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

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

8.16.01 All equipment/ piping/ pipe services are to be painted by the Bidder in accordance with Owner's standard colour coding scheme, which will be furnished to the Bidder during detailed engineering stage.

8.17.00 **Protection and Preservative Shop Coating**

8.17.01 **Protection**

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either metallic or a nonmetallic protection device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather, should also be properly treated and protected in a suitable manner. All primers/paints/coatings shall take into account the hot humid, corrosive & alkaline, subsoil or overground environment as the case may be.

8.17.02 **Preservative Shop Coating**

All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. All surfaces which will not be easily accessible after the shop assembly, shall be treated beforehand and protected for the life of the equipment. All surfaces shall be thoroughly cleaned of all mill scales, oxides and other coatings and prepared in the shop. The surfaces that are to be finish-painted after installation or require corrosion protection until installation, shall be shop painted with atleast two coats of primer.

Transformers and other electrical equipment if included shall be shop finished with one or more coats of primer and two coats of high grade epoxy. The finished colors shall be as per manufacturer's standards, to be selected and specified by the Owner at a later date.

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

9.00.00 QUALITY ASSURANCE PROGRAMME

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

- (a.) His organization structure for the management and implementation of the proposed quality assurance programme
- (b.) Quality System Manual
- (c.) Design Control System
- (d.) Documentation and Data Control System
- (e.) Qualification data for bidder's key personnel.
- (f.) The procedure for purchase of materials, parts, components and selection of sub-Bidder's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.
- (g.) System for shop manufacturing and site erection controls including process, fabrication and assembly.
- (h.) Control of non-conforming items and system for corrective actions and resolution of deviations.
- (i.) Inspection and test procedure both for manufacture and field activities.

- (j.) Control of calibration and testing of measuring testing equipment.
- (k.) System for Quality Audits.
- (l.) System for identification and appraisal of inspection status.
- (m.) System for authorising release of manufactured product to the Owner.
- (n.) System for handling, storage and delivery.
- (o.) System for maintenance of records, and
- (p.) Quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component.

9.02.00 General Requirements - Quality Assurance

- 9.02.01 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the Bidder for some of the major items is given in the respective technical specification. This is, however, not intended to form a comprehensive programme as it is the Bidder's responsibility to draw up and implement such programme duly approved by the Owner. The detailed Quality Plans for manufacturing and field activities shall be drawn up by the Bidder and will be submitted to Owner for approval. Schedule of finalisation of such quality plans will be finalised before award. Monthly progress reports on MQP/FQP submission/approval shall be furnished.
- 9.02.02 Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Bidder's/ Sub-Bidder's/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media e.g. Compact Disc or E-mail in addition to hard copy, for review and approval. After approval the same shall be submitted in compiled form on CD-ROM.
- 9.02.03 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Bidder's "Site Quality Control Organisation", during various stages of site activities starting from receipt of materials/equipment at site.
- 9.02.04 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference

documents/standards etc. will be subject to Owner's approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved Quality Plans, Owner shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Owner's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Owner in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Owner along with technical justification for approval and dispositioning.

- 9.02.05 No material shall be despatched from the manufacturer's works before the same is accepted, subsequent to predespatch final inspection including verification of records of all previous tests/inspections by Owner's Project Manager/Authorised representative and duly authorised for despatch by issuance of Material Despatch Clearance Certificate (MDCC).
- 9.02.06 All material used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties; chemical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details.
- 9.02.07 The Bidder shall submit to the Owner Field Welding Schedule for field welding activities in the enclosed format No.: QS-01-QAI-P-02/F3. The field welding schedule shall be submitted to the Owner along with all supporting documents, like welding procedures, heat treatment procedures, NDT procedures etc. at least ninety days before schedule start of erection work at site.
- 9.02.08 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the Owner.
- All welding/brazing procedures shall be submitted to the Owner or its authorised representative for approval prior to carrying out the welding/brazing.
- 9.02.09 All brazers, welders and welding operators employed on any part of the contract either in Bidder's/sub-Bidder's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Owner.
- 9.02.10 Welding procedure qualification & Welder qualification test results shall be furnished to the Owner for approval. However, where required by the Owner, tests shall be conducted in presence of Owner/authorised representative.
- 9.02.11 For all pressure parts and high pressure piping welding, the latest applicable requirements of the IBR (Indian Boiler Regulations) shall also be essentially complied with. Similarly, any other statutory requirements for the

equipment/systems shall also be complied with. On all back-gauged welds MPI/LPI shall be carried before seal welding.

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

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

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

9.02.15 All non-destructive examination shall be performed in accordance with written procedures as per International Standards, The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination). NDT shall be recorded in a report, which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job.

All plates of thickness above 40mm & all bar stock/Forging above 40mm dia shall be ultrasonically tested. For pressure parts, plate of thickness equal to or above 25mm shall be ultrasonically tested.

9.02.16 The Bidder shall list out all major items/ equipment/ components to be manufactured in house as well as procured from sub-contractors bought out items (BOI). All the sub-Bidder proposed by the Bidder for procurement of major bought out items including castings, forging, semi-finished and finished components/equipment etc., list of which shall be drawn up by the Bidder and finalised with the Owner, shall be subject to Owner's approval. The Bidder's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified sub-contractors enclosed and shall be submitted to the Owner for approval within the period agreed at the time of pre-awards discussion and identified in review category prior to any procurement. Monthly progress reports on sub-Bidder detail submission / approval shall be furnished. Such vendor approval shall not relieve the Bidder from any obligation, duty or responsibility under the contract.

9.02.17 For components/equipment procured by the contractors for the purpose of the contract, after obtaining the written approval of the Owner, the Bidder's purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the sub-Bidder shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the vendor's quality control organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc. Such quality plans of the successful vendors shall be finalised with the Owner and such approved Quality Plans shall form a part of the purchase order/contract between the Bidder and sub-Bidder. 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.

9.02.18 Owner reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Bidder's or their sub-Bidder's quality management and control activities. The Bidder shall provide all necessary assistance to enable the Owner carry out such audit and surveillance.

9.02.19 The Bidder shall carry out an inspection and testing programme during manufacture in his work and that of his sub-Bidder's and at site to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identity and acceptability of all materials parts and equipment. Bidder shall carry out all tests/inspection required to establish that the items/equipment conform to requirements of the specification and the relevant codes/standards specified in the specification, in addition to carrying out tests as per the approved quality plan.

9.02.20 Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Owner to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the Bidder in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.

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

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

9.02.23 Burn in and Elevated Temperature Test Requirement for Electronics Solid State Equipment

All solid state electronic systems/equipment shall be tested as a complete system/equipment with all devices connected for a minimum of 168 hours (7 Days) continuously under energized conditions prior to shipment from manufacturing works, as per the following cycle.

Elevated Temperature Test Cycle

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

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

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

Burn in Test Cycle

The 48 hours elevated temperature test shall be followed by 120 hours of burn in test as above except that the temperature shall be reduced to the ambient temperature prevalent at that time.

During the above tests, the process I/O and other load on the system shall be simulated by simulated inputs and in the case of control systems, the process which is to be controlled shall also be simulated. Testing of individual components or modules shall not be acceptable.

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

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

9.03.00 QA Documentation Package

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

9.03.01 Each QA Documentation shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document.

The QA Documentation file shall be progressively completed by the Supplier's sub- supplier to allow regular reviews by all parties during the manufacturing.

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

9.03.02 Typical contents of QA Documentation is as below:-

- (a.) Quality Plan
- (b.) Material mill test reports on components as specified by the specification and approved Quality Plans.

- (c.) Manufacturer / works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.
- (d.) Non-destructive examination results /reports including radiography interpretation reports. Sketches/drawings used for indicating the method of traceability of the radiographs to the location on the equipment.
- (e.) Heat Treatment Certificate/Record (Time- temperature Chart)
- (f.) All the accepted Non-conformance Reports (Major/Minor) / deviation, including complete technical details / repair procedure).
- (g.) CHP / Inspection reports duly signed by the Inspector of the Owner and Bidder for the agreed Customer Hold Points.
- (h.) Certificate of Conformance (COC) wherever applicable.
- (i.) MDCC

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

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

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

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

9.03.05 Transmission Of QA Documentation

On release of QA Documentation by Inspector, one set of quality document shall be forwarded to Corporate Quality Assurance Department and other set to respective Project Site of Owner.

For the particular case of phased deliveries, the complete quality document to the Owner shall be issued not later than 3 weeks after the date of the last delivery of equipment.

9.04.00 Project Manager's Supervision

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

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

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

9.05.00 Inspection, Testing And Inspection Certificates

9.05.01 The word 'Inspector' shall mean the Project Manager and/or his authorized representative and/or an outside inspection agency acting on behalf of the

Owner to inspect and examine the materials and workmanship of the works during its manufacture or erection.

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

- 9.05.07 The inspection by Project Manager / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Bidder in respect of the agreed Quality Assurance Programme forming a part of the contract.
- 9.05.08 To facilitate advance planning of inspection in addition to giving inspection notice as specified at clause no 9.05.03- of this chapter, the Bidder shall furnish quarterly inspection programme indicating schedule dates of inspection at Customer Hold Point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.
- 9.05.09 All inspection, measuring and test equipment used by Bidder shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Bidder shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by the Owner. Wherever asked specifically, the Bidder shall re-calibrate the measuring/test equipment in the presence of Project Manager/Inspector.
- 9.06.00 **Associated document for quality assurance programme:**
- 9.06.01 List of items requiring quality plan and sub supplier approval. (Annexure-III).
- 9.06.02 Status of items requiring Quality Plan and sub supplier approval. (Annexure-IV).
- 9.06.03 Field Welding Schedule (Annexure-V).
- 9.06.04 Manufacturing Quality Plan (Annexure-VI).
- 9.06.05 Field Quality Plan (Annexure-VII).
- 10.00.00 PRE-COMMISSIONING AND COMMISSIONING FACILITIES**
- (a.) As soon as the facilities or part thereof has been completed operationally and structurally and before start-up, each item of the equipment and systems forming part of facilities shall be thoroughly cleaned and then inspected jointly by the Owner and the Bidder for correctness of and completeness of facility or part thereof and acceptability for initial pre-commissioning tests, commissioning and start-up at Site. The list of pre-commissioning tests to be performed shall be as mutually agreed and included in the Bidder's quality assurance programme as well as those included elsewhere in the Technical Specifications.
- (b.) The Bidder's pre-commissioning/ commissioning/start-up engineers, specially identified as far as possible, shall be responsible for carrying out all the pre-commissioning tests at Site. On completion of inspection, checking and after the pre-commissioning tests are satisfactorily over, the commissioning of the complete facilities shall

be commenced during which period the complete facilities, equipment shall be operated integral with sub-systems and supporting equipment as a complete plant.

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

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

- (3.) Expected duration of posting of the above Commissioning Engineers at site.

10.02.00

Initial Operation

- a) On completion of all pre-commissioning activities / tests and as a part of commissioning the complete facilities shall be put on 'Initial Operation' during which period all necessary adjustments shall be made while operating over the full load range enabling the facilities to be made ready for the Guarantee Tests.
- b) The 'Initial Operation' of the complete facility as an integral unit shall be conducted for 720 continuous hours. During the period of initial operation of 720 hours, the unit shall operate continuously at full rated load for a period not less than 72 hours.
- c) The Initial Operation shall be considered successful, provided that each item/ part of the facility can operate continuously at the specified operating characteristics, for the period of Initial Operation with all operating parameters within the specified limits and at or near the predicted 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.

10.03.00

Guarantee Tests

- a) The final test as to prove the Functional Guarantees shall be conducted at Site by the Bidder in presence of the Owner. The Bidder's Commissioning, Start-up Purchaser shall make the unit ready to conduct such test. Such test will be commenced and completed as per schedule indicated in Vol I GCC
- b) These tests shall be binding on both the parties of the Contract to determine compliance of the equipment with the functional guarantee.

- c) For performance/ demonstration tests instrumentations, of accuracy class, to the approval of the Owner shall be used. The numbers and location of the instruments shall be as per the specified test codes. In addition the values of parameters shall be logged from the information system provided under Owner's Distributed Digital Control Monitoring and Information system. Test will be conducted at specified load points.
- d) Any special equipment, tools and tackles required for the successful completion of the Guarantee Tests shall be provided by the Bidder, free of cost.
- e) The Guarantee tests and specific tests to be conducted on equipment have been brought out in detail elsewhere in the specification.

11.00.00 TAKING OVER

Upon successful completion of Initial Operations and all the tests other than guarantee tests conducted to the Owner's satisfaction, the Owner shall issue to the Bidder a Taking over Certificate as a proof of the final acceptance of the equipment. Such certificate shall not unreasonably be 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.

12.00.00 TRAINING OF OWNER'S PERSONNEL

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

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

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

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

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

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

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

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

12.05.00 Exact details, extent of training and the training schedule shall be finalised based on the Bidder's proposal within two (2) months from placement of award.

12.06.00 In all the above cases, wherever the training of Owner's personnel is arranged at the works of the manufacturer's it shall be noted that the lodging and boarding of the Owner's personnel shall be at the cost of Bidder. The Bidder shall make all necessary arrangements towards the same.

12.07.00 Take off prices (product wise) should be indicated by the Bidder in the Bid Proposal Sheets. Owner reserves the right to include or exclude these item(s) during place of Award. All expenses except travelling expenses shall be borne by the contractor.

13.00.00 SAFETY ASPECTS DURING CONSTRUCTION AND ERECTION

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

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

14.00.00 NOISE LEVEL

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

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

15.00.00 PACKAGING AND TRANSPORTATION

All the equipment & spares shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. Each spare shall be clearly marked or labeled on the outside of the packing with its description. When more than one spare part is packaged in a single case, a general description of the contents shall be shown on the outside of such a case and other packages must be suitably marked and numbered for the purpose of identification. All cases, containers or packages, are liable to be opened for such examination as may be considered reasonable by the Engineer. In case of equipment supplied with grease/lubricants from imported origin, the supplied shall clearly indicate the indigenous equivalent of the grease/lubricant and source of supply so as to enable the Owner to procure these items from indigenous sources. While packing all the materials, the limitation from the point of view of the sizes of railway wagons available in India should be taken account of. The Bidder shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The Bidder shall ascertain the availability of Railway wagon sizes from the Indian Railways or any other agency concerned in India well before effecting dispatch of equipment. Before dispatch it shall be ensured that complete processing and manufacturing of the components is carried out at shop, only restricted by transport limitation, in order to ensure that site works like grinding, welding, cutting & pre-assembly to bare minimum. The Owner's Inspector shall have right to insist for completion of works in shops before dispatch of materials for transportation.

16.00.00 ELECTRICAL ENCLOSURE

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

17.00.00 INSTRUMENTATION AND CONTROL

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

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

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

a)	Temperature	-	Degree centigrade (deg C)
b)	Pressure	-	Kilograms per square centimeter (Kg/cm ²). Pressure instrument shall have the unit suffixed with 'a' to indicate absolute pressure. If nothing is there, that will mean that the indicated pressure is gauge pressure.
c)	Draught	-	Millimeters of water column (mm wc).
d)	Vacuum	-	Millimeters of mercury column (mm Hg) or water column (mm Wcl).
e)	Flow (Gas)	-	Tonnes/ hour
f)	Flow (Steam)	-	Tonnes/ hour
g)	Flow (Liquid)	-	Tonnes / hour
h)	Flow base	-	760 mm Hg. 15 deg.C
i)	Density		Grams per cubic centimeter.

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

17.03.00 All electronic modules shall have gold plated connector fingers and further all input and output modules shall be short circuit proof. These shall also be tropicalized & components shall be of industrial grade or better.

18.00.00 ELECTRICAL NOISE CONTROL

The equipment furnished by the Bidder shall incorporate necessary techniques to eliminate measurement and control problems caused by electrical noise. Areas in Bidder's equipment, which are vulnerable to electrical noise shall be hardened to eliminate possible problems. Any additional equipment, services required for effectively eliminating the noise problems shall be included in the proposal. The equipment shall be protected against ESD as per IEC-801- 2. Radio Frequency interference (RFI) and Electro Magnetic Interference (EMI) protection against hardware damage and control system mal-operations/errors shall be provided for all systems.

19.00.00 INSTRUMENT AIR SYSTEM

The instrument air supply system as supplied by the Bidder for various pneumatic control & instrumentation devices like pneumatic actuators, power cylinders, E/P converters, piping / tubing etc. shall be as per the details furnished elsewhere.

Each pneumatic instrument shall have an individual air shut - off valve. The pressure-regulating valve shall be equipped with an internal filter, a 50 mm pressure gauge and a built-in filter housing blow down valve.

20.00.00 TAPPING POINTS FOR MEASUREMENTS

Tapping points shall include probes, wherever applicable, for analytical measurements and sampling.

For direct temperature measurement of all working media, one stub with internal threading of approved pattern shall be provided along with suitable plug and washer. The Bidder will be intimated about thread standard to be adopted.

The following shall be provided on equipment by the Bidder. The standard which is to be adopted, will be intimated to the Bidder.

- (a.) Temperature test pockets with stub and thermowell
- (b.) Pressure test pockets

21.00.00 ELECTRONIC MODULE/COMPONENT DETAILS

The Bidder shall have to furnish all technical details including circuit diagrams, specifications of components, etc., in respect of each and every electronic card/module as employed on the various solid state as well as microprocessor based systems and equipment including conventional instruments, peripherals etc.

It is mandatory for the Bidder to identify clearly the custom built ICs used in the package. The Bidder shall also furnish the details of any equivalents of the same.

22.00.00 ENVIRONMENTAL MONITORING & CONTROL MEASURES

Bidder to note that MOEF has declared Manali area as critically polluted area and also imposed certain restrictions on consideration of developmental projects.

Concerned authorities have been addressed to have self monitoring system (for Air, Water & Land) so as to ascertain the level of compliance of standards prescribed by MOEF and also to furnish the action plan ie., for the establishment of self monitoring system. It is also directed to undertake Environmental Audit (EA) to ascertain the compliance level of standards notified by MOEF.

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

Environmental Clearance:

The environmental appraisal minutes are indicated below.

“Expert Appraisal Committee/MoEF has considered the project on 25th June 2012 and recommended issue of EC subject to TANGEDCO furnishing the cumulative impact on air, water and soil considering the Industries located 15km radius from the Ennore SEZ Project Site. The same is being furnished. Copy of Minutes of EAC is enclosed. Final Environmental Clearance yet to be received. For Compliance of conditions stipulated by TNPCB under section 21 of the Air (Prevention and control of Pollution) Act 1981 as amended in 1987, the following are included in the specification:

- a) RCC chimney with designed height of 275mtrs included in the specification.
- b) High efficiency ESPs (99.9% efficiency) have been proposed to ensure emission of particulate matter within 50 mg/Nm³.
- c) Bag filters have been proposed for the coal crushers to collect suspended particulate emission.
- d) Dust suppression system has been proposed for the coal yard.
- e) Equipment for continuous monitoring of Ambient Air Quality has been proposed.
- f) On line / automatic continuous stack monitor has been proposed.
- g) Port holes in the chimney and sampling facilities for the stack for the proposed Boiler, as per the Central Pollution Control Board guide lines.
- h) The unit shall have suitable sufficient acoustic measures for Generator, Turbine, Coal crusher and other sources including special anti vibration Foundation for which all the heavy rotating equipments / machines shall be erected over the Anti vibration foundations to reduce noise, vibration etc.,
- i) The unit shall have separate energy meter for the operation of the Electro Static Precipitator, the Air pollution control equipment for the proposed Boiler.

- j) Alternate power source will come into effect in case of power failure for the operation of Air Pollution Control measures
- k) laboratory for analysis of gaseous / particulate emissions
- l) The coal shall be stored in a completely paved area with the provisions for leach ate collection. The coal storage yard shall be provided with wind barriers of sufficient height. The height of the coal piles shall be lower than that of the wind barrier.
- m) The location of wind barriers shall be based on the predominant wind direction and shall be in consultation with TNPCB so as to avoid fugitive dust emission.
- n) Closed conveyors for coal transport and Bag filters in all the transfer points to control dust emission have been proposed
- o) Dust suppression system / water sprinklers to keep the stock pile sufficiently wet all the time to avoid carryover of dust.
- p) All the internal roads shall be well paved and be provided with water sprinkling arrangement to avoid fugitive dust emission during vehicle movement. The unit shall limit the speed of the vehicle to 10KM/hr. for heavy vehicles within the plant premises to prevent the road dust emission.
- q) Burners have been designed for low NOx.
- r) Space provision made for installation of FGD of requisite efficiency of removal of SO₂, if required at a later stage for which adequate space is provided near the chimney.
- s) The unit shall ensure that the velocity of the exit gas from the stack shall be greater than 25 m/sec and the ratio of the exit gas to wind velocity shall not be less than 1.5 to eliminate or reduce pollutant down wash.
- t) The unit shall have on line/automatic continuous stack monitors with computer recording arrangement for monitoring SPM, Sox and Nox in the boiler emission.
- u) Sewage Treatment Plant & Effluent Treatment Plant has been proposed.
- v) Natural draft cooling tower has been included in the specification.
- w) 100% Dry fly ash collection system and conventional wet bottom ash disposal is included. However ash water recovery system is included in this scope if ash slurry is disposed in the ash pond in emergencies.

- x) Ash slurry pipe lines and ash water recovery pipe lines of adequate capacity and strength are proposed to be provided. However these pipe lines will be used only during emergency, since 100% dry fly ash collection is proposed.

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

- Continuous Air quality monitoring stations
- Online monitoring system
- Effluent Treatment plant
- Sewage treatment plant
- Optimum use of land area
- 100% Ash collection & utilisation
- Green Belt Development.

ANNEXURE-I

S. NO.	DESCRIPTION OF MANUALS	NO OF PRINTS (sets)	NO. OF CD- ROMs (sets)
1.	PLANT DEFINITION MANUAL-	-	3 CD-ROMs
2.	Drawings "FOR APPROVAL"	10	Soft Copy
3.	Drawings "FOR INFORMATION"	10	Soft Copy
4.	Drawings "FINAL APPROVED DRAWING"	8	Soft Copy
5.	Drawings "AS BUILT "	8	3 CD-ROMs
6	DATASHEETS,DESIGNCALCULATIONS,PURCHASE SPECIFICATIONS, etc. and Other type of documents		
	i) For Approval	10	SOFT COPY
	ii) FINAL	8	3 CD-ROMs -
	iii) Analysis reports of equipment/ piping/ structures components/ systems employing software packages as detailed in the specifications		
	a) Input	10	SOFT COPY
	b) Output	10	SOFT COPY
	c) Drawings/ Sketches	10	SOFT COPY
7	Erection manual "FINAL"	8	3CD ROMS
8	Operation & Maintenance manual	10	3CD ROMS
9	Plant Hand Book "DRAFT"	6	SOFT COPY
10	Plant Hand Book "FINAL"	15	3CD ROMS
11	Commissioning and Performance Procedure manual	10	3CD ROMS
12	Performance and Functional Guarantees test report	6	3CD ROMS
13	Progress Reports	6	3CD ROMS
14	Project completion report	10	3CD ROMS
15	QA programme including	1	

S. NO.	DESCRIPTION OF MANUALS	NO OF PRINTS (sets)	NO. OF CD- ROMs (sets)
	Organization for implementation and QA system manual (with revision-servicing)		
16	Vendor details in respect of proposed vendors including Bidder's evaluation report.	1	
17	Manufacturing QPs, Field QPs, Field welding schedules and their reference documents like test procedures, WPS, POR etc.		
	(i) For review/comment	3	
	(ii) For final approval	4	1 set CD ROMS
18	Welding Manual, Heat Treatment Manuals, Storage & preservation manuals	4	
	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

ANNEXURE-II

(Total within 52 man months)

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit Manufacturer's Work	Operation & Maintenance Of Plant
STEAM GENERATOR	Thermal design and hydraulic circulation balance	Familiarization with various system and equipment	Manufacturing processes of pressure parts, and equipment	Control philosophy operation, notices, logic & protection schemes, O&M manual familiarization O&M issues
	Combustion and Air & gas weight calculation	Performance data collection analysis and review	Welding process	
	Pressure part calculation	O&M feed back	Testing facilities	Familiarization of special maintenance techniques.
	Pressure part and strength calculation	Operation history of various equipment and system	Product development in process	Special tool and tackles familiarization
	Tube metal temp. calculation and selection.	Failure analysis	Future plan for technology induction	
	Performance calculation Duct design. Pressure part		R&D work inprogress	

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
	Equipment and system sizing and selection of mills, fans, airpreheater, soot blowers, dampers, valves heater, soot blowers, dampers, valves, feeders, burners startup system, fuel firing system, draft plant Flow scheme develop- ment of air & flue gas, fuel oil, auxiliary steam, main and reheat steam feed water.			
	Layout of over all plant, steam generator area, pressure part arrangements, platforms, equipment, piping and duct, coal pipe, flue gas ducts, bunker arrangement, valves and damper, ESP area, cable & piping tressels etc.			
	Erection strategies, 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.			

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit Manufacturer's Work	Operation & Maintenance Of Plant
	Hands on experience on the development of detailed/realistic CFD models for the steam generator and ESP. The Bidder/trainer shall develop CFD models for SG & ESPas per the Contract requirement with complete association of the Owner's engineers.			
	Validation of the above CFD model for SG & ESPby Bidder in association with the Owner's Engineers.			
MANDAYS	120 for SG and 60 for ESP	-	-	-

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