

**TAMILNADU GENERATION AND DISTRIBUTION
CORPORATION LIMITED (TANGEDCO)**

**2X660 MW ENNORE SEZ
SUPERCRITICAL THERMAL POWER PROJECT**

**TECHNICAL SPECIFICATION
FOR
PRE-TREATMENT PLANT**

SPECIFICATION NO.: PE-TS-412-158-A001



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



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

REV 00

SHEET

SECTION	DESCRIPTION	PAGE NO.
SECTION – A	PROJECT INFORMATION	1-10
SECTION – I	SPECIFIC TECHNICAL REQUIREMENTS	11
SECTION – IA	SPECIFIC TECHNICAL REQUIREMENTS (MECHANICAL) ➤ ANNEXURE I : QUALITY PLAN ➤ ANNEXURE II : SUB VENDORS LIST ➤ ANNEXURE III : FUNCTIONAL GUARANTEES AND LIQUIDATED DAMAGES ➤ ANNEXURE IV : DRAWING DOCUMENTS DISTRIBUTION PROCEDURE ➤ ANNEXURE V : PAINTING SPECIFICATION ➤ ANNEXURE VI : MANDATORY SPARES LIST ➤ ANNEXURE VII : DRAWING/DOCUMENTS SUBMISSION SCHEDULE ➤ ANNEXURE VIII : WATER ANALYSIS ➤ ANNEXURE IX: LIST OF TOOLS & TACKLES (AS APPLICABLE) ➤ ANNEXURE X: FORMAT FOR OPERATION AND MAINTENANCE MANUAL ➤ ANNEXURE XI : SITE STORAGE AND PRESERVATION ➤ DATASHEET FOR PRETREATMENT PLANT ➤ P&ID FOR PRETREATMENT PLANT ➤ GA DRAWING OF CLARIFIED WATER STORAGE TANK	12-171
SECTION – IB	SPECIFIC TECHNICAL REQUIREMENTS (ELECTRICAL) ➤ ELECTRICAL EQUIPMENT SPECIFICATION ➤ ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (PT Plant) ➤ ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (ELECTRIC HOIST) ➤ ELECTRICAL LOAD DATA FORMAT ➤ CABLE SCHEDULE FORMAT	172-178
SECTION – IC	SPECIFIC TECHNICAL REQUIREMENTS (CONTROL & INSTRUMENTATION)	179-186
SECTION – II	GENERAL TECHNICAL REQUIREMENT	187
SECTION – IIA	GENERAL TECHNICAL REQUIREMENT (MECHANICAL)	188-298
SECTION – IIB	GENERAL TECHNICAL REQUIREMENT (ELECTRICAL)	299-514
SECTION – IIC	GENERAL TECHNICAL REQUIREMENT (CONTROL AND INSTRUMENTATION)	515-525
SECTION – IID	GENERAL TECHNICAL REQUIREMENT (CIVIL)	526-874
SECTION - III	➤ SCHEDULE OF PRE BID CLARIFICATIONS ➤ COMPLIANCE CUM CONFIRMATION SCHEDULE ➤ SCHEDULE OF DECLARATION ➤ GUARANTEED AUXILIARY POWER CONSUMPTION ➤ SCHEDULE OF DEVIATIONS	875-880



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PE-TS-412-158-A001

SECTION-A

REV 00

**SECTION – A
PROJECT INFORMATION**

CHAPTER 1

PROJECT SYNOPSIS

1.0 GENERAL BACKGROUND AND SALIENT FEATURES

1.1 Introduction

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

1.2 Location

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

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

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

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

1.3 Type of Plant

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

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

1.4 PROJECT INFORMATION

Project Title : **2 x 660 MW Ennore SEZ Coal Based Supercritical Thermal Power Project at Ash Dyke of NCTPS**

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

LOCATION

The site is located near Vayalur Village, Ennore

Latitude : 13⁰17' N to 13⁰18' N

Longitude : 80⁰18' E to 80⁰19' 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

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	} Refer details in the specification elsewhere.
	a.	Crops	
	b.	Forest	
	c.	Grass land	
	d.	Endangered species	
	e.	Others (Specify)	
2.6.2		Give details of the following features, if they exist, within a radius of 25 km of the proposed site?	
	i.	Fisheries	:
	ii.	Sanctuary / natural park biosphere reserve	:
	iii.	Lakes / ponds / reservoir	:
	iv.	Stream / river	: Buckingham canal is close to the site
	v.	Estuary / sea	: Bay of Bengal is 5 km from site

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

2.7 Human settlement :

2.7.1 Total number of persons :
proposed to be employed

i. During construction : 2500

450(0.75person/MW) TANGEDCO

ii. During operation : direct employees

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SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

SECTION - IA
SPECIFIC TECHNICAL REQUIREMENTS (MECHANICAL)



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SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

1.0 SCOPE:**1.1 PRE TREATMENT PLANT (PT PLANT)**

The intent of this specification is to cover design (excluding civil design of chemical house building/shed.), engineering, manufacture, supply, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance / special tools & tackles, mandatory spares along with spares for erection as required, start up and commissioning spares as required, forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation & storage at site, in site transportation, assembly, erection & commissioning including supervision of civil works of clarifiers, trial run at site, preparation and submission of drawing /documents including "As Built" drawings and carrying out performance guarantee/Functional/Demonstration tests at site (As applicable) & equipment/system guarantee etc. inclusive of all prevailing taxes, duties and other levies and handover in flawless condition to end customer complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification no. **PE-TS-412-158-A001** for **2X660 MW ENNORE SEZ STPP Pre-Treatment Plant**. The scope of supply shall fully cover the requirement of the Design Criteria and Technical specification of this specification.

The bidder's scope shall also include any other services, etc. if called for in the succeeding sections of the specification.

BROAD SCOPE OF SUPPLY**(REFER FLOW DIAGRAM FOR PRETREATMENT PLANT)**

Broad scope of supply (Mechanical) for this package is detailed below and as indicated in relevant portion of this specification. Please refer Electrical, C&I & civil specifications also for respective scope and design guidelines for Electrical, C&I & civil items.

- i. Entire Pre-treatment plant as per P&ID (PE-DG-412-158-A001 REV 0- P & ID FOR PRE TREATMENT PLANT), Data Sheet-A and technical specification requirements.
- ii. Raw water inlet piping to aerator complete with piping, fitting and valves. The inlet piping is to include two number motorized butterfly type control valves with necessary manual isolation/control valve and necessary instrumentation.
- iii. Piping along with valves from raw water supply pumps to aerator as per flow diagram enclosed for pre-treatment plant.
 - i. Mechanical, Electrical, Instrumentation etc. as required for one no (1). Aerator of RCC construction as per P & ID enclosed for pre-treatment plant with accessories as required.
 - ii. Mechanical, Electrical, Instrumentation etc. as required for one no (1). Stilling chamber as per P & ID enclosed for pre-treatment plant with accessories as required.
 - iii. Mechanical, Electrical, Instrumentation etc. as required for one no (1). Parshall flume as per P & ID enclosed for pre-treatment plant with accessories as required.
 - iv. Mechanical, Electrical, Instrumentation etc. as required for one no (1). Flash Mixer with motorized stirrer as per P & ID enclosed for pre-treatment plant with accessories as required.
 - v. Mechanical, Electrical, Instrumentation etc. as required for two (2) nos. 2X50 % calrifloculators with sampling points at different elevation of clarifiers as per P & ID enclosed for pre-treatment plant with accessories as required.
 - vi. Clarifier bridge (half bridge mechanism) assemblies with VFD drive, hand railings, required motors, valves, piping, instrumentation etc as per P & ID enclosed for pre-treatment plant.
 - vii. Sludge disposal system from clarifier with piping, valves and instrumentation up to sludge collection pit as per P & ID enclosed for pre-treatment plant with accessories as required.
 - viii. Mechanical, Electrical, Instrumentation etc. as required for one (1) no. RCC Sludge Pit (in twin section) interconnected through gate as per P & ID enclosed for pre-treatment plant with accessories as required.



TITLE

2X660 MW, ENNORE SEZ STPP
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PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

- ix. Three (3) nos. sludge transfer pump with electric motor drive, piping, valves, fittings and instrumentation upto guard pond. The distance between Guard pond and PT plant is 350m.
- x. Two nos. polyelectrolyte dosing tanks along with motorised stirrer, flushing arrangement, instrumentation, valves, fittings, ladders, platforms, lifting lugs and piping etc. as indicated in P & ID enclosed for Pre-treatment plant.
- xi. Two (2) nos. (1w+1s) polyelectrolyte dosing pumps with electric motor drive, piping, valves, fittings and instrumentation as indicated in P & ID enclosed for Pre-treatment plant
- xii. Three (3) nos. alum dosing tanks along with motorised stirrer, flushing arrangement, instrumentation, valves, fittings, ladders, platforms, lifting lugs and piping etc. as indicated in P & ID enclosed for Pre-treatment plant.
- xiii. Two (2) nos. (1w+1s) alum dosing pumps with electric motor drive, piping, valves, fittings and instrumentation as indicated in P & ID enclosed for Pre-treatment plant.
- xiv. Two nos. lime dosing tanks along with motorised stirrer, flushing arrangement, instrumentation, valves, fittings, ladders, platforms, lifting lugs and piping etc. as indicated in P & ID enclosed for Pre-treatment plant.
- xv. Two (2) nos. (1w+1s) lime dosing pumps with electric motor drive, piping, valves, fittings and instrumentation as indicated in P & ID enclosed for Pre-treatment plant.
- xvi. One no. Hypo dosing tank along with motorised stirrer, flushing arrangement, instrumentation, valves, fittings, ladders, platforms, lifting lugs and piping etc. as indicated in P & ID enclosed for Pre-treatment plant.
- xvii. Two (2) nos. (1w+1s) Hypo dosing pumps with electric motor drive, piping, valves, fittings and instrumentation as indicated in P & ID enclosed for Pre-treatment plant.
- xviii. Clarified water overhead storage tank (civil work by BHEL) with float type valve, overflow arrangement, level indicator, level transmitter etc.
- xix. Piping along with valves and fittings as required from clarified overhead tank to dosing systems as per P & ID enclosed for Pre-treatment plant.
- xx. All piping, valves, instruments as required for the system completion.
- xxi. All piping, valves, fitting, instruments indicated in P&ID shall be in bidder's scope unless otherwise exclusively excluded.
- xxii. All other things are also included in scope of supply as specified in other part of the specification including under design criteria and technical details.
- xxiii. Coating, rapping and protection of buried pipes will be in bidder's scope.
- xxiv. All pipes, fittings etc. required for hand railing, platforms, and ladders shall be in the scope of bidder of supply and erection of complete PT plant. Hand railing shall be provided by bidder wherever required for safety point.
- xxv. All insert plates, puddle pipes, nuts and bolts, counter flanges, grouting material wherever applicable shall be in the scope of bidder.
- xxvi. Embedment plates with lugs shall also be provided by bidder as per system requirement.
- xxvii. Edge angle required in a proper shape for edge protection in civil works will be provided by bidder.
- xxviii. All sluice gates shall be in the scope of bidder.
- xxix. The pipe sizes indicated in the tender specification/ flow Diagram are minimum. Wherever pipe sizes are not indicated, the same shall be selected based on the specification requirement and shall be subject to BHEL/ customer approval during detailing engineering. All pipes shall be carbon steel unless exclusively mentioned.
- xxx. Bidder to be note that the outlet suspended solid guarantee for PT clarifier shall be <10 ppm.
- xxxi. One set of (2 x 100% Capacity) centrifugal type blower with acoustic enclosures along with piping valves fitting and instrument as per flow diagram of PT Plant for clarifier sludge sump.
- xxxii. Pipe racks shall be provided by BHEL wherever available. However where pipe racks are not available the pipe shall run on pipe pedestals All auxiliary steel structures (U-clamps, nuts, bolts, channels etc.) for fixing the pipe on the pedestal or trestles shall be in the scope of bidder.
- xxxiii. All motorized valves shall be provided with integral starter.
- xxxiv. Bidder to note that 5 ppm continuous chlorine will be dosed by chlorination plant vendor in stilling chamber. Bidder to take care while selection of MOC due to effect of chlorine.



TITLE

**2X660 MW, ENNORE SEZ STPP
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PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

- xxxv. Initial charge of all lubricants & grease are in bidder's scope.
- xxxvi. Wherever terminal points between BHEL and bidder indicated, blank flanges/counter flanges, isolations valves, tees etc. to interconnect the pipes at all terminal points.
- xxxvii. Bidder to note that civil of Chemical House shall be done by BHEL. However, all the other necessary inputs for construction of foundations of equipment etc. shall be provided by the bidder.
- xxxviii. RCC pedestals design and construction for all piping of PT plant except chemical house shall be in bidder's scope.
- xxxix. One (1) number Electrically Operated Monorail Hoist of 1.0 Ton (minimum) safe working capacity and complete with all accessories for handling of Sludge Transfer Pumps within Sludge Sump cum Pump House.
- xl. Two (2) numbers Electrically Operated Monorail Hoists, each of 1.0 Ton safe working capacity and complete with all accessories for handling of chemicals at ground floor and first floor of Chemical House.
- xli. The chemical house shall be equipped with two weighing scales of platform & dial type suitable for chemicals being handled. Range of weighing scales shall be suitable for weighing 0-1000 Kg. Technical requirements of weighing scale shall be as specified in Datasheet – A.
- xl.ii. All handrails shall be of 32 mm nominal bore MS pipes (medium class) as per IS: 1161 galvanized using 750 gm/sq. m of zinc. Hand railing shall be a two-rail system with the top rail 1000 mm above the walkway surface and the intermediate rail 450 mm below the top rail. Handrail post spacing shall be limited to 1500 mm as far as possible but can be proportioned to the length of the opening. In such a case spacing shall not exceed 1850 mm centre to centre of posts. Hand railing shall be shop fabricated for specific locations and field welded or bolted to the erected structural steel. Railings shall be provided with 100 mm wide and 8 mm thick MS strip at bottom as toe guard all along the length of railing in horizontal plane. For RCC stairs, hand railing with 20 mm square MS bar balustrade with suitable MS flat and Aluminium / Teakwood handrail shall be provided, unless specifically mentioned otherwise. Hand rail supply shall and erection at site on structures is also in Bidder's scope.
- xl.iii. Finish paints for touch up painting of equipment after erection at site in sealed container. Bidder shall also provide one final coat additionally of same DFT as specified in tender specification at site after completion of erection of each equipment / item.
- xl. iv. Monitoring gadgets, instruments and equipment required for commissioning & maintenance (till PG test and plant handover).
- xl. v. Instrument hook up material shall be in bidder's scope.
- xl. vi. Wrapping, coating and protection of the entire buried pipe shall be as per IS 10221 or AWWA C 203-93.
- xl. vii. Hydraulics of the Complete Pre-treatment Plant shall be designed to take an occasional over loading of 20% over the design flow.
- xl. viii. One set of all special tools & tackles of reputed make necessary for proper maintenance or adjustment of the equipment being supplied by the bidder, packed in permanent box.
- xl. ix. Bidder to note that the equipment, valves, instruments indicated in the P&ID (PE-DG-427-158-A001 REV 00) attached in the technical specification are minimum and are in bidder's scope. During detailed engineering, bidder to furnish complete and detailed scheme in all respects including all valves, equipment's etc. for smooth, safe, efficient and trouble free operation of the plant meeting the specification requirement and also considering the applicable statutory requirement.
- l. All channels & brackets, mounting plates as required for mounting of motors, pumps, stirrers, tank etc shall be in bidder's scope.
- li. All necessary structural steel for pipe supporting structure, platforms, walkways / pathways and access stairs, mechanical plant and equipment, mechanical services and pipe work associated with Pre Treatment Plant.
- lii. All Motorized valves with integral starter as per requirement and as indicated in the P&ID.
- lii. iii. Instrument hook up material shall be in bidder's scope.



TITLE

2X660 MW, ENNORE SEZ STPP
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SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

- liv. Permanent ladder (not rungs) for approaching the top of tanks, valves for All steel inserts with lugs, plates, bolts, nuts, sleeves, edge angles and all other embedding components etc as required to grout in civil works and to support/hold the equipment being supplied under this specification for opening/maintenance purpose.
- lv. All the first fill and one Year's topping requirements of consumable such as greases, oil, lubricants, servo fluids/control fluids etc. which will be required to put the equipment covered under the scope of specifications, into successful commissioning / initial operation and to establish completion of facilities shall be in bidder's scope. Suitable standard lubricants as available in India are desired. Efforts should be made to limit the variety of lubricants to minimum.

1.2 PIPING

All the piping as listed below shall be in bidder's scope. The below indicated pipes shall be designed, supplied, erected, laid and tested by the bidder. Elbows, tees, flanges Hangers and supports, embedment plates with lugs etc. required for the below given piping shall also be provided by the bidder.

- All piping within the Pre-Treatment Plant.
- Inlet and outlet pipes for each sumps, pits, pumps, other equipment, etc. with pipe connections to the respective sumps, pits, equipment as indicated in the P&ID of Pretreatment plant.
- Service water piping, instrument air piping, service air piping, potable water piping, etc. as applicable as per the Terminal Points.
- In addition, any additional piping and associated accessories required to complete the system shall be in bidder's scope.
- Supply and erection of raw water inlet pipe to clarifiers, sludge pipe from clarifiers to sludge pit & pipe for power/control cable for mechanism drive is in bidder scope.

1.3 PAINTING

The painting of the supplied equipment shall be as per Annexure-V of the technical specification only. Painting as per specified above. However, any variation in the painting schedule as finally approved by customer shall be taken care by bidder without any commercial and delivery implication. Colour-coding scheme shall be intimated to vendor during detailed engineering.

1.4 SCOPE OF SERVICE

The bidder's scope also includes following services for scope under this specification:

- a) Design and engineering of entire Pretreatment plant.
- b) Complete civil design of Entire Pretreatment plant (excluding Chemical house building).
- c) Unloading, Storage, handling and transportation at site.
- d) Minor Civil work including chipping of foundation, grouting below base plate for all structures, equipment, grouting of anchor bolts wherever these are not placed in the foundation during casting of foundation itself etc. To the extent possible, vendor shall ensure to supply all foundation bolts timely so as to facilitate placement of these bolts while casting the foundation. Wrapping, coating and protection of all the buried pipe shall be as per IS 10221.
- e) Pre- Commissioning work such as flushing, hydraulic testing etc. Necessary consumables and instrumentation as required for inspection and testing at works as well as at site including pre-commissioning activities shall be arranged by the successful bidder at their own cost.
- f) Erection and Commissioning of entire Pre-treatment plant.
- g) Supervision of all Civil works of clarifier.
- h) Arrangement of all lubricants, chemicals, instruments, reagents for carrying out trial run, commissioning and PG test.
- i) Monitoring gadgets, instruments and equipment required for maintenance (till PG test & Plant Hand over).
- j) All personnel required during commissioning, trial run and PG Test.

**TITLE**

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

- k) Trial run for requisite period.
- l) Performance testing.
- m) Painting of all equipment within scope of supply as per Annexure V. Final touch up painting at site.

- n) Preparation of civil assignment drawings i.e. pedestals details; insert plates / embedment's plates required for supporting pipes and equipment etc. and review of civil drawing prepared by BHEL based on civil assignment drawing of bidder. In case any modification is required in the civil work already done based on civil inputs given by vendor, rework shall be done at the cost and risk of the vendor.
- o) Preparation & submission of all drawings as per list enclosed Annexure IV in Section IA, and Drawing/Document submission schedule enclosed Annexure VII in Section IA.
- p) Training of plant Owner's personnel, O&M operators' personnel on plant operation and maintenance.
- q) All other facilities/ services as described in sections/volumes on site services in specification and related to Pre Treatment Plant scope of work.
- r) Relevant requirements as per GTR, GCC, ECC & SCC.
 - s) Any other service required for making the installation complete in all respect within battery limits and for satisfactory erection & commissioning of the system as well as to meet any statutory requirement relevant to the package, unless specifically EXCLUDED from scope of services.

1.5 TERMINAL POINT

- a) Raw water: 20m from Aerator central shaft at 0.5m above FGL.
- b) Service Water and Instrument Air: 5m at 0.5m above FGL from PTP chemical House.

1.6 ELECTRICAL SCOPE

Complete electrical as per specification / details indicated in Section IB (Specific Technical Requirement Electrical) and IIB (General Technical Requirement Electrical).

1.7 C&I SCOPE

Complete C&I as per specification / details indicated in Section IC (Specific Technical Requirement C&I) and IIC (General Technical Requirement C&I).

1.8 CIVIL SCOPE

Total Civil construction work at site is in BHEL's Scope of work, however complete grouting for equipment, pumps, blowers etc. fixing of equipment, pumps, blowers etc. as required shall be in bidder's scope.

Detailed Civil designing and input civil assignment drawing shall be provided by bidder. However civil input drg for chemical house shall be provided by bidder for preparation of civil construction drgs by BHEL and furnished to bidder for concurrence during detailed engineering.

Brief scope of supplier for civil portion is as follows

The scope of the work for PT Plant shall include preparation of detailed design and construction drawings, submission of design basis report, calculation of BOQ against drawing submitted, complete all as required to give satisfactory performance and as stipulated in various clauses in this document.

**TITLE**

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

BIDDER shall also submit all drawings in AutoCAD format along with PDF files. All excel sheets, STAAD files and other files used in detail design shall also be submitted along with design documents and overall compiled quantity for PT Plant as a whole.

The specification covers general requirements of materials, design and testing of R.C.C works, Structural works and finishing work etc. involved in the design of PT Plant. This document is not exhaustive. Relevant codes and standard practices to be followed by BIDDER where ever required, not conflicting with the provisions of this specification, for delivering performance as per the satisfaction of OWNER.

Any other design, drawing etc. if required for completion of the system but not mentioned below shall also be included in the scope of bidder. The bidder's scope under the specification shall include:-

1. Civil design (both sub and super structure) of aerator, stilling chamber, flash mixer, water channels, clarifiers, chemical storage tanks and clarified water overhead tank & sludge pit etc for PT plant.
2. Civil design of Support details of pipes, cable tray, earthing & auxiliary structures (if required) etc.
3. Civil design of buried pipes, ground improvement design drgs if required as per civil specification shall also to be provided by bidder.
4. Civil construction drawings to enable civil works by others at site.
5. Supervision of civil works for PT plant clarifier.
6. Various drawings, datasheets, calculation, including "As built drawings" etc. as specified & as necessary.

1.9 EXCLUSIONS

- a) Instrument air up to the terminal point.
- b) Air-conditioning, ventilation and firefighting facilities.
- c) Civil works of Chemical House building at site.
- d) Service water and potable water up to the terminal point.
- e) All civil construction Works at site.
- f) Chemicals required for PT Plant.

1.10 QUALITY ASSURANCE PLANS

Bidder to note the QP requirement shall be in line with the Annexure-I of technical specification. However, detailed QP, inspection checklist, certificate of conformance etc. for each sub-vendor shall be decided during detailed engineering. All inspection & testing etc. shall be carried out accordingly. Any changes/additional tests insisted upon by Owner during detailed engineering shall be accepted by bidder without any commercial implication to BHEL/Owner.

1.11 SUB VENDOR

Bidder to note the sub vendors shall be selected from the sub vendor list enclosed in Annexure-II of the technical specification. Additionally proposed sub vendor over and above specified in the enclosed list shall be subjected to BHEL / Customer approval during detailed engineering without any commercial / delivery implication to BHEL / Customer. Requirement of detailed QP, inspection checklist, certificate of conformance etc. for each sub-vendor shall be finalized during detailed engineering stage; decision of BHEL/Owner shall be binding on vendor in this regard.



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

1.12 SPARE

- A) Start up and Commissioning spares as required will be in the scope of bidder.
B) Mandatory spares shall be supplied as per Annexure-VI of the technical specification.

A) START-UP & COMMISSIONING SPARES

- a. Start-up and commissioning spares are those spares which are required during the start-up and commissioning of the equipment/system. All spares used till the plant is handed over to the BHEL/Customer shall come under this category. The Bidder shall provide for an adequate stock of such start up and commissioning spares to be brought by him to the site for the plant erection and commissioning. They must be available at site before the equipment are energized. The unused spares, if any, should be removed from there only after the issue of Taking Over certificate. All start up spares which remain unused at the time shall remain the property of the Bidder.
- b. The Bidder shall indicate the service expectancy period for the spares under normal operating conditions before replacement is necessary.
- c. All spares supplied under this contract shall be strictly inter changeable with the parts for which they are intended for replacements. The spares shall be treated and packed for long storage under the climatic conditions prevailing at the site e.g. small items shall be packed in sealed transparent plastic with desecrator packs as necessary.
- d. All the spares (mandatory) shall be manufactured along with the main equipment components as a continuous operation as per same specification and quality plan.
- e. Each spares part shall be clearly marked or labelled on the outside of the packing with its description. When more than one spares part is packed in a single case, a general description of the content shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purposes of identification.
- f. All cases, containers or other packages are to be opened for such examination as may be considered necessary by BHEL / Customer.
- g. The Bidder will provide the BHEL/Customer with all the addresses and particulars of his sub suppliers while placing the order on vendors for items/components/equipment covered under the contract and will further ensure with his vendors that the BHEL/Customer, if so desires, will have the right to place order for spares directly on them on mutually agreed terms based on offers of such vendors.
- h. The Bidder shall warrant that all spares supplied will be new and in accordance with the contract Documents and will be free from defects in design, material and workmanship.
- i. The bidder to provide datasheets/assembly drawings of the manufacturer/ any other relevant document showing Bill of Material(s), Make, Model Number, Part Number etc. through which the mandatory spares to be supplied can be uniquely identified.

B) MANDATORY SPARES

- a. The list of mandatory spares which is to be considered by bidder in their scope are indicated in Annexure VI.
- b. All mandatory spares shall be delivered at site at least two months before scheduled date of initial operation of the first unit. However, spares shall not be dispatched before dispatch of



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

corresponding main equipment.

- c. Wherever quantity is specified both as a percentage and a value, the Bidder has to supply the higher quantity until and unless specified otherwise.
- d. Inspection of mandatory spares shall be in line with the approved quality plans for the respective items/equipment. The inspection categorization of mandatory spares shall also be in line with the approved Categorization plan for the respective items/equipment.

1.13 CONTROL PHILOSOPHY

The operation of the Pre-Treatment Plant shall be done from PLC based Control Panel located in Chemical House of Pre Treatment Plant. Two no. OWS, one no. Operating cum engineering station with one no. A3/A4 size color LJP and Redundant hot standby processors (Quantities shall be decided as per functional grouping), with One (1) no Digital copier cum LaserJet printer A3 size B/W & one no. A3 DMP. In addition Backup control desk with colored Mimic, H.W. Annunciator, P.B. Ammeters, parameters Indicators, recorders and indication Lamps, Ammeters shall also be provided for this plant.

- i. All remote indications from instruments as per P & ID such as raw water flow transmitter, opening / closing status and percentage positioning indicator for inlet motor operated flow control valve, level indicating controller for Clarified Water Tank etc. shall be available on the OWS.
- ii. Local Start / Stop push buttons for all pumps shall be provided. The remote operation (ON/OFF) shall be made through OWS. Current indication wherever required shall also be displayed on OWS.
- iii. Further to above, all drive motors shall have the facility of local Start / Stop. Local/Remote selection shall be done in PLC. Drive motors can be stopped by local lockable stop irrespective of local / remote selector switch position. All the drives motors and valves shall be operated by the OWS and their status indications shall be available there.
- iv. Alarm annunciations as per P & ID & as per system requirement and trip annunciation of all drives shall be displayed on OWS.
- v. The drives as categorized below will be operated also through local start /stop push buttons:
 - a. Drives Motors on the Bridge of Clarifier i.e. rake mechanism drive motor and recirculation drive motors.
 - b. Drives Motors for Sludge Transfer Pumps.
 - c. Agitators of flash mixer, FeCl₃ dosing tanks, Lime Dosing Tanks and PE dosing tanks.
- vi. Suitable arrangement by adjustable timers to be provided for sludge blow down valve of Clarifier with the provision for manual intervention and adjustment independently.
- vii. Provisions for data transfer with reference to important parameters related with Pre Treatment Plant to DCS shall be made through soft link through OPC on Fiber optic.
- viii. All the dosing pumps shall be capable of being adjusted manually to any output with in the stated range.
- ix. All pumps and agitators shall trip at level low in respective tanks.
- x. Alarms pertaining to Clarified water tank- Very High (VH), High (H), Low (L), Very Low (VL) shall be included in PT plant controls.
- xi. All the drives shall be started and stopped from PLC.
In addition to above Local Start/Stop facility from individual pump shall be provided.
- xii. The following shall be monitored from PLC.
 - a) Scrapers on the clarifier tank.
 - b) A soft mimic in the OWS with the status of drives including ON, OFF, TRIP indication of respective motors/pumps and control valve shall be provided.
 - c) All the dosing pumps shall be capable of being adjusted manually to any output with in the stated range.
 - d) All pumps shall trip at level low in respective tanks or Sumps.
 - e) Standby pump will start in case of pressure low at running pump discharge.
 - f) Flow at inlet of aerator shall be controlled through motor operated valve w.r.t. clarified water storage tank.



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

- g) Motor operated sluice gate shall be controlled w.r.t. the water level in Clarified Water Storage Tank i.e. in case one compartment of clarified water storage tank is full then the inlet valve of this compartment will be closed and the inlet valve of other compartment will be open.

1.14 ADDITIONAL REQUIREMENT

- Bidder to submit BBU during detailed engineering after approval of Basic documents. BBU shall be equal to BOQ for the package and there shall be no price and delivery implication is applicable to BHEL / customer for the same. None of the items supplied for the project as non-billable. Incomplete BBU shall not be review by BHEL.

Break-up (%) of Supply prices of Pre Treatment plant package. (To be used during contract execution for payment).	
Lump sum firm price for supply of Clarifier Mechanism along with accessories inclusive of all taxes, duties and other levies as applicable.	10% of Total supply price of Pre Treatment plant package.
Lump sum firm price for supply of pumps, blowers, agitators, Motors inclusive of all taxes, duties and other levies as applicable.	23% of Total supply price of Pre Treatment plant package.
Lump sum firm price for supply of Piping & fittings inclusive of all taxes, duties and other levies as applicable.	13% of Total supply price of Pre Treatment plant package.
Lump sum firm price for supply of Valves inclusive of all taxes, duties and other levies as applicable.	16% of Total supply price of Pre Treatment plant package.
Lump sum firm price for supply of Instrument & analysers inclusive of all taxes, duties and other levies as applicable.	17% of Total supply price of Pre Treatment plant package.
Lump sum firm price for supply of PLC system, UPS with battery. along with accessories etc. inclusive of all taxes, duties and other levies as applicable.	8% of Total supply price of Pre Treatment plant package.
Lump sum firm price for supply of Misc. Balance Items inclusive of all taxes, duties and other levies as applicable.	13% of Total supply price of Pre Treatment plant package.

- Any statutory requirement / clearance required for the package from government / local body shall be in bidder's scope.
- 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 shall be taken from BHEL. 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.
- KKS numbering if required, as per BHEL/Customer requirement shall be provided by the Bidder during detailed engineering stage without any commercial/delivery implication to BHEL.
- Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the works for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The bidder without any extra charge shall provide the same.
- Buried piping shall be protected as under (as per IS-10221).
- Surface cleaning by wire brush, power tool cleaning etc.
 - Apply one coat of coaltar/primer/enamel.
 - Apply one layer of tape comprising of coaltar. Application of tape shall conform to AWWA C-203/IS 10221 (appendix-B) with Minimum thickness of tape as 4MM +10%
- 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.
- In case vendor submits revised drawing after approval of the corresponding drawing, any delay in



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

approval of revised drawing shall be to vendor's account and shall not be used as a reason for extension in contract completion.

- Bidders shall make Site visit in order to familiarize themselves with existing condition of site before submitting the bid in order to make their offer complete. During detail engineering also, the successful bidder shall be responsible for the correctness of details w.r.t. existing facility at site. Customer approval on any drawing having details of existing facility shall not be cited by the successful bidder a valid reason for any shortcoming in the work by them. BHEL shall also not entertain any cost implication for any lack of input data with regard to site during detail engineering.
- Preparation of drawings / document / P&ID's in 3D modelling software and providing soft copy of same to BHEL.
- Bidders shall make Site visit in order to familiarize themselves with existing condition of site before submitting the bid in order to make their offer complete. During detail engineering also, the successful bidder shall be responsible for the correctness of details w.r.t. existing facility at site. Customer approval on any drawing having details of existing facility shall not be cited by the successful bidder a valid reason for any shortcoming in the work by them. BHEL shall also not entertain any cost implication for any lack of input data with regard to site during detail engineering.
- Service water shall be available near to pretreatment plant/ system building/ area at approximately 1.5 to 2.0 Kg/ Cm². Hence, bidder to take care for cooling/ lubrication of the pumps along with electric motor drive being supplied by the bidder under this technical specification. If service water pressure requirement is more than available pressure, bidder to consider two (2) nos. cooling pump for pretreatment plant.
- Wherever local instruments for measurement of Flow, Pressure, Level is indicated in the P&ID, Bidder to provide Diaphragm seal type instrument for Chemical (all type and concentration), corrosive, viscous fluids application.
- All the vertical pumps shall be considered as self-lubricating type unless specifically mentioned.
- All piping, valves, fittings to be selected by bidder of minimum PN 10 or 150# class rating.

1.15 DRAWING/DOCUMENTS REQUIREMENT

- 1.14.1 For the Drawings/Documents distribution Procedure, please refer attached Annexure-IV. Bidder has to submit the revised drawing/document along with the compliance sheet indicating enumerate reply to all BHEL and customer comments or observations. Without compliance sheet the submission of the drawings/documents will not be considered and the delay on this account will be solely on bidder's side only. The numbers of soft copies & hard copies of drawing/documents to be submitted by the bidder shall be as per enclosed Annexure-IV.
- 1.14.2 After award of LOI/LOA, drawing/documents to be submitted by the bidder for BHEL/Customer approval has been indicated in Annexure VII. However any additional drawing/document if found necessary for completion of the engineering, the same shall be submitted by bidder without any commercial & delivery implication to BHEL.
- 1.14.3 Bidder to note that the successful bidder, during detail engineering, will submit the drg/doc through web based Document Management System in addition to hard copies to be submitted as per the Annexure III of this specification. 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:
- Internet explorer version – Minimum Internet Explorer 7



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

- 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>

- 1.16** 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 vendor from the responsibility of providing such facilities to complete the supply and erection & commissioning of PRE-TREATMENT PLANT
- 1.17** It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to high 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 judgment is not in full accordance herewith.
- 1.18** 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.
- 1.19** The general term and conditions, instructions to tenderer and other attachment referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification are subject to compliance to all attachments referred in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.
- 1.20** While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under section-III of the specification. 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 to BHEL / Customer.
- 1.21** Deviations along with cost of withdrawal (positive or negative), if any, should be very clearly brought out clause by clause in the enclosed schedule; otherwise, it will be presumed that the vendor's offer is strictly in line with tender specification & there is no deviation. (Price to be given in sealed envelope only.)
- 1.22** In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

1.23 Unless specified otherwise, all through the specification, the word contractor shall have same meaning as successful bidder / vendor and Customer / Purchaser / Employer will mean BHEL and /or TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION (TANGEDCO)

1.24 The equipment covered under this specification shall not dispatch unless the same have been finally inspected, accepted and shipping release issue by BHEL/Customer.

1.25 BHEL's/Customer's representative shall be given full access to the shop in which the equipment are being manufactured or tested and all test records shall be made available to him.

1.26 CIVIL DESIGN EVALUATION CRITERIA:

a) For all the civil works for which civil design is in Bidder's scope evaluation shall be done for the total concrete & reinforcement quantity quoted by the Bidder. The bids will be evaluated based on the Pre treatment plant prices quoted by the bidder and quantities of reinforcement steel and concrete used in the Pre treatment plant (except Chemical house) quoted by the bidder.

b) The evaluation shall be done as per the following:

- Bidder to consider all Civil structural & related work (except Chemical house) as defined in tender specification for quoting the concrete and reinforcement quantity.
- The concrete and reinforcement quantity quoted by the Bidder shall be considered as the basis for evaluation.
- The bidder shall furnish quantities of reinforcement steel and concrete in the Price offer. The evaluation rates for reinforcement steel and concrete shall be as per NIT.

c) During civil design while furnishing the drawing/ design for BHEL's review/ approval, bidder shall also furnish the design quantities of reinforcement steel and concrete and furnish in the drawings.

d) If the total quantity of reinforcement steel and concrete during contract execution is found to be more than the quantities quoted at tender stage, the additional cost for excess quantity of reinforcement steel and concrete shall be deducted from the bidder's payments as per the rates specified in the NIT. No benefit will be given to Bidder, in case of reduction in actual quantity of reinforcement steel and concrete with respect to the quantities quoted in bid evaluation.

1.27 Bidder to furnish 4 sets of techno-commercial bid including following documents/information (For Electrical and C&I please refer the respective section of the specification).

- Detailed process writes up of the system offered for information (meeting the specification requirement for information purpose only).
- Deviation if any in the enclosed Schedule of deviation with cost of withdrawal only with mention of specification clause for which deviation is being asked. (Stamped & Signed)
- Compliance certificate.(Stamped & Signed)
- Schedule of Declaration. (Stamped & Signed)
- Unpriced Price Schedule duly filled as "Quoted". (Stamped & Signed).

Any other documents submitted by bidder except as asked in the bid's specification shall not be evaluated & considered as **null & void**.



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

1.28 INSTRUCTIONS TO BIDDER

- a) 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 them of the responsibility of providing such facilities to complete the supply, erection and commissioning of Complete Pretreatment Plant.
- b) It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to high 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 judgment is not in full accordance herewith.
- c) 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.
- d) The general terms and conditions, instructions to tenderer and other attachment referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification are subject to compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.
- e) While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under Vol-III of the specification **within 10 days of receipt of tender documents**. In absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of BHEL/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 BHEL/ Customer as and when brought to their notice either by the bidder or by BHEL/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.
- f) The bidder's offer shall not carry any sections like clarification, interpretations and /or assumptions.
- g) 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.
- h) In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.
- i) Unless specified otherwise, all through the specification, the word contractor shall have same meaning as successful bidder/vendor and Customer/Purchaser/Employer will mean BHEL and/or Customer.
- j) The equipment covered under this specification shall not be dispatched unless the same have been finally inspected, accepted and dispatch release issued by BHEL/Customer as per approved QAP.

	TITLE 2X660 MW, ENNORE SEZ STPP TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT	SPECIFICATION NO. PE-TS-412-158-A001
		SECTION-IA
		REV 00

- k) BHEL's/Customer's representative shall be given full access to the shop in which the equipment are being manufactured or tested and all test records shall be made available to him.
- l) Pre-bid meeting shall be held before bid submission. Bidder to ask all their queries in pre-bid meeting.



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

ANNEXURES

	TITLE 2X660 MW, ENNORE SEZ STPP TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT	SPECIFICATION NO. PE-TS-412-158-A001 SECTION-IA REV 00
ANNEXURE-I: QUALITY PLAN		

QUALITY ASSURANCE

Test Items / Components	s/Check	Material Test	WPS/PQR/Welder Qualification	DPT/MPI	Assembly Fit up	Dimension	RT	Hydraulic / Water Fill	Performance Test	Test as per relevant Std/ Appd. Data Sheets	Other Tests	Remarks
1. Horizontal Centrifugal Pumps					Y	Y			Y ¹	Y		LEGENDS: Y Applicable Y ^a One per Heat/Heat Treatment batch./Lot Y ^b On machined surfaces only. Also 100% on Butt Welds & 10% on Fillet Welds. Y ^c UT shall be done for shafts with Dia 50 mm or above & Plates of Thickness 20 mm or above. Y ^d Dynamic Balancing per ISO: 1940, Grade 6.3 minimum. Y ¹ As per HIS, USA. Y ² 10% RT to be conducted on butt welds for Thk $\geq$ 10 mm. Y ³ Seat Leakage Test for actuator operated valves shall be done by closing the valve with job actuator. Y ⁴ Tests on Rubber Diaphragms per batch of Rubber mix such as Tensile, Elongation, Hardness, Thickness, Bleed Resistance, Flex Test for 1500 cycles etc. shall be conducted. In addition, Type Test for 50,000 cycles for each type of diaphragm shall also be conducted, if not carried out earlier. Y ⁵ Seat Leakage Test is required to be done in both directions. Disc strength test as per relevant code shall be carried out. Y ⁶ Blue Matching, Wear Travel for Gate Valves, reduced pressure test for check valves shall be conducted per relevant standards.
1.1. Casing		Y ^a		Y ^b				Y				
1.2. Impeller		Y ^a		Y ^b							Y ^d	
1.3. Shaft		Y ^a		Y						Y ^c		
2. Vertical Pumps					Y	Y			Y ¹	Y		
2.1. Casing		Y ^a		Y ^b				Y				
2.2. Impeller		Y ^a		Y ^b							Y ^d	
2.3. Shaft		Y ^a		Y						Y ^c		
2.4. Fabricated Parts		Y ^a	Y	Y ^b			Y ²	Y				
3. Dosing/ Metering Pumps		Y ^a						Y Y	Y ¹	Y		
4. Gate/ Globe/ Check Valves		Y ^a		Y ^b	Y			Y Y		Y	Y ⁶	
5. Dual Plate Check Valves		Y ^a		Y ^b	Y			Y Y		Y	Y ¹²	
6 Diaphragm Valves		Y ^a				Y		Y ³	Y		Y ⁴	
6. Butterfly Valves (Low Pr.)					Y Y			Y ³	Y		Y ⁵	
7.1 Body (Cast)		Y ^a		Y ^b								
7.2 Disc (Cast)		Y ^a		Y ^b								
7.3 Shaft		Y ^a		Y ^b							Y ^c	
8. Plug/ Ball Valves (Low Pr.)		Y ^a		Y ^b	Y Y			Y Y		Y		
9. Blowers		Y ^a		Y ^b	Y Y			Y Y		Y	Y ^{dc}	
10. Atmospheric Storage Tanks/ Pressure Vessels		Y ^a	Y	Y ^b	Y Y		Y ⁸	Y		Y ^c	Y ⁷	

QUALITY ASSURANCE

Test s/Check Items / Components	Material Test	WPS/PQR/Welder Qualification	DPT/MPI	Assembly Fit up	Dimension	RT	Hydraulic / Water Fill	Performance Test	Test as per relevant Std/ Appd. Data Sheets	Other Tests	Remarks
11. Rubber lining	Y ^a			Y					Y	Y ⁹	Y⁷ Heat Treatment of the Tank/Vessel shall be done per fabrication code requirement. Welded dished ends shall be stress relieved. Dished ends manufactured by cold working shall be stress relieved as per the requirement of code. Y⁸ RT as per fabrication code requirements. However, dished ends welds, if manufactured by using welded plates shall be subjected to 100% RT. Y⁹ Rubber Lining Mix shall be subjected to Bleed Resistance Test on mould sample. Adhesion Test, Spark Test and Hardness Test for the Rubber lined jobs shall also be conducted. Y¹⁰ Gear Boxes shall be checked for smooth No Load Operation at shop to verify noise and vibration levels. Gear Ratio and Kerosene Leak Test shall also be conducted. Y¹¹ One Fan of each type & size shall be routine performance tested as per corresponding code fir air flow, static pressure, total pressure, speed, efficiency, power consumption, noise & temperature rise. Also all Fans shall be subjected to run test of 4 hours during which noise, vibration, temperature rise and current drawn shall be measured. Y¹² Blue Matching, reduced pressure test for check valves shall be conducted per relevant standards. Dry cycle test on valve spring for 100000 cycles shall be carried out as type test, if not carried out earlier, for the similar MOC, size and type of spring.
12. Reactor Clarifier	Y ^a	Y	Y ^b	Y Y					Y	Y ¹⁰	
13. Clariflocculator/ Plate or Tube Settler	Y ^a			Y	Y				Y		
14. Hoists & Cranes	Y ^a	Y	Y ^b	Y Y		Y ⁸	Y		Y		
15. Chlorine Tonner	Y ^a	Y	Y ^b	Y Y		Y ⁸	Y				
16. Chlorine Evaporator	Y ^a	Y	Y	Y Y	Y Y						
17. Chlorinator & injector	Y ^a			Y	Y		Y	Y			
18. Agitators /Flash Mixer/ Flocculator	Y ^a	Y	Y ^b	Y Y			Y			Y ¹⁰	
19. Pipes	Y ^a	Y		Y Y			Y		Y		
20. Ventilation/Exhaust Fan	Y ^a		Y ^b	Y Y				Y ¹¹	Y	Y ^{dc}	
After erection, the complete Piping system along with valves & fittings shall be hydraulically tested.											

NOTE:- Category of inspection for items / equipment shall be decided by BHEL only during detailed engineering. All the inspection shall be carried out by BHEL or its designated agency only. And further no customer / consultant inspection is envisaged.

		QUALITY PLAN SHEET 1 OF 2	CUSTOMER :			PROJECT TITLE			SPECIFICATION :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			NUMBER :			
			SYSTEM			ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SPECIFICATION TITLE			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION AGENCY VOLUME III			
									P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	2	-	-	
		2.DIMENSIONS	MA	-DO-	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	2	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE	MA	VISUAL	100%	MFG.SPEC./ RELEVANT IS	MFG.SPEC. RELEVANT IS	-DO-	2	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MANUFR'S SPEC/BHEL SPEC./RELEVANT STANDARD	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	IS-325/ BHEL SPEC./ DATA SHEET	SAME AS COL.7	TEST REPORT	2	1		NOTE -1 & NOTE-3
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPN. REPORT	2	1	-	NOTE -1 & NOTE-3
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									

		QUALITY PLAN		CUSTOMER :		PROJECT			SPECIFICATION :			
				BIDDER/ :		TITLE			NUMBER :			
		SHEET 2 OF 2		VENDOR		NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION :			
		SYSTEM		ITEM AC ELECT. MOTORS BELOW 55KW (LV)			TITLE :			SECTION VOLUME III		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	P	W	V	11
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2	1	-	
NOTES: 1 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON 2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. 3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW , ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY. <u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY												
BHEL			PARTICULARS		BIDDER/VENDOR							
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN		CUSTOMER :			PROJECT TITLE		SPECIFICATION : NUMBER :			
				BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03		SPECIFICATION : TITLE			
		SHEET 1 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SECTION		VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE F NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	
1.0	RAW MATERIAL & BOUGHT OUT CONTROL											
1.1	SHEET STEEL, PLATES, SECTION, EYEBOLTS	1.SURFACE CONDITION	MA	VISUAL	100%	-	FREE FROM BLINKS, CRACKS, WAVINESS ETC	LOG BOOK	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	-DO-	3	-	-	
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	-DO-	-DO-	-DO-	INSPEC. REPORT	3	-	2	
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, UN-EVENNESS ETC.	-DO-	3	-	-	
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	MANFR'S DRG./SPEC BOOK	RELEVANT IS/SPEC.	SUPPLIERS TC & LOG	3	-	2	
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, BLOW HOLES ETC.	LOG BOOK	3	-	2	
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1/HEAT NO.	MANFR'S DRG./SPEC	RELEVANT IS/	SUPPLIER'S TC	3	-	2	
		3.DIMENSIONS	MA	MEASUREMENT	100%	MANUFR'S M DRG.	MANUFR'S DRG.	LOG BOOK	3	-	2	
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	LOG BOOK	3	-	2	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN SHEET 2 OF 9		CUSTOMER :		PROJECT TITLE			SPECIFICATION : NUMBER :			
				BIDDER/ VENDOR :		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
				SYSTEM		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION VOLUME III			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE F NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	MFG. DRG. SPEC.	RELEVANT IS	SUPPLIER'S TC	3	-	2	
		3. DIMENSIONS	MA	MEASUREMENT	100%	-DO-	MANUFR'S DRG.	LOG BOOK	3	-	2	
		4. INTERNAL FLAWS	CR	UT	-DO-	ASTM-A388	MANUFR'S SPEC. BHEL SPEC.	-DO-	3	2	1	
1.6	SPACE HEATERS, CONNECTORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING	MA	VISUAL	-DO-	MANUFR'S DRG. SPEC.	MANUFR'S DRG. SPEC.	-DO-	3	-	2	
		2. PHYSICAL COND.	MA	-DO-	-DO-	-	NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY	-DO-	3	-	2	
		3. DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG./ SPEC.	MANUFR'S DRG. / SPEC.	-DO-	3	-	2	
		4. PERFORMANCE/ CALIBRATION	MA	TEST	100%	-DO-	-DO-	INSP. REPORT	3	-	2	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE									
									BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN SHEET 3 OF 9		CUSTOMER :		PROJECT			SPECIFICATION :				
				BIDDER/ VENDOR :		TITLE			NUMBER :				
				SYSTEM		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE				
				ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SECTION			VOLUME III				
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE F NORM	OR MAT OF RECORD	AGENCY			REMARKS	
									P	W	V		
1	2	3	4	5	6	7	8	9	10			11	
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC. 2. OTHER CHARACTERISTICS	MA MA	VISUAL TEST	100% SAMPLE	- MANUF'S SPEC.	NO VISUAL DEFECTS MANUF'S SPEC.	INSPT. REPORT LOG BOOK AND OR SUPPLIER'S TC	3 3	- -	2 2		
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND. 2. DIMENSIONS INCLUDING BURS HEIGHT 3. ACCEPTANCE TESTS	MA MA MA	VISUAL MEASUREMENT ELECT. & MECH TESTS	100% SAMPLE -DO-	- MANUFR'S DRG. . MANUF'S SPEC./ RELEVANT IS	NO VISUAL DEFECTS (FREE FROM BURS) MANUFR'S DRG. RELEVANT IS	LOG BOOK -DO- SUPPLIER'S TC	3 3 3	- - -	- 2 2		FOR MV MOTOR INSULATION/VARNISH THICKNESS SHALL BE MORE THAN THE BURS HEIGHT
1.9	CONDUCTORS	1. SURFACE FINISH 2. ELECT. PROP. & MECH. PROP	MA MA	VISUAL ELECT. & MECH. TEST	100% SAMPLES	- RELEVANT IS/ BS OR OTHER STANDARDS	FREE FROM VISUAL DEFECTS RELEVANT IS/ BS OR OTHER STANDARDS	LOG BOOK SUPPLIERS TC & VENDOR'S INSPN. REPORTS	3* 3	- -	2* 2		* MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY BHEL/CUSTOMER.
BHEL			PARTICULARS			BIDDER/VENDOR							
			NAME										
			SIGNATURE										
			DATE										
									BIDDER'S/VENDORS COMPANY SEAL				

		QUALITY PLAN SHEET 4 OF 9		CUSTOMER :		PROJECT			SPECIFICATION :					
				BIDDER/		TITLE			NUMBER :					
				VENDOR		QUALITY PLAN			SPECIFICATION :					
				SYSTEM		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE F NORM	ORMAT OF RECORD	AGENCY			REMARKS		
									P	W	V			
1	2	3	4	5	6	7	8	9	10			11		
1.10	BEARINGS	3.DIMENSIONS	MA	MEASUREMENT	-DO-	-DO-	-DO-	Log Book	3	-	2			
		1.MAKE & TYPE	MA	VISUAL	100%	MANFR'S DRG./ APPROVED DATASHEET	MANFR'S DRG./ APPROVED DATASHEET	-DO-	3	-	2			
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	BHEL DATA SHEET	BHEL DATA SHEET BEARING MANUF'S CATALOGUES	-DO-	3	-	2			
		3.SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	2			
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-DO-	-DO-	3	-	-			
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-			
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	-DO-	MANUF'S SPEC./ BHEL SPEC.	MANUF'S SPEC./ BHEL SPEC.	-DO-	3	-	2			
		4.HV/IR	MA	-DO-	100%	-DO-	-DO-	-DO-	3	-	2			
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	MANUF'S DRG/SPECS	MANUF'S DRG./ SPECS.	-DO-	3	-	-			
		2.SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-			
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-			
BHEL			PARTICULARS			BIDDER/VENDOR								
			NAME											
			SIGNATURE											
			DATE											
									BIDDER'S/VENDORS COMPANY SEAL					

		QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :		
				BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE		
		SHEET 5 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION		VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE F NORM	ORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	P	W	V	11
2.0	IN PROCESS											
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNES	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	3/2	2	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	2	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	-DO-	RELEVENT SPEC./ ASTM-E165	MANUFR'S SPEC./ BHEL SPEC./	-DO-	2	-	1	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	MANFR'S SPEC/BHEL SPEC./ RELEVANT STAND	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-DO-	-DO-	-DO-	2	-	-	
		3.SHADE	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	-DO-	-DO-	-DO-	Log Book	2	-	-	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN SHEET 6 OF 9		CUSTOMER :			PROJECT			SPECIFICATION :		
				BIDDER/ VENDOR :			TITLE			NUMBER :		
				SYSTEM			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE F NORM	ORMAT OF RECORD	SECTION			VOLUME III
									AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	MANUFR'S SPEC.	MANUFR'S SPEC.	Log Book	2	-	-	(FOR MOTORS OF 2MW AND ABOVE) * ON 10% RANDOM SAMPLE
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-DO-	-DO-	Log Book	2	-	-	
		3.CORE LOSS & HOTSPOT	MA	ELECT.TEST	-DO-	-DO-	-DO-	Log Book	2	1*	1	
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	MANUFR'S SPEC./BHEL SPEC. SPEC.	MANUFR'S SPEC. /BHEL	Log Book	2	-	-	FOR MV MOTOR
		2.CLEANLINESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.IR-HV-IR	CR	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.RESISTANCE	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
		5.INTERTURN INSULATION	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		6.SURGE WITH STAND AND TAN. DELTA TEST	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
2.6	IMPREGNATION	1.VISCOSCITY	MA	PHY. TEST	AT STARTING	-DO-	-DO-	Log Book	2	-	-	THREE DIPS TO BE GIVEN
		2.TEMP. PRESSURE VACCUM	MA	PROCESS CHECK	CONTINUOUS	-DO-	-DO-	Log Book	2	-	-	
		3.NO. OF DIPS	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN SHEET 7 OF 9		CUSTOMER :		PROJECT TITLE			SPECIFICATION : NUMBER :			
				BIDDER/ VENDOR		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
				SYSTEM		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION VOLUME III			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE F NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	
2.7	COMPLETE STATOR ASSEMBLY	4.DURATION	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	VERIFICATION FOR MV MOTOR ONLY
2.8	BRAZING/COMPRESSION JOINT	1.COMPACTNESS & CLEANLINESS	MA	VISUAL	100%	-DO-	-DO-	Log Book	2	-	-	
2.9	COMPLETE ROTOR ASSEMBLY	1.COMPLETENESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.SOUNDNESS	CR	MALLET TEST & UT	-DO-	-DO-	-DO-	Log Book	2		1	
		3.HV	MA	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2		1	
2.10	ASSEMBLY	1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	-DO-	MFG SPEC./ ISO 1940	MFG. DWG.	Log Book	2		1	
		2.SOUNDNESS CR OF DIE CASTING		ELECT. (GROWLER TEST)	-DO-	MFG. SPEC.	MFG. SPEC.	Log Book	2		1	
2.10	ASSEMBLY	1.ALIGNMENT	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.WORKMANSHIP	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.AXIAL PLAY	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.DIMENSIONS	MA	-DO-	-DO-	MFG.DRG./ MFG SPEC.	MFG. DRG/ RELEVANT IS	Log Book	2	-	-	
		5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2	-	-	
		6. RTD, BTD & SPACE HEATER MOUNTING.	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2		1	
BHEL			PARTICULARS		BIDDER/VENDOR							
			NAME									
			SIGNATURE									
			DATE					BIDDER'S/VENDORS COMPANY SEAL				

		QUALITY PLAN SHEET 8 OF 9		CUSTOMER :		PROJECT			SPECIFICATION :			
				BIDDER/		TITLE			NUMBER :			
				VENDOR		QUALITY PLAN			SPECIFICATION :			
		SYSTEM		NUMBER PED-506-00-Q-007, REV-03			TITLE					
		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SECTION			VOLUME III					
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE F NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
3.0	TESTS	1. TYPE TESTS INCLUDING SPECIAL TESTS AS PER BHEL SPEC.	MA	ELECT. TEST	1/TYPE/SIZE	IS-325/ BHEL SPEC./ DATA SHEET	IS-325/ BHEL SPEC./ DATA SHEET	TEST REPORT	2	1*	1	* NOTE - 1
		2. ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1 ^s	1	\$ NOTE - 2
		3. VIBRATION & NOISE LEVEL	MA	-DO-	100%	IS-12075 & IS-12065	IS-12075 & IS-12065	-DO-	2	1 ^s	1	\$ NOTE - 2
		4. OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPC. REPORT	2	1	-	
		5. DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	RELEVANT IS	BHEL SPEC. AND DATA SHEET	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1 ^s	1	\$ NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1 ^s	1	\$ NOTE - 2
		8. NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPC. REPORT	2	1 ^s	1	\$ NOTE - 2
		9. EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	IS-3682 IS-8239 IS-8240	IS-3682 IS-8239 IS-8240	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	BHEL SPEC. & DATA SHEET	BHEL SPEC. & DATA SHEET	TC	2	1 ^s	1	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY \$ NOTE - 2
BHEL			PARTICULARS		BIDDER/VENDOR							
			NAME									
			SIGNATURE									
			DATE					BIDDER'S/VENDORS COMPANY SEAL				

		QUALITY PLAN SHEET 9 OF 9		CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER :		
				BIDDER/ VENDOR		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03		SPECIFICATION : TITLE		
				SYSTEM		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SECTION VOLUME III		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE F NORM	ORMAT OF RECORD	AGENCY P W V	REMARKS
1	2	3	4	5	6	7	8	9	10	11
NOTES: 1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED. 2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON. 3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THESE TEST MAY NOT BE REPEATED. 4 WHEREVER CUSTOMER IS INVOLVED IN INSPECTION, AGENCY (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. <u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY										
BHEL			PARTICULARS		BIDDER/VENDOR					
			NAME							
			SIGNATURE							
			DATE				BIDDER'S/VENDORS COMPANY SEAL			

बीएचएल PEM :: C&I		STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER						QUALITY PLAN NO.: PE-QP-999-145-I036__				
								VOLUME IIB				
								SECTION D				
								REV. NO. 01		DATE: 24.08.2007		
								SHEET 1		OF 8		
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records P	Agency \$			Remarks
										W	V	
1.0	Materials /Components											
1.1	Panels & Control Desks	Physical Inspection for Dimensions, Painting, Cutouts, Lifting / Locking Arrangements, Components, Drawing Pocket, Mounting accessories, Plinth & AV Pads, Cable Gland Plates, Hardwares, Hinges, Louvers & Filters, Fans & Panel Lamps	MA Visual	I	100%	Contract specifications, Approved GA Drawings, BOQ	As per ref documents. No physical damage.	BHEL Quality Inspection Report.	3/2 2		1	
1.2	Power Supply/Packs, Battery & Battery charger, Transformer, UPS.	Physical Inspection Physical Damages Dimensions Mounting Accessories	MA Visual	I	100%	Contract specifications, BOQ.	As per reference documents, Test Report	BHEL Quality Inspection Report.	3/2 2		1	
1.3	Indicating Lamp, Annunciator, Meters, Transducers, Signal Converters, Instruments, Single Loop Controllers	Physical Verification Physical Damages Dimensions Accessories	MA Visual	I	100%	Contract specifications, BOQ.	As per ref documents No physical damage. Test/ Calibration report.	BHEL Quality Inspection Report	3/2 2		1	
1.4	PLC processors, I/O modules, Power Supply modules, Communication modules, Mounting Racks, Ethernet	Physical Inspection • Identification Labels • Physical Damages • Quantity • Spare Capacity	MA Visual	I	100%	Product Catalogue, Data sheets, Approved Configuration diagram, BOQ	As per ref documents. Test Certificates	BHEL Quality Inspection Report.	3/2 2		1	

LEGEND: * CR - Critical characteristics
 MA - Major characteristics
 MI - Minor characteristics

\$ P - Agency Performing the Test.
 W - Agency Witnessing the Test.
 V - Agency Verifying the Test.

1 - BHEL
 2 - Vendor
 3 - Sub-vendor

 PEM :: C&I		STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER					QUALITY PLAN NO.: PE-QP-999-145-I036					
							VOLUME IIB					
							SECTION D					
							REV. NO. 01			DATE: 24.08.2007		
							SHEET 2			OF 8		
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records P	Agency \$			Remarks
										W	V	
1.5	CPU, Monitor, Keyboard, Mouse, CD Drives, Printers, OS, System Software, Engineering software in the form of Licensed CD.	Physical Inspection Identification Labels, Tech. Specification Physical Damages Accessories Installation arrangements for Computers & Printers	MA	Visual	100%	Contract specifications, Product Catalogue, Approved GA / Configuration drawing, BOQ.	As per reference documents.	BHEL Quality Inspection Report.	3/2 2		1	

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 PEM :: C&I		STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER						QUALITY PLAN NO.: PE-QP-999-145-I036				
								VOLUME IIB				
								SECTION D				
								REV. NO. 01		DATE: 24.08.2007		
								SHEET 3		OF 8		
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records P	Agency \$			Remarks
										W	V	
2.0 Assembly												
2.1	Functional Test for HMI/OWS devices such as Monitors, Keyboards, Mouse, Printers etc.	Operation	MA	Functional	100%	Approved Configuration Diagram & BOQ and FAT	Correct Operation of interconnected Devices of HMI system.	BHEL Quality Inspection Report.	2 1		1	
2.2	Hardware Functional Verification.	Physical arrangement, Wiring check & labeling, Continuity Checking, IR & HV test	MA	Visual/ Electrical	100%	Approved GA Drawing, Panel Wiring Diagram, IR & HV as per relevant International standard	Test Certification	BHEL Quality Inspection Report.	2 2		1	
2.3	Powering Up	Healthiness of all the modules/equipment, associated with Powering of PLC system	MA	Visual /Electrical	100%	Approved power supply scheme	All equipment to be healthy on power ON	BHEL Quality Inspection Report.	2 1		1	
2.4	Burn in test for PLC modules	Healthiness of PLC modules on Continuous Energisation, Temperature maintenance	MA	Visual/ Electrical	100% F	AT Procedure	Test certification as per FAT	BHEL Quality Inspection Report.	2 2		1	

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बीएसडीएल  PEM :: C&I		STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER						QUALITY PLAN NO.: PE-QP-999-145-I036__				
								VOLUME IIB				
								SECTION D				
								REV. NO. 01		DATE: 24.08.2007		
								SHEET 4		OF 8		
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records P	Agency ^{\$}			Remarks
										W	V	
3.0	Factory Acceptance Test (FAT)											
3.1	Input Output Functional Verification	I/O configuration, I/O operation	MA	Visual/ Eletrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.2	Processor Verification	Processor configuration, Powering up, standby operation (as applicable) and Loading	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.3	Power Supply Module Verification	Redundancy Operation	MA	Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.4	Communication System Verification	Redundancy operation of Communication System, Measurement of Response Time, Communication with third party system	MA	Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.5	Diagnostic Verification	Self Diagnostic features of PLC system	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.6	Control Panel/Desk Verification	Operation of PLC driven annunciation system, Mosaic, Push buttons & selector switches, Indicating lamps	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.7	Software Verification	(i) Control Logics (ii) Engineering Features (iii) HMI Features	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	

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QUALITY PLAN NO.: PE-QP-999-145-I036		
VOLUME IIB		
SECTION D		
REV. NO. 01	DATE: 24.08.2007	
SHEET 5	OF	8

FACTORY ACCEPTANCE TEST (FAT) PROCEDURE

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

- a) Technical Specification of PLC.
- b) PLC System Configuration
- c) General Assembly Drawings.
- d) Panel Wiring Diagrams.
- e) Bill of Quantity for PLC System.
- f) Logic Diagram.
- g) HMI Schematics.
- h) Input / Output List.

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

APPLICABLE TEST PROCEDURE:

1. Input/Output Functional Verification.

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

2. Processor Verification

PLC Configuration drawing to be referred for ascertaining

- i) Redundancy

STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER

QUALITY PLAN NO.: PE-QP-999-145-I036		
VOLUME IIB		
SECTION D		
REV. NO. 00	DATE: 23.03.2005	
SHEET 6	OF	8

ii) Type (Hot or Cold)

Both the processors are to be checked for healthiness in case of redundant configuration as per vendor's standard practice. In case of hot redundancy, switchover of control from primary processor to standby processor shall be demonstrated for uninterrupted control and data processing as per vendor's standard practice. Switchover shall be witnessed, by manual power off or resetting the Primary CPU or simulating failure of primary processor. Checking should be by witnessing the lighting up of Processor's LEDs as per manufacturer's product standard.

Vendor shall demonstrate, as per Vendor's standard practice, adequate Loading (Spare Capacity) of Processors, as mentioned in contract specs. This shall be done, by simulating worst load operation of fully integrated PLC system.

3. Power Supply Module Verification

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

4. Communication System Verification

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

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

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

5. Diagnostic Verification

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

STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER

QUALITY PLAN NO.: PE-QP-999-145-I036		
VOLUME IIB		
SECTION D		
REV. NO. 00	DATE: 23.03.2005	
SHEET 7	OF	8

6. Control Panel /Desk Verification

- i) PLC driven annunciation system should be checked by alarm signal simulation.
- ii) Push Button and selector switch operation should be checked by verification of corresponding change of status of Data Base point.
- iii) Indicating lamp / MIMIC should be checked by corresponding Data Base point simulation.

7. Software Verification

- i). Control Logics:– Software switches, lamps and Analog sources shall be used for simulation of field conditions .Control logics shall be checked for its correct functionality as per approved logic schemes
- ii). Engineering features:-
 - a) Online changing of parameters, set points.
 - b) Online modification in Control Logic Diagrams.
 - c) Online configuration of Graphics, Trends, Logs, HSR.
- iii). HMI features:-
Check for configuration & operation of Graphics, Trends, Logs, HSR and Alarms, in the form of Displays and Printouts, by simulation of Inputs as per approved documents.

8. Burn in **Elevated Temperature test**

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

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

**STANDARD QUALITY PLAN
FOR
PROGRAMMABLE LOGIC CONTROLLER**

QUALITY PLAN NO.: PE-QP-999-145-I036		
VOLUME IIB		
SECTION D		
REV. NO. 00	DATE:	
23.03.2005		
SHEET 8	OF	8

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

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



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

ANNEXURE II: SUB VENDORS LIST



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
1.	PRESSURE VESSELS	GLOBAL STRUCTURES & COMPOSITE LTD	-	
		JASMINO POLYMERTECH	TALOJA	
		SYSCON ENGINEERS	AMBERNATH	
		S.V. FABRICATORS	NAVI MUMBAI	
		SPARK FABRICATORS / STEELCON	-	
		ANUP ENGINEERING	AHMEDABAD	
		MURTHAL TANKS & VESSELS	SONEPAT	
		TITAN ENGG.	DURGAPUR	
		RISHI INDUSTRIES	BAHALGARH	
		UNIVERSAL HEAT EXCHANGERS	-	
		ATS CHEM	SALEM/HOSUR	
		CHEM PROCESS SYSTEM	SANAND	
		PROGEN	CHENNAI	
		CRYSTAL ENGINEERING	HOSUR	
		ISHAN EQUIPMENTS	VADODARA	
2.	ATMOSPHERIC/ STORAGE TANKS	GLOBAL STRUCTURES & COMPOSITE LTD	-	
		JASMINO POLYMERTECH	TALOJA	
		SYSCON ENGINEERS	AMBERNATH	
		S.V. FABRICATORS	NAVI MUMBAI	
		SPARK FABRICATORS / STEELCON	-	
		ANUP ENGINEERING	AHMEDABAD	
		MURTHAL TANKS & VESSELS	SONEPAT	
		TITAN ENGG.	DURGAPUR	
		RISHI INDUSTRIES	BAHALGARH	
		UNIVERSAL HEAT EXCHANGERS	-	
		ATS CHEM	SALEM/HOSUR	
		CHEM PROCESS SYSTEM	SANAND	
		PROGEN	CHENNAI	
		CRYSTAL ENGINEERING	HOSUR	
		ISHAN EQUIPMENTS	VADODARA	
3.	RUBBER LINING (AT SHOP)	TEMSEC	KOLKATA	
		RISHI INDUSTRIES	SONEPAT	
		CORI ENGINEERS	CHENNAI	
		POLY RUBBER	MUMBAI	
		INDUSTRIAL LINING	VADODARA	
		ARUL RUBBERS	CHENNAI	
		JASMINO POLYMERTECH	TALOJA	
		WESTERN RUBBER	NAVI MUMBAI	
		ELASTOMER LINING	AMBERNATH	



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		EMKAY RUBBER	MUMBAI	
4.	AIR BLOWERS (TWIN LOBE TYPE)	SWAN PNEUMATIC	NOIDA	
		EVEREST TRANSMISSION	NEW DELHI	
		KAY INTERNATIONAL	NEW DELHI / SONEPAT	
		EVEREST BLOWER	BAHADURGARH	
		KULKARNI POWER TOOLS	KOLHAPUR/ PUNE	
5.	METERING PUMPS	VK PUMPS	NASIK	
		MILTON ROY INDIA	CHENNAI	
		SWELLORE	AHMEDABAD	
		POSITIVE METERING PUMPS	NASIK	
		METACHEM	MUMBAI	
6.	AGITATOR	REMI PEOCESS PLANT & M/C	MUMBAI	
		FIBRE & FIBRE	MUMBAI / SILVASA	
		CEECONS	CHENNAI	
		STANDARD ENGINEERS	MUMBAI	
7.	HORIZONTAL CENTRIFUGAL PUMPS	BEST AND CROMPTON ENGG LTD.	CHENNAI	
		BHARAT PUMPS & COMPRESSORS LTD	ALLAHABAD	
		FLOWMORE LTD.	GURGAON	
		FLOWSERVE INDIA CONTROLS PVT. LTD.	COIMBATORE	
		JYOTI LTD.	VADODARA	
		KIRLOSKAR BROTHERS LTD	PUNE	
		WILO MATHER & PLATT PUMPS PVT. LTD.	PUNE	
		V-FLO PUMPS & SYSTEMS CO. LTD.,	BEIJING-CHINA	
8.	VERTICAL CENTRIFUGAL PUMPS	WPIL LIMITED	KOLKATA	
		BHARAT PUMPS & COMPRESSORS LTD	ALLAHABAD	
		FLOWMORE LTD.	GURGAON	
		FLOWSERVE INDIA CONTROLS PVT. LTD.	COIMBATORE	
		JYOTI LTD.	VADODARA	
		WILO MATHER & PLATT PUMPS PVT. LTD.	PUNE	
		SULZER PUMPS INDIA LTD.	THANE	
9.	SCREW PUMP	WPIL LIMITED	KOLKATA	
		UT PUMP		
		ROTO PUMPS		
10.	HORIZONTAL CENTRIFUGAL PUMPS (RUBBER LINED)	TUSHACO		
		KISHORE PUMPS	PUNE	
11.	NON METALLIC (PP/FRP) HORIZONTAL CENTRIFUGAL	SU MOTORS	MUMBAI	
		ENGINEERS COMBINE	THANE	
		ANTICORROSIVE	VALSAD	



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
	PUMPS	LEAK PROOF PUMPS PVT. LTD. (RAJEDIA)	-	
12.	MISC. PUMP VERTICAL TURBINE TYPE	KBL	PUNE	
		M&P	PUNE	
		WPIL	GHAZIABAD	
		KISHORE PUMPS	PUNE	
		FLOWMORE	SAHIBABAD	
		CHHABI ELECTRICALS PVT.LTD.	JALGAON	
		CHLORIDE POWER SYSTEMS & SOLUTIONS LIMITED	KOLKATA	
		DUBAS ENGG PVT LTD	BANGALORE	
		HBL POWER SYSTEMS LTD	HYDERABAD	
		JEMA ENERGY	SPAIN	FOR STATIC SCR TYPE FULL WAVE FULLY CONTROL TYPE
		MASS-TECH CONTROLS PVT.LTD.	MUMBAI	
		STATCON POWER CONTROLS LTD	NOIDA	
13.	UNDER BED NOZZLE	JONSONS SCREEN	AUSTRALIA/ IRELAND	
14.	COATING & WRAPPING MATERIAL TAPE	IWL LTD.	CHENNAI	
		MP TAR PRODUCT	BHILAI	
		PORWAL INDUSTRIES	RAIPUR	
		RUSTECH	KOLKATA	
		STP	JAMSHEDPUR	
15.	HEATER	ESCORTS	FARIDABAD	
		RACOLDS	FARIDABAD	
16.	CLARIFIER/ THICKENER MECHANISM	CLEAR WATER	DELHI	
		TRIVENI	NOIDA	
		PBJ ASSOCIATE	PUNE	
17.	CENTRIFUGE	HUMBOLT	-	
		HILLER	-	
18.	CAST IRON GATE/GLV/IRV/SRV	A.V. VALVES LTD	AGRA	
		ATAM VALVES PVT. LTD.	JALANDHAR	
		FLUIDLINE VALVES COMPANY PVT.LTD.	GHAZIABAD	
		G.M. DALUI AND SONS PVT.LTD.	HOWRAH	
		H.SARKER AND COMPANY	HOWRAH	
		LEADER VALVES LTD.	JALANDHAR	
		VENUS PUMPS AND ENGG. WORKS	KOLKATA	
19.	BALL VALVE (MANUAL /PNEUMATIC/ ELECTRIC) CLASS 150	A.V. VALVES LTD	AGRA	
		AKAY INDUSTRIES PVT.LTD.	DHARWAD	
		BELGAUM AQUA VALVES PVT. LTD.	BELGAUN	
		ASIAN INDUSTRIAL VALVES & INSTRUMENTS.	CHENNAI	



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		ATAM VALVES PVT. LTD.	JALANDHAR	
		DEMBLA VALVES LTD.	THANE	
		M/S GM ENGINEERING	RAJKOT	
		HAWA VALVES (INDIA) PVT. LTD.	NAVI MUMBAI	
		INTERVALVE (INDIA) LTD.	PUNE	
		LEADER VALVES LTD.	JALANDHAR	
		MICROFINISH VALVES PVT LTD.	HUBLI	
		NILON VALVES PRIVATE LIMITED	AHMEDABAD	
		SURYA VALVES AND INSTRUMENTS MFG CO.	CHENNAI	
		UNIFLOW	CHENNAI	
		VALTECH INDUSTRIES	MUMBAI	
		VAAS AUTOMATION PVT. LTD.	NEW DELHI	
		WEIR BDK VALVES- A UNIT OF WEIR INDIA PVT. LTD.	NEW DELHI	
		NGEF	BANGALORE	
		KIRLOSKAR ELECTRIC CO LTD.		
		ASEA BROWN BOVERI		
		MARATHON	KOLKATA	
20.	BUTTER-FLY VALVE	ADVANCE VALVES PVT. LTD.	NOIDA	
		FLUIDLINE VALVES COMPANY PVT.LTD.	GHAZIABAD	
		INSTRUMENTATION LTD.	PALAKKAD	
		INTERVALVE (INDIA) LTD.	PUNE	
		R AND D MULTIPLES (METAL CAST) PVT LTD	MUMBAI	
		SURYA VALVES AND INSTRUMENTS MFG CO.	CHENNAI	
		PENTAIR VALVES AND CONTROLS INDIA PRIVATE LIMITED	NAVI MUMBAI	
		UPADHAYA VALVES MANUFACTURERS PRIVATE LIMITED,	KOLKATA	
		VENUS PUMPS AND ENGG. WORKS	KOLKATA	
		WEIR BDK VALVES- A UNIT OF WEIR INDIA PVT. LTD.	NEW DELHI	
21.	DIAPHRAGM VALVE (MANUAL / PNEUMATIC) CLASS 150	WEIR BDK	HUBLI	
		CRANE FLOW PROCESS	SATARA	
		PROCON	MUMBAI	
		MAJESTIC VALVES (LABLINE)	-	
		HAWA ENGINEERS	AHMEDABAD	
22.	DUAL PLATE CHECK VALVES	ADVANCE VALVES PVT. LTD.	NOIDA	
		FLUIDLINE VALVES COMPANY PVT.LTD.	GHAZIABAD	1. DUAL PLATE CHECK VALVE CI - CLASS 150 & UP TO 600NB, 2. DUAL PLATE CHECK VALVE CCS - CLASS



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
				150 & UP TO 500NB
		R AND D MULTIPLES (METAL CAST) PVT LTD	MUMBAI	
		VENUS PUMPS AND ENGG. WORKS	KOLKATA	CI, CCS & STAINLESS STEEL SPRING ASSISTED DUAL PLATE CHECK VALVES UPTO 700 NB AND 150 CLASS RATING.
23.	Y-TYPE STRAINER / STRAINER (WATER SERVICE)	OTOKLIN GLOBAL BUSINESS LIMITED	MUMBAI	
		GRAND PRIX	NEW DELHI	
		JAYPEE	NEW DELHI	
		GREAVES COTTON	MUMBAI	
		MULTITEX FILTRATION ENGINEERS LIMITED,	NEW DELHI / NOIDA	
		FILTRATION ENGINEERS (I) PVT. LTD	MUMBAI	
		FLUIDNYE	-	
		SUNGOV ENGINEERING PVT. LTD.	DELHI	
		GRAND PRIX	FARIDABAD	
		JAYPEE INDUSTRIES PVT. LTD.	DELHI	
		BHATIA ENGINEERING CO.	DELHI	
24.	RUBBER FLAP TYPE CHECK VALVES	ASHVIK VALVES	-	
		FLOW WAY VALVES	-	
		BDK	-	
		MAJESTIC VALVES (LABLINE INST)	-	
		ADVANCE VALVES	-	
25.	SOLENOID VALVES	ROTEX	-	
		AVCON	-	
26.	CHAIN PULLEY BLOCK	ARMSEL MHE PVT. LTD	BANGALORE	
		CENTURY CRANE ENGINEERS PVT. LTD.	FARIDABAD	
		HERCULES HOISTS LTD.	RAIGAD	
		LIFTING EQUIPMENTS AND ACCESSORIES	DELHI	
		TUOBRO FURGUSON (INDIA) PVT LTD	KOLKATA	UPTO 10 TONNE.
		TRACTEL TIRFOR INDIA PVT. LTD.	FARIDABAD	
		TECHNO INDUSTRIES	AHMEDABAD	
		ARMSEL MHE PVT. LTD	BANGALORE	
		ALPHA SERVICES	BHIWADI	
		CONSOLIDATED HOISTS PVT LTD	PUNE	UPTO 20 TONNES
		CENTURY CRANE ENGINEERS PVT. LTD.	FARIDABAD	
		EDDY CRANES PVT. LTD.	MUMBAI	CAPACITY UPTO 10 TONS. BOIS BHEL APP.SUB-VENDORS.
		GRIP ENGINEERS PVT. LTD.,	FARIDABAD,	



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		GLOBAL TECHNOLOGIES	HYDERABAD	
		HERCULES HOISTS LTD.	RAIGAD	
		LIFTING EQUIPMENTS AND ACCESSORIES	DELHI	
		MANGLA HOISTS PVT LTD	NEW DELHI	
		MEEKA MACHINERY PVT. LTD.	AHMEDABAD	
		REVA INDUSTRIES LTD.	FARIDABAD	UPTO 25.0 T CAPACITY.
		ROCKWELL HOISTO CRANES PVT. LTD.	BAHADURGARH	
		SAFEX ENERGY PVT. LTD.	AHMEDABAD	
		TUOBRO FURGUSON (INDIA) PVT LTD	KOLKATA	UPTO 15 TONNES.
		TECHNO INDUSTRIES	AHMEDABAD	
		ARMSEL MHE PVT. LTD	BANGALORE	
		ALPHA SERVICES	BHIWADI	
		CONSOLIDATED HOISTS PVT LTD	PUNE	UPTO 20 TONNES
		CENTURY CRANE ENGINEERS PVT. LTD.	FARIDABAD	
		EDDY CRANES PVT. LTD.	MUMBAI	CAPACITY UPTO 10 TONS. BOIS BHEL APP.SUB-VENDORS.
		GRIP ENGINEERS PVT. LTD.,	FARIDABAD,	
		GLOBAL TECHNOLOGIES	HYDERABAD	
		HERCULES HOISTS LTD.	RAIGAD	
		LIFTING EQUIPMENTS AND ACCESSORIES	DELHI	
		MANGLA HOISTS PVT LTD	NEW DELHI	
		MEEKA MACHINERY PVT. LTD.	AHMEDABAD	
		REVA INDUSTRIES LTD.	FARIDABAD	UPTO 25.0 T CAPACITY.
		ROCKWELL HOISTO CRANES PVT. LTD.	BAHADURGARH	
		SAFEX ENERGY PVT. LTD.	AHMEDABAD	
		TUOBRO FURGUSON (INDIA) PVT LTD	KOLKATA	UPTO 15 TONNES.
		TECHNO INDUSTRIES	AHMEDABAD	
		SPX CORPORATION, USA	AHMEDABAD	
		CONTROL COMPONENT INC.	CALIFORNIA	
		DRESSER VALVE INDIA PVT. LTD	COIMBATORE	
		DAUME REGELARMATUREN GMBH,	GERMANY	
		EMERSON PROCESS MANAGEMENT CHENNAI LIMITED	CHENNAI	
		WEIR VALVES & CONTROLS UK LTD.	U.K	
		HOLTER REGELARMATUREN GMBH & CO.KG	GERMANY	
		INSTRUMENTATION LTD.	KERALA	



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		KOSO INDIA PRIVATE LIMITED,	NASHIK	
		LESLIE CONTROLS, INC	USA	
		MIL CONTROLS LTD.	KERALA	
		METSO SINGAPORE PTE. LTD.,	SINGAPORE	
		PARCOL S.P.A	ITALY	
		R.K.CONTROL INSTRUMENTS PVT. LTD.	THANE	
		RINGO VALVULAS S.L,	SPAIN	
		SHENJIANG VALVE CO. LTD.	CHINA	
		VALVITALIA S.P.A. ,	ITALY	
		WALDEMAR PRUSS ARMATURENFABRIK GMBH	GERMANY	
		ASHCROFT INDIA PVT LTD.	GUJARAT	
		BUDENBERG GUAGE CO.LTD.	UK	
		FORBES MARSHALL (HYD) LTD.	HYDERABAD	
		GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	GOA	
		GOA THERMOSTATIC INSTRUMENTS PVT.LTD.		
		GAUGE BOURDON INDIA PVT. LTD.	MUMBAI	
		H.GURU INDUSTRIES	KOLKATA	
		H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	BANGALORE	
		BAUMER TECHNOLOGIES INDIA PVT. LTD.	MUMBAI	
		FLOW STAR ENGINEERING PVT. LTD.,	FARIDABAD	
		FLOWTECH INSTRUMENTS SERVICRS	VADODARA	
		INSTRUMENTATION ENGINEERS PVT LTD	TELANGANA	
		SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	NAVI MUMBAI	
		ABB	-	
		HONEYWELL	-	
		V AUTOMAT	-	
		YOKOGAWA	-	
		SIEMENS	-	
		FORBES MARSHALL	-	
		YOKOGAWA	-	
		HONEYWELL	-	
		ABB	-	
		HACH	-	
		FORBES MARSHALL	-	
		APC	BANGALORE	
		DELTA	GURGAON	



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		EMERSON	MUMBAI	
		DB POWER	PUNE	
		APLAB	MUMBAI	
		COMET	-	
		DOWELL	-	
		CHETNA	-	
29.	MS PLATES	SAIL		
		ESSAR STEEL		
		TISCO		
		RINL		
		JINDAL		
		LLOYD		
		ISPAT		
		INDIAN IRON & STEEL CO. LTD		
30.	CS PIPE (ASTM A 106 GR. B)	INDIAN SEAMLESS METAL TUBES	AHMEDABAD	UPTO 150 NB
		MAHARASHTRA SEAMLESS	RAIGAD	UPTO 350 NB
31.	MS PIPES (IS: 1239 & 3589)	SAIL	ROURKELA	
		JINDAL	GHAZIBAD/HISSAR	
		SURYA ROSHNI	BAHADUR GARH	
		TATA TUBE	JAMSHEDPUR	
		PSL	CHENNAI/VIZAG/KUTCH/DAMAN	
		LALIT PROFILE	THANE	
		SAMSHI PIPES INDUSTRIES	VADODARA	
		MUKUT PIPES	RAJPURA	
		INDUS TUBES	G B NAGAR	
		MANN IND	INDORE	
		SURENDRA ENGG	RAJPURA	
		PRATIBHA PIPES & STRUCTURE PVT LTD	THANE	
		JCO GAS PIPE	CHINDWARA	
		NUKAT TANKS AND VESSELS	TARAPUR	
		DADU PIPES	SIKANDRABAD	
		GOOD LUCK TUBES	SIKANDRABAD	
		ADVANCE STEEL TUBES	SAHIBABAD	
		BIHAR TUBES	SIKANDRABAD	
		HI TECH PIPES	SIKANDRABAD	
		RATNAMANI	KUTCH/AHMEDABAD/CHHATRAL	



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		MAHARASHTRA SEAMLESS	RAIGAD	
		WELSPUN	ANJAR/BHARUCH	
32.	SS PIPES / TUBES	APEX TUBES	BEHROR (ALWAR)	
		RATNAMANI	CHATTRAL	
		REMI	TARAPUR	
		PRAKASH STEELAGE	-	
		RADIANT CABLES	HYDERABAD	
		POLYCAB	DAMAN	
		KEI	BHIWADI	
		NICCO	KOLKATA	
		RAVIN CABLES	PUNE	
		INCAB	PUNE	
		HVPL	FARIDABAD	
		TORRENT CABLE	NADIAD	
		HAVELLS	ALWAR	
		PARAMOUNT	KHUSHKHERA	
		SRI RAM CABLES	BHIWADI	
		THERMOCABLES	HYDERABAD	
		TORRENT CABLE	NADIAD	
		UNIVERSAL CABLES	SATNA	
		GEMSCAB	BHIWADI	
		DELTON	FARIDABAD	
33.	SAFETY SHOWER	UNICARE	-	
		MOHAN INDUSTRIES	-	
		SUPER SAFETY SERVICES	-	
34.	FRP TANKS & FITTINGS	GLOBAL COMPOSITE	-	
		EPP	-	
		DEEPA COMPOSITE	-	
		COROSEAL INDUSTRIES	-	
		CHEMICAL PROCESS & EQUIPMENT PVT LTD	-	
		J.R FIBRE INDUSTRIES PVT LTD	-	
		POLYPLAST	-	
35.	EJECTOR	ESSEM TECHNOLOGIES	-	
		RATNA PRASAD	-	
		POSITRONICS	-	
		DELTA CONTROL	-	
		L & T	-	



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		GE POWER	-	
		PYROTECH	-	
		C& S	-	
36.	TANK (FRP)	INDUSTRIAL SERVICE	KOLKATA	
		SUNRISE	BARODA	
		GANDHI & ASSOCIATES	AHMEDABAD	
		MODERN EQUIPMENTS	CHENNAI	
		EAGLE PLAST	PUNE	
		OMEGA PLAST	MUMBAI	
		METACHEM	MUMBAI	
		SWELORE	AHMEDABAD	
		MILTON ROY INDIA	CHENNAI	
37.	SAFETY VALVES/RELIEF VALVES	METACHEM	MUMBAI	
		KEYSTONE	BARODA	
		V K PUMPS	NASIK	
		MILTON ROY	CHENNAI	
38.	DUPLEX STRAINER	JAYPEE INDUSTRIES PVT. LTD.	NEW DELHI	
		MULTITEX FILTRATION ENGINEERS LIMITED,	NEW DELHI	
		OTOKLIN GLOBAL BUSINESS LIMITED	MUMBAI	
		SUNGOV ENGINEERING PVT. LTD.	CHENNAI	
39.	ORIFICE PLATE	MICRO PRECISION	FARIDABAD	
		INSTRUMENTAION LTD	PALGHAT	
		CARLO DYNAMICS	HYDERABAD	
40.	STEEL GATE/GLOBE/NR VALVES	A.V. VALVES LTD	AGRA	
		ATAM VALVES PVT. LTD.	JALANDHAR	(1) CARBON STEEL GATE VALVES & NON RETURN VALVES: 15 NB TO 50 NB (#800) & 65 NB TO 300 NB (#150) (2) CARBON STEEL GLOBE VALVES: 15 NB TO 50 NB (#800) & 65 NB TO 200 NB (#150)
		FLUIDLINE VALVES COMPANY PVT.LTD.	KAUSHAMBI	
		M/S GM ENGINEERING	RAJKOT	
		INTERVALVE (INDIA) LTD.	PUNE	A) STEEL GATE VALVES: UPTO 50NB, #800 AND 65NB TO 150NB, #150 B) STEEL GLOBE VALVES: UPTO 50NB, #800 AND 65NB TO 100NB, #150 C) SUPPLIER NOT REGISTERED FOR NR



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
				VALVES
		LEADER VALVES LTD.	JALANDHAR	
		NITON VALVE INDUSTRIES PVT LTD	MUMBAI	
		NSSL LIMITED.	NAGPUR	
		STEEL STRONG VALVES (I) PVT.LTD.,	NAVI MUMBAI	LIMITED TO RANGES & CLASSES AS AVAILABE IN VD FILE.
		VENUS PUMPS AND ENGG. WORKS	KOLKATA	CC/CSS-GATE-BBT- UPTO600NB CL UPTO300,GATE-PSBT UPTO250NB CL 1500, GLV-BBT- UPTO300NB CL UPTO600,SCNRV-BBT- UPTO600NB CL UPTO150,SCNRV-BBT- UPTO300NB CL 300,SCNRV-PSBT- UPTO150NB CL UPTO900
		VALTECH INDUSTRIES	MUMBAI	
		V.K. VALVES PVT. LTD.,	JALANDHAR	
		WEIR BDK VALVES- A UNIT OF WEIR INDIA PVT. LTD.	NEW DELHI	
41.	SLUICE GATE	H SARKAR	KOLKATA	
		JASH ENGINEERING	-	
		YASHWANT INDUSTRIES	-	
42.	3 WAY VALVE	HI TECH	AHMEDABAD	
		ADVANCE VALVES PVT.LTD	NOIDA	
		BDK	HUBLI	
		FOURESS ENGG.INDIA LTD.	MUMBAI	
		FLUIDLINEVALVES COMPANY PRIVATE LTD.,	MUMBAI	
		INSTRUMENTATION LTD.	PALAKAD	
		KIRLOSKAR BROTHERS LTD.	PUNE	
		VENUS PUMP & ENGG. WORKS	KOLKATA	
		SURYA VALVES AND INSTRUMENTS MANUFACTURING COMPANY	CHENNAI	
		STAFFORD CONTROLS LIMITED	PUNE	
		MICON VALVES (INDIA) PVT.LTD	MUMBAI	
43.	PLUG VALVE(MANUAL)	BDK	HUBLI	
		HAWA ENGINEERS / MARCK & CARE	-	
		MICON VALVES	-	
		MICON VALVES (INDIA) PVT.LTD	MUMBAI	
44.	FITTINGS (CS/SS)	M.S. FITTINGS	KOLKATA	



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		METAL LLOYDS	MUMBAI	
		TRUE FORGE	FARIDABAD	
		TUBE PRODUCTS	BARODA	
		NL HAZRA	KOLKATA	
		GUJRAT INFRA PIPES	BARODA	
		EDWARDS	USA	
		PIPEFIT ENGINEERS	BARODA	
		SIDDARTH & GAUTAM	FARIDABAD	
		EBY	MUMBAI	
45.	FLANGES (SS/CS)	PRADEEP METALS LTD	MUMBAI	
		TUBE PRODUCT INCORPORATION	BARODA	
		MS FITTINGS	KOLKATA	
		HAWA ENGINEERING	-	
		ALIANCE PIPE & PLANGES	KOLKATA	
		JAI AMBE	MUMBAI	
46.	PIPE & FILLTING (PP,HDPE,PVC & CPVC)	GEROGE FISHCHER	DELHI	
		ASTROL PLYTECHINC LTD	AHMEDABAD	
		JAIN IRRIGATION	-	
		ORIPLAST	-	
47.	VALVES (GATE/GLOBE/NRV/BALL)- (PP,HDPE,PVC & CPVC)	GEROGE FISHCHER IPING SYSTEMS PVT LTD	DELHI	
		ASTROL PLYTECHINC LTD	AHMEDABAD	
		JAIN IRRIGATION	-	
		ORIPLAST	-	
48.	AIR FILTER REGULATOR	SHAVO NORGEN	-	
		PLACKA INSTRUMENTS	-	
49.	FILTER MEDIA	GLOBAL ABSORBENT	KOLKATA	
		BHARAT MINERALS		
50.	DC LEAD ACID / NI-CD BATTERIES	AMCO SAFT INDIA LTD	BANGALORE	NI-CD BATTERIES ONLY
		EXIDE INDUSTRIES LTD	NEW DELHI	LEAD ACID BATTERIES ONLY.
		HBL POWER SYSTEMS LTD	HYDERABAD	NI/CD AND TUBULAR TYPE FOR LEAD ACID
		HOPPECKE BATTERIEN GMBH & CO.KG,	GERMANY	
51.	DC LEAD ACID BATTERIES	EXIDE INDUSTRIES LTD	NEW DELHI	
		HBL POWER SYSTEMS LTD	HYDERABAD	TUBULAR TYPE
		HOPPECKE BATTERIEN GMBH & CO.KG,	GERMANY	
52.	DC NI CD BATTERIES	AMCO SAFT INDIA LTD	BANGALORE	
		HBL POWER SYSTEMS LTD	HYDERABAD	



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		HOPPECKE BATTERIEN GMBH & CO.KG,	GERMANY	
53.	SIGHT FLOW INDICATORS	B.K.EQUIPMENTS PVT.LTD.	CHENNAI	
		BLISS ANAND PVT. LTD.	GURGAON	
		FLOWTECH INSTRUMENTS SERVICRS	VADODARA	
		INSTRUMENTATION ENGINEERS PVT LTD	TELANGANA	
		SIGMA INSTRUMENTS CO.	MUMBAI	
		SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	NAVI MUMBAI	
		TELACE EQUIPMENT PVT.LTD.	CHENNAI	
54.	PAINT	ASIAN PAINTS (I) LTD.		
		BERGER PAINTS INDIA LTD		
		GOODLASS NEROLAC		
		JENSON & NICHOLSON (I) LTD		
		CDC CARBOLINE (I) LTD.		
		SHALIMAR PAINTS LTD.		
		ADDISON PAINTS LTD		
		GRAND POLYCOAT		
		BOMBAY PAINTS		
		HEMPLE PAINTS (SINGAPORE)		
		JOTUN PAINTS		
55.	PNEUMATIC ACTUATOR	PROCON ENGINEERS	-	
		TYCO	-	
		CRANE PROCESS	-	
		BDK	-	
		INTERVALVE	-	
		BRAY CONTROL	-	
56.	MOTORISED ACTUATOR	ROTARK	-	
		AUMA	-	
		LIMITORK	-	
57.	LT MOTORS	ABB	14, MATHURA ROAD, FARIDABAD, HARYANA-121003	
		BHARAT BIJLEE LTD.	BHARAT BIJLEE LIMITED, 1ST FLOOR, 7-B, RAJINDRA PARK, PUSA ROAD, NEW DELHI - 110 060.	
		CROMPTON GREAVES	3RD FLOOR, EXPRESS BUILDING,9-10, BAHADUR SHAH ZAFAR MARG, NEAR ITO CROSSING,NEW DELHI-110002, INDIA	
		GE-POWER	KAMAK TOWER, 3RD FLOOR, PLOT NO. 12-A, TVK INDUSTRIAL ESTATE,	



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
			EKKADUTHANGAL, GUINDY, CHENNAI-600032	
		KIRLOSKAR ELECTRIC CO LTD.	P.O. BOX 5555 , MALLESWARAM WEST BANGALORE 560055	
		LAXMI HYDRAULICS PVT. LTD	129/130, INDUSTRIAL ESTATE PATIL NAGAR, HOTGI ROAD SOLAPUR-413003, MAHARASHTRA	
		MARATHON	MARATHON ELECTRIC INDIA PRIVATE LTD.SECTOR - 11, MODEL TOWN, FARIDABAD - 121006	
		NGEF	POCKET NO.10, FLAT NO. 37 & 38, EXPANDABLE DDA FLATS, NASIRPUR DWARKA, PHASE-I NEW DELHI-110 045	
		RAJINDRA ELECT INDUSTRIES	14 SHAH IND.ESTATE VEERA DESAI RD,ANDHERI(W) MUMBAI-400053	
		SIEMENS	RC-IN I S NR DEL AREA, JIL BUILDING, TOWER-B, PLOT NO. 78, SECTOR 18, GURGAON-122015, INDIA	
58.	JUNCTION BOXES	Jasper Engineers Pvt. Ltd.	A-23, SECTOR - 8, NOIDA- 201301	
		Electro Controls & Devices	F-41, SITE-C, SURAJPUR INDUSTRIAL AREA GREATER NOIDA, UTTAR PRADESH :201308	
		M/s Shrenik & Co.	39A/3, PANCHRATNA INDUSTRIAL ESTATE, SARKHEJ-BAVLA ROAD, CHANGODAR, AHMEDABAD - 382 213	
		M/s PHOENIX MECANO LTD.,	388 BHARE, TALUKA MULSHI, POST GHOTAWADE, PIRANGOOT, INDUSTRIAL AREA, PUNE-412115	
		Adroit Control Engineers Pvt.Ltd.	PLOT-3, KRISHNA INDL. AREA, SECTOR-25 FARIDABAD - 121004	
		M/s PHOENIX MECANO LTD.,	388 BHARE, TALUKA MULSHI, POST GHOTAWADE, PIRANGOOT, INDUSTRIAL AREA, PUNE-412115	
		MIKA ENGINEERS	BRANCH OFFICE : 'D'-101, DHEERAJ HERITAGE RESIDENCY II, SHASTRI NAGAR, SANTACRUZ (W), MUMBAI 400 054.	
		M/s PHOENIX MECANO LTD.,	388 BHARE, TALUKA MULSHI, POST GHOTAWADE, PIRANGOOT, INDUSTRIAL AREA, PUNE-412115	
		BAJAJ ELECTRICALS	ENGINEERING & PROJECTS BU (NORTH) 3rd FLOOR, GULMOHARHOUSE, COMMUNITY CENTRE 161/B-4, GAUTAM NAGAR, YUSUF	



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
			SARAI NEW DELHI – 110049	
		AJMERA INDUSTRIES & ENGG. WORKS	AJMERA INDL. AND ENGG. WORKS. AJMERA HOUSE, A-61 / KHAIRANE MIDC. , TTC INDL. AREA, NAVI MUMBAI – 400705.	
		S.B. ELECTRICAL ENGINEERING CORPORATION	03, SARDAR GRIHA BUILDING, LOHAR CHAWAL, MUMBAI-400002	
59.	DC BATTERY CHARGER	AMARA RAJA POWER SYSTEMS LIMITED	TAMIL NADU	
		CHHABI ELECTRICALS PVT.LTD.	MAHARASHTRA	
		CHLORIDE POWER SYSTEMS & SOLUTIONS LIMITED	KOLKATA	
		DUBAS ENGG PVT LTD	BANGALORE	
		EMERSON NETWORK POWER (INDIA) PVT. LTD.	MAHARASHTRA	
		HBL POWER SYSTEMS LTD	HYDERABAD	
		JEMA ENERGY (For Static SCR Type Full Wave fully Control type)	Lasarte-Oria--SPAIN	
		MASS-TECH CONTROLS PVT.LTD.	MUMBAI-MAHARASHTRA	
		STATCON POWER CONTROLS LTD	NOIDA-UTTAR PRADESH	
60.	DC NI-CD BATTERY	AMCO SAFT INDIA LTD	BANGALORE-KARNATAKA	
		HBL POWER SYSTEMS LTD	HYDERABAD-TELANGANA	
61.	DC LEAD ACID BATTERY	EXIDE INDUSTRIES LTD	NEW DELHI	
		HBL POWER SYSTEMS LTD (FOR TUBULAR TYPE)	HYDERABAD-TELANGANA	
		HOPPECKE BATTERIEN GMBH & CO.KG,	HOPPECKE, GERMANY	
62.	LUGS	DOWELLS	47/47A, SATGURU INDUSTRIAL ESTATE. OFF AAREY ROAD, GOREGOAN (EAST). MUMBAI 400 063.	
		UNIVERSAL MACHINES LTD.	4,B.B.D.BAG (EAST) 90,STEPHEN HOUSE,5TH FLR CALCUTTA-700001	
63.	GLANDS	ALLIED TRADERS & EXPORTERS	C-124 A, SECTOR-2, NOIDA -201 301, UTTAR PRADESH, INDIA	
		ARUP ENGG & FOUNDARY WORKS	391/119,PRINCE ANWAR SHAH ROAD, CALCUTTA-700068	
		BALIGA LIGHTING EQPT.PVT.LTD.	63A,CP RAMASWAMY ROAD, ALWARPET,P.B.No 6910, CHENNAI-600018	
		COMMET BRASS PRODUCTS	NUTAN CHEMICAL COMPOUND, WALBHAT ROAD, GOREGAON, MUMBAI-400063	
		DOWELLS	47/47A, SATGURU INDUSTRIAL ESTATE.OFF AAREY ROAD,	



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
			GOREGOAN (EAST). MUMBAI 400 063.	
		ELECTROMAC INDUSTRIES	27/28AF NEW EMPIRE IND. ESTT., R. KRISHNA MANDIR RD. JB NGR , ANDHERI (E), MUMBAI-400059	
		INCAB	HARE STREET, KOLKATA, WEST BENGAL-700001	

Customer Vendor List

2X660 MW Ennore SEZ SUPERCRITICAL TPS

Sl. No.	Package Name	Vendor Name	Remarks
CONTROL AND INSTRUMENTATION (C&I) PACKAGES			
1	ANUBAR (DELTA TUBE)	STAR-MECH CONTROLS (I) PVT.LTD.	Approved
		TM TECNOMATIC SPA	Submit credentials
		SWITZER INSTRUMENT LTD.	Approved
2	CONTROL VALVE	RINGO VALVULAS S.L,	Submit credentials
		Severn Glocon India Pvt. Ltd.	Submit credentials
		CONTROL COMPONENT INC.	Approved
		DRESSER VALVE INDIA PVT. LTD	Submit credentials
		LESLIE CONTROLS, INC	Submit credentials
		SPX Corporation, USA	Submit credentials
		Daume Regelarmaturen GmbH,	Submit credentials
		INSTRUMENTATION LTD.	Approved
		Valvitalia S.P.A. ,	Submit credentials
		WEIR VALVES & CONTROLS UK LTD.	Approved
		Koso India Private Limited,	Submit credentials
		FORBES MARSHALL ARCA PVT.LTD.	Approved
		R.K.CONTROL INSTRUMENTS PVT. LTD.	Approved

		EMERSON PROCESS MANAGEMENT CHENNAI LIMITED	Approved
		HOLTER REGELARMATUREN GmbH & Co.KG	Submit credentials
		MIL CONTROLS LTD.	Approved
		SHENJIANG VALVE CO. LTD.	Submit credentials
		Metso Singapore PTE. LTD.,	Approved
3	FLOW ELEMENT - NOZZLE	HYDROPNEUMATICS PVT. LTD.	Approved
		INSTRUMENTATION LTD.	Approved
		MICRO PRECISION PRODUCTS PVT. LTD.	Approved
		STAR-MECH CONTROLS (I) PVT.LTD.	Approved
		SEIKO FLOW CONTROL GMBH	Approved
4	FLOW ELEMENT - ORIFICE	MICRO PRECISION PRODUCTS PVT. LTD.	Approved
		INSTRUMENTATION LTD.	Approved
		HYDROPNEUMATICS PVT. LTD.	Approved
		Flow Star Engineering Pvt. Ltd.,	Approved
		STAR-MECH CONTROLS (I) PVT.LTD.	Approved
		MINCO (INDIA) PRIVATE LIMITED	Approved
		INSTRUMENTATION ENGINEERS PVT LTD	Approved

5	PROGRAMMABLE LOGIC CONTROLLER	GE Intelligent Platforms Private Limited	Approved
		SIEMENS LIMITED	Approved
		ROCKWELL AUTOMATION INDIA LTD	Approved
		SCHNEIDER ELECTRIC INDIA PVT.LTD.	Approved
		Honeywell Automation India Limited	Approved
6	ROTAMETER	FLOWTECH INSTRUMENTS SERVICES	Approved
		Flow Star Engineering Pvt. Ltd.,	Approved
		EUREKA INDUSTRIAL EQUIPMENTS PVT.LTD.	Approved
		SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Approved
		INSTRUMENTATION ENGINEERS PVT LTD	Approved
7	ULTRASONIC FLOW TRANSMITTERS	New Package	
8	SIGHT FLOW INDICATORS	TELACE EQUIPMENT PVT.LTD.	Submit credentials
		BLISS ANAND PVT. LTD.	Approved
		B.K.EQUIPMENTS PVT.LTD.	Approved
		SIGMA INSTRUMENTS CO.	Approved
		FLOWTECH INSTRUMENTS SERVICES	Approved
		INSTRUMENTATION ENGINEERS PVT LTD	Approved
		SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Approved

PACKAGE CATEGORY – CONTROL & INSTRUMENTATION

SL. NO.	ITEM	VENDOR NAME
1.	CONTROL VALVE	
		DeZURIK – COPES VULCAN LTD., U.K
		CONTROL COMPONENT INC., USA
		DRESSER VALVE INDIA PVT. LTD
		FISHER SANMAR LIMITED
		INSTRUMENTATION LTD.
		FORBES MARSHALL ARCA PVT.LTD.
2.	FLOW ELEMENT	
		BRISTOL BABCOCK LTD., U.K
		BALIGA LIGHTING EQUIPMENTS PRIVATE LIMITED, CHENNAI
		ENGINEERING SPECIALITIES PRIVATE LTD
		INSTRUMENTATION LTD
		MICRO PRECISION PRODUCTS
		STAR-MECH CONTROLS (I) PVT.LTD

PACKAGE CATEGORY: CIVIL

I	VIBRATION ISOLATION SYSTEM	
		GERB SCHWINGUNGSISOLIERUNGEN GmbH & CO. KG
II	VIS FOR MILLS/ FANS/ FOUNDATIONS/ SUPERVISION	
		GERB VIBRATION CONTROL SYSTEMS PVT LTD
III	WEIGH BRIDGE	
		TECHNO SCALE INDUSTRIES, AHMEDABAD
		SOUTHERN SCALES COMPANY, NASIK
		IPA PVT LTD, BANGALORE

PACKAGE CATEGORY: MECHANICAL AUXILIARY (2nd ADDN LIST)

I	ASH HANDLING SYSTEM	
		MELCO INDIA PVT. LTD., FARIDABAD
		DRIPLEX WATER ENGG. LTD.
		DC INDTL. PLANT SERVICES PVT. LTD.
		INDURE PVT. LTD.
		MAHINDRA ASHTECH LTD.
		McNALLY BHARAT ENGG. CO. LTD.
		MACAWBER BEEKAY PVT. LTD.
		UNITED CONVEYOR CORPORATION, USA
		UNITED CONVEYOR CORPORATION (INDIA) PVT. LTD., KOLKATA
II	CHIMNEY ELEVATORS	
		AVON CRANES PVT. LTD.

Shrinani
 EXECUTIVE ENGINEER/PROJECTS
 TAMILNADU ELECTRICITY BOARD
 5th FLOOR, NPKR/ MAALIGAI
 144, ANNA SALAI, CHENNAI-600 002

BHEL Vendor List

PEM REGISTERED VENDOR

SLNO	Package Code	Package Name	Vendor Code	Vendor Name	Reg Status	Grade	Vendor Address	Remarks
1	145-07000-A	ANALYTICAL INSTS.SAMPLE COOLER	J001	FORBES MARSHAL PVT. LTD.	REGULAR	NA	A-33/34, MIDC ESTATE, H-BLOCK, PIMPRI, PUNE-MAHARASHTRA-INDIA Phone- 27470171,27477472 Pincode : 411018 Email : nkaushal@forbesmarshall.com	, ,
2	145-07000-A	ANALYTICAL INSTS.SAMPLE COOLER	R002	EMERSON PROCESS MANAGEMENT (INDIA) PVT.LTD.	REGULAR	NA	Mr. Amit Paithankar/Vikram Raj Singh 206-210,BALARAMA BUILDING 2ND FLR. BANDRA EAST MUMBAI-MAHARASHTRA-INDIA Phone- 9619121500 Pincode : 400051 Email : vikramraj.singh@emerson.com	, ,
3	145-07000-A	ANALYTICAL INSTS.SAMPLE COOLER	S001	SIEMENS LIMITED	REGULAR	NA	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai-Maharashtra-INDIA Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com	, ,
4	145-23000-A	ANUBAR (DELTA TUBE)	S009	SWITZER PROCESS INSTRUMENTS PVT. LTD.	REGULAR	NA	B Kannan/V S Jayaprakash 9, SOUTH BOAG ROAD, II FLOOR, PB NO-1423, T.NAGAR, CHENNAI-TAMIL NADU-INDIA Phone- 044-24340999 / 24344 Pincode : 600017 Email : marketing@switzerinstrument.com	Name changed from "M/s Switzer Instrument Ltd." to "M/s Switzer Process Instruments Pvt. Ltd." w.e.f. 27.07.2016; , ,
5	145-23000-A	ANUBAR (DELTA TUBE)	S044	STAR-MECH CONTROLS (I) PVT.LTD.	REGULAR	B	SUSHILLOTAM, SUSHILLOTAM, 29/3A/3, SASANE NAGAR, HADAPSAR, PUNE-MAHARASHTRA-INDIA Phone- 02026970450 Pincode : 411028 Email : marketing@star-mech.net	, ,
6	145-23000-A	ANUBAR (DELTA TUBE)	M009	MICRO PRECISION PRODUCTS PVT. LTD.	REGULAR	NA	K.P. CHANDHOK/ATUL CHANDHOK 4, LINK ROAD, FARIDABAD-HARYANA-INDIA Phone- 9810265688 Pincode : 121002 Email : nal@microa1.com	, ,
7	145-23000-A	ANUBAR (DELTA TUBE)	D212	DYNAFLUID VALVES AND FLOW CONTROLS (P) LTD.	REGULAR	NA	Mr. Yogish M. Kulkarni Plot # 23, Udyambag, Belgaum-karnataka-India Phone- 0831-4210386 Pincode : 590008 Email : yogish@dynafluid.com	, ,
8	145-23000-A	ANUBAR (DELTA TUBE)	T108	TM TECNOMATIC SPA	REGULAR	NA	MR. ANTONIO NOVIELLO/Mrs. Enrica Bazzoc VIA DELLE INDUSTRIE, 36 CREMONA-ITALY Phone- 39037221574 Pincode : 26100 Email : info@tmtcnomatic.com	, ,
9	145-31000-A	Cold Junction Compensation Box (CJCB)	C048	CREATIVE INSTRUMENTS & CONTROLS	REGULAR	B	NO-17/1, 1ST FLOOR, 11TH CROSS 1ST K BLOCK, RAJAJINAGAR, BANGALORE-560010 -- Phone- Pincode : Email : crinstruments@gmail.com	, ,

10	145-04000-A	CONTROL VALVE	C010	SPX Flow Technology (I) Pvt. Ltd.	REGULAR	NA	Survey No 275, Odhav Road, Odhav Ahmedabad-Gujarat-India Phone- +91 (0) 8939963099 Pincode : 382415 Email : siva.prakash@spx.com	Name changed from M/s DeZURIK-Copes Vulcan Ltd. to M/s SPX Corporation, USA as per 25th MISCC-Electrical and C&I dtd. 20.02.2014; Put on HOLD for 6 months w.e.f. 18.05.2012 & uplifted on 19.03.2014.; , POs to be placed on Indian subs.M/s SPX Flow Technology (I) Pvt. Ltd., Ahmedabad, India and the material will be supplied as per scope matrix[Available at CMM-->VD DOCUMENTS-->SCOPE
11	145-04000-A	CONTROL VALVE	D027	DRESSER VALVE INDIA PVT. LTD	REGULAR	NA	Mr. Raj Raman/Mr. Rajkumar Moria S.F. No: 608,Chettipalayam Road, Echanari Post, Coimbatore-Tamilnadu-INDIA Phone- +91-98451 19085 Pincode : 641021 Email : Anoop.Ramachandran@ge.c	, ,
12	145-04000-A	CONTROL VALVE	D057	Daume Regelarmaturen GmbH,	REGULAR	NA	Mr. Björn Carstensen Am Springbrunnen 23, Barleben--Germany, Phone- 9820805424, Pincode : 39179 Email : madhu@aumvn.com, info@daume-regelarmaturen.de,	GCC R.5 accepted by vendor. , Reviewed in MISCC dt. 21.07.2015 for non-response in 4 consecutive tender enquiry;
13	145-04000-A	CONTROL VALVE	F015	EMERSON PROCESS MANAGEMENT CHENNAI LIMITED	REGULAR	C	147, KARAPAKKAM VILLAGE, CHENNAI-TAMIL NADU-INDIA Phone- 23722184, 23716242 Pincode : 600096 Email : jatinder.singh@emerson.com	Vendor's name changed from "Fisher Sanmar Limited" to "Emersion Process Management Chennai Limited" w.e.f. 22.09.2011 , ,
14	145-04000-A	CONTROL VALVE	F030	FORBES MARSHALL ARCA PVT.LTD.	REGULAR	NA	A-34/35 , MIDC ESTATE, H-BLOCK, PIMPRI, PUNE,- MAHARASTRA-INDIA, Phone- 020-27442020, Pincode : 411018 Email : mnadgaundi@forbesmarshall.com	, Technical limit reviewed on 30.04.2014 and further revised on 29.12.2015; , Reviewed in MISCC dt. 21.07.2015 for non-response in 4 consecutive tender enquiry;
15	145-04000-A	CONTROL VALVE	H057	HOLTER REGELARMATUREN GmbH & Co.KG	REGULAR	NA	HOLTER REGELARMATUREN GmbH & Co.KG , Helleforthstrasse 58-60, D 33758 Schloss Holte-Stukenbrock Germany-- Phone- 0049-05207/88037 Pincode : Email : mail@hora.de	, HOLD due to non-responsse /non-participation w.e.f. 31.01.2013; Hold removed w.e.f. 16.10.2014.

16	145-04000-A	CONTROL VALVE	K048	Koso India Private Limited,	REGULAR	A	H 33 & 34, MIDC, Ambad, Nashik,-Maharashtra,-India, Phone- 91 944 744 3198 Pincode : 422010, Email : seemaanand_sa@koso.co.in	, The name has been changed from M/s KOSO FLUID CONTROLS (PVT) LTD to M/s Koso India Private Limited as per 11th MISCC Elect and C&I dated 30.07.2013. , Approved works at Control Valve Division, H-33&34, Ambad, Nashik w.e.f. 12.10.2015; Additional works at "J-1,MIDC,Ambad, nashik-422010" approved w.e.f. 17.06.2016;
17	~~145-04000-A~~	CONTROL VALVE	M005	MIL CONTROLS LTD.	REGULAR	B	Mr.Jacob Cherian/Mr.Geo Jolly Meladoor, Annamanada P.O. MALA, Thrissur-KERALA INDIA Phone- 0480-2695700 Pincode : 680741 Email : biju.simon@ksb.com	, ,
18	~~145-04000-A~~	CONTROL VALVE	I006	INSTRUMENTATION LTD.	REGULAR	B	KANJIKODE WEST, PALAKKAD, PALAKKAD-KERALA-INDIA Phone- 2566127-130,2567128 Pincode : ~~670623~~ Email : icvldil@gmail.com;fa2@ilpgt.com	SICK PSU. BIFR CASE. , ,
19	145-04000-A	CONTROL VALVE	P203	PARCOL S.p.A	REGULAR	NA	Mr. Erminio Campanelli, Via Isonzo, 2, Canegrate MI--Italy Phone- 0349-7417774 Pincode : 200010 Email : mazurizio.para@parcol.com	Indian Representative-M/s Astrotech, 35, MV Compound, Bridge Way Colony, Tiruppur - 641607, Tamil Nadu, India, Ph. No.-+91 975 199 4989; Email- mani@astrotech india.in , ,
20	145-04000-A	CONTROL VALVE	R001	R.K.CONTROL INSTRUMENTS PVT. LTD.	REGULAR	NA	PLOT NO.A-250, OPP.POLICE STATION, WAGLE INDUSTRIAL ESTATE, THANE-MAHARASHTRA-INDIA Phone- 25820943/2331 Pincode : 400604 Email : rkcipl@vsnl.com ; rkcinpvt@bol.net.in	HOLD due to non-responsse /non-participation w.e.f. 10.01.2013.HOLD due to non-responsse /non-participation w.e.f. 01.02.2013.Hold is lifted w.e.f. 21.09.2013. , Reassessed on ~~26.02.2016~~ ; Technical limit added w.e.f. 26.02.2016; ,
21	145-04000-A	CONTROL VALVE	S237	SUZHOU DELAN ENERGY SCIENCE & TECHNOLOGY CO., LTD.	REGULAR	NA	No 566 Fangqiao Road Caohu Industrial Park, Xiangcheng Economic Development Zone, Suzhou-Jiangsu-China Phone- 008618012776062 Pincode : 215143 Email : ~~huanlele@delan-valve.com~~	, ,

30	~~145-44000-A~~	FLOW ELEMENT - NOZZLE	S165	SEIKO FLOW CONTROL GMBH	REGULAR	NA	Mr. Friedrich Rupprecht/ Mr. S. Subhash Zur Schleuse 5, 2000 Stockerau, Stockerau--Austria Phone- 9811047972 Pincode : Email : office@seiko-flowcontrol.com	Indian Representative: M/s Menon Associates, 118, Aurobindo Commercial Complex, New Delhi-110016
31	~~145-44000-A~~	FLOW ELEMENT - NOZZLE	I006	INSTRUMENTATION LTD.	REGULAR	B	KANJIKODE WEST, PALAKKAD, PALAKKAD-KERALA-INDIA Phone- 2566127-130,2567128 Pincode : 678623 Email : icvildil@gmail.com,raz@ipgt.com	SICK PSU. BIFR CASE. , ,
32	~~145-44000-A~~	FLOW ELEMENT - NOZZLE	M009	MICRO PRECISION PRODUCTS PVT. LTD.	REGULAR	B	K.P. CHANDHOK/ATUL CHANDHOK 4, LINK ROAD, FARIDABAD-HARYANA-INDIA Phone- 9810265688 Pincode : 121002 Email : nal@micro1.com	REGISTERED AS MSMD VENDOR W.E.F.15.11.2011 FOR FY 2011-12. , ,
33	145-44000-A	FLOW ELEMENT - NOZZLE	M201	MINCO (INDIA) FLOW ELEMENTS PVT. LTD.	REGULAR	NA	Mr. Raghavendra M. Kulkarni D2-49/50, Tivim Industrial Estate, Karaswada Mapusa-Goa-India Phone- 0832-2257059 Pincode : 403526 Email : gicflowelement@giconindia.com	, ,
34	~~145-44000-A~~	FLOW ELEMENT - NOZZLE	S044	STAR-MECH CONTROLS (I) PVT.LTD.	REGULAR	B	SUSHILLOTAM, SUSHILLOTAM, 29/3A/3, SASANE NAGAR, HADAPSAR, PUNE-MAHARASHTRA-INDIA Phone- 02026970450 Pincode : 411028 Email : madkoting@star-mech.net	, ,
35	145-44000-A	FLOW ELEMENT - NOZZLE	D212	DYNAFLUID VALVES AND FLOW CONTROLS (P) LTD.	REGULAR	NA	Mr. Yogish M. Kulkarni Plot # 23, Udyambag, Belgaum-karnataka-India Phone- 0831-4210386 Pincode : 590008 Email : yogish@dyna-fluid.com	, ,
36	~~145-44000-A~~	FLOW ELEMENT - NOZZLE	H066	HYDROPNEUMATICS PVT. LTD.	REGULAR	NA	Mr. DM Bichu G/B, Hill Crown Apts., College Road Mapusa-Goa-India Phone- 0832-2360364 Pincode : 403507 Email : ajayrc@hydropneumatics.co.in	, ,
37	145-43000-A	FLOW ELEMENT - ORIFICE	H066	HYDROPNEUMATICS PVT. LTD.	REGULAR	NA	Mr. DM Bichu G/B, Hill Crown Apts., College Road Mapusa-Goa-India Phone- 0832-2360364 Pincode : 403507 Email : ajayrc@hydropneumatics.co.in	, ,
38	~~145-43000-A~~	FLOW ELEMENT - ORIFICE	F033	Flow Star Engineering Pvt. Ltd.,	REGULAR	A1	MR. KHALID AKHTAR/MR. TAPAN KUMAR JANA Plot No- 7 F/2, Northern India Industrial 20/3, Mathura Road FARIDABAD-HARYANA-INDIA Phone- 9818176380 Pincode : 121005 Email : khalid@flowstar.co.in	, ,
39	145-43000-A	FLOW ELEMENT - ORIFICE	D212	DYNAFLUID VALVES AND FLOW CONTROLS (P) LTD.	REGULAR	NA	Mr. Yogish M. Kulkarni Plot # 23, Udyambag, Belgaum-karnataka-India Phone- 0831-4210386 Pincode : 590008 Email : yogish@dyna-fluid.com	, ,
40	~~145-43000-A~~	FLOW ELEMENT - ORIFICE	S044	STAR-MECH CONTROLS (I) PVT.LTD.	REGULAR	B	SUSHILLOTAM, SUSHILLOTAM, 29/3A/3, SASANE NAGAR, HADAPSAR, PUNE-MAHARASHTRA-INDIA Phone- 02026970450 Pincode : 411028 Email : madkoting@star-mech.net	, ,
41	~~145-43000-A~~	FLOW ELEMENT - ORIFICE	M009	MICRO PRECISION PRODUCTS PVT. LTD.	REGULAR	B	K.P. CHANDHOK/ATUL CHANDHOK 4, LINK ROAD, FARIDABAD-HARYANA-INDIA Phone- 9810265688 Pincode : 121002 Email : nal@micro1.com	REGISTERED AS MSMD VENDOR W.E.F.15.11.2011 FOR FY 2011-12. , ,

22	145-04000-A	CONTROL VALVE	V051	Valvitalia S.P.A. ,	REGULAR	NA	Mr. Salvatore Ruggeri Via Tortona 69, Rivanazzano (Pavia) --Italy, Phone- +39-03839459875 Pincode : 27055 Email : gianluca.angeleri@valvitalia.com	One Time Code accorded for "Control Valves" package for "1x500 MW Vindhychal STPP Stage-V" project. , Supplier registered in permanent category as per 28th MISCC-Electrical and C&I dtd. 31.03.2014 , Deleted due to non-response in 4 consecutive tenders w.e.f. 27.07.2016; Decision revoked as per MISCC dt. 05.08.2016;
23	145-04000-A	CONTROL VALVE	W202	WALDEMAR PRUSS ARMATURENFABRIK GMBH	REGULAR	NA	Mr. Winfried Dremhel Schulenburgerlandstrasse 261, Hannover--Germany Phone- +49-511279260 Pincode : 30419 Email : dremhel@pruss.de; vogel@pruss.de	Indian Representative- M/s H S Engineering & Marketing Services, B2/73C Safdarjung Enclave, New Delhi - 110029, Ph No.-011-26193156/9313 007463; Email- joy@hsgroupdelhi.com , ,
24	145-47000-A	ELECTROMAGNETIC FLOW METER	E211	Electronet Equipments Pvt Ltd.	REGULAR	NA	Plot No. 84, 85 & 86, Tiny Industrial Estate Kondhwa Budruk, Pune-Maharashtra-India Phone- 020-2026932039 Pincode : 411048 Email : ho@eenindia.com	, ,
25	145-47000-A	ELECTROMAGNETIC FLOW METER	A216	Adept Fluidyne Pvt. Ltd.	REGULAR	NA	Vinayak Gadre Plot No 4,S.No.17/1-B Kothrud Industrial Estate Pune-Maharashtra-India Phone- 020 25464551 Pincode : 411038 Email : info@adeptfluidyne.com	, ,
26	145-12000-A	FLOW ELEMENT	S044	STAR-MECH CONTROLS (I) PVT.LTD.	REGULAR	C	SUSHILLOTAM, SUSHILLOTAM, 29/3A/3, SASANE NAGAR, HADAPSAR, PUNE-MAHARASHTRA-INDIA Phone- 02026970450 Pincode : 411028 Email : modulation@star-mech.net	, ,
27	145-12000-A	FLOW ELEMENT	I006	INSTRUMENTATION LTD.	REGULAR	C	KANJIKODE WEST, PALAKKAD, PALAKKAD-KERALA-INDIA Phone- 2566127-130,2567128 Pincode : 678623 Email : icvdlil@gmail.com;fa2@ilpgt.com	SICK PSU. BIFR CASE. , ,
28	145-12000-A	FLOW ELEMENT	M009	MICRO PRECISION PRODUCTS PVT. LTD.	REGULAR	C	K.P. CHANDHOK/ATUL CHANDHOK 4, LINK ROAD, FARIDABAD-HARYANA-INDIA Phone- 9810265688 Pincode : 121002 Email : nal@micro1.com	REGISTERED AS MSED VENDOR W.E.F.15.11.20 11 FOR FY 2011-12. , ,
29	145-12000-A	FLOW ELEMENT	T108	TM TECNOMATIC SPA	REGULAR	NA	MR. ANTONIO NOVIELLO/Mrs. Enrica Bazzoc VIA DELLE INDUSTRIE, 36 CREMONA-ITALY Phone- 39037221574 Pincode : 26100 Email : info@tmtecnomatic.com	, ,

42	145-43000-A	~~FLOW ELEMENT - ORIFICE~~	I006	INSTRUMENTATION LTD.	REGULAR	NA	KANJIKODE WEST, PALAKKAD, PALAKKAD-KERALA-INDIA Phone- 2566127-130,2567128 Pincode : 678623 Email : icvdlil@gmail.com;fa2@ilpgt.com	SICK PSU. BIFR CASE. , ,
43	~~145-43000-A~~	~~FLOW ELEMENT - ORIFICE~~	~~I030~~	~~INSTRUMENTATION ENGINEERS PVT LTD~~	~~REGULAR~~	~~B~~	~~SH.N.V.RAM GOPAL/MS. N.NIHARIKA PLOTS 1,2,3, PHASE-III, IDA, JEEDIMETLA HYDERABAD-TELANGANA-INDIA Phone- 9848407365 Pincode : 500055 Email : jeeedimetla@jeedimetla.com~~	~~, ,~~
44	145-45000-A	INSTRUMENT FITTINGS	P046	PRECISION ENGINEERING INDUSTRIES	REGULAR	NA	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI-MAHARASHTRA-INDIA Phone- 022 42631700 Pincode : 400 062 Email : peiks@vsnl.com	, ,
45	145-45000-A	INSTRUMENT FITTINGS	P082	PANAM ENGINEERS	REGULAR	NA	Mr. Santosh Shukla 203, Jaisingh Business,Parsiwada, Sahar road,Andheri(East), Mumbai,-Maharashtra,-India, Phone- 9892179529, Pincode : 400099, Email : santosh@panamengineers.com,	, ,
46	145-45000-A	INSTRUMENT FITTINGS	P81	Perfect Instrumentation Control (India) Pvt. Ltd.	REGULAR	NA	MD Hussain Shaikh/Shahanawaz Khan Gala No. 168, Loheki Chwal,216/ 218, Maulana Azad Rd. Nagpada Junction Mumbai-Maharashtra-INDIA Phone- 91-9324383121 Pincode : 400008 Email : shahanawaz.khan@perfectinstrumentation.com	, ,
47	145-45000-A	INSTRUMENT FITTINGS	C067	Comfit & Valve Pvt. Ltd.	REGULAR	NA	Mr. Jeetu Jain/Mr. Vinay Sosa Survey No. 23/1, Part 2, Ahmedabad-Mehsana Highway Laxmipura, Nandasan-Gujarat-INDIA Phone- 02764-267036/37 Pincode : 382705 Email : jeetukojin@com-fit.com	, ,
48	145-45000-A	INSTRUMENT FITTINGS	A079	AURA INCORPORATED	REGULAR	NA	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI-DELHI-INDIA Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com	, ,
49	145-45000-A	INSTRUMENT FITTINGS	A121	Arya Crafts & Engineering Pvt. Ltd.	REGULAR	NA	Mr.Sanjay Brahman/Mr.Shyam Vazirani 102, Vora Industrial Estate No.4 Navghar, Vasai Road (E) Dist.Thane, Mumbai-Maharashtra-INDIA Phone- +91-250-2392246 Pincode : 401210 Email : arya@aryaengg.com	, ,
50	145-45000-A	INSTRUMENT FITTINGS	F040	FLUIDFIT ENGINEERS PVT. LTD.	REGULAR	NA	Mr. Abbas Bhola Potia Building No. 2, Office No. 3,292, Bellasis Road,Mumbai Central (East) Mumbai-Maharashtra-India Phone- 9920044113 Pincode : 400008 Email : ab@fluidfitengg.com	Registered as per 22nd Electrical and C&I MISCC Meeting dtd. 15.01.2014 , ,
51	145-45000-A	INSTRUMENT FITTINGS	H61	HP VALVES & FITTINGS INDIA PVT. LTD.	REGULAR	C	S. Harichandran/P.S. Pandi B-11, Mugappair Industrial Estate, CHENNAI-Tamilnadu-INDIA Phone- 044 26252537 Pincode : 600037 Email : sales@hpvalvesindia.com	, ,

52	145-45000-A	INSTRUMENT FITTINGS	H024	Fluid Controls Pvt. Ltd.	REGULAR	NA	Sophie Y. Mochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI-MAHARASHTRA-INDIA Phone- (022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com	Name changed from M/s Hyd-Air Valves Pvt. Ltd. to M/s Fluid Controls Pvt. Ltd. as per 25th MISCC-Electrical and C&I dtd. 20.02.2014 , ,
53	145-45000-A	INSTRUMENT FITTINGS	V039	VIKAS INDUSTRIAL PRODUCTS	REGULAR	NA	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA-UTTAR PRADESH-INDIA Phone- +91-9810122070 Pincode : 201301 Email : naveensingh@vsnl.com	, Financial limit reviewed on 05.06.2014 ,
54	145-38000-A	INSTRUMENTS PIPE FITTINGS	V039	VIKAS INDUSTRIAL PRODUCTS	REGULAR	A	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA-UTTAR PRADESH-INDIA Phone- +91-9810122070 Pincode : 201301 Email : naveensingh@vsnl.com	, ,
55	145-38000-A	INSTRUMENTS PIPE FITTINGS	H024	Fluid Controls Pvt. Ltd.	REGULAR	B	Sophie Y. Mochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI-MAHARASHTRA-INDIA Phone- (022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com	, ,
56	145-38000-A	INSTRUMENTS PIPE FITTINGS	A079	AURA INCORPORATED	REGULAR	NA	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI-DELHI-INDIA Phone- 9810182430 Pincode : 110048 Email : nirai@aurainc.com	, ,
57	145-38000-A	INSTRUMENTS PIPE FITTINGS	P046	PRECISION ENGINEERING INDUSTRIES	REGULAR	NA	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI-MAHARASHTRA-INDIA Phone- 022 42631700 Pincode : 400 062 Email : peiks@vsnl.com	, ,
58	145-32000-A	INSTRUMENTS TUBE FITTINGS	P046	PRECISION ENGINEERING INDUSTRIES	REGULAR	C	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI-MAHARASHTRA-INDIA Phone- 022 42631700 Pincode : 400 062 Email : peiks@vsnl.com	, ,
59	145-32000-A	INSTRUMENTS TUBE FITTINGS	A079	AURA INCORPORATED	REGULAR	C	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI-DELHI-INDIA Phone- 9810182430 Pincode : 110048 Email : nirai@aurainc.com	, ,
60	145-32000-A	INSTRUMENTS TUBE FITTINGS	H024	Fluid Controls Pvt. Ltd.	REGULAR	B	Sophie Y. Mochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI-MAHARASHTRA-INDIA Phone- (022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com	, ,
61	145-32000-A	INSTRUMENTS TUBE FITTINGS	V039	VIKAS INDUSTRIAL PRODUCTS	REGULAR	NA	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA-UTTAR PRADESH-INDIA Phone- +91-9810122070 Pincode : 201301 Email : naveensingh@vsnl.com	, ,

62	145-25000-A	JUNCTION BOX	S114	Shrenik & Company,	REGULAR	NA	Mr. Mitesh Shah/Mr. Pulin Shah 39 A/3 ,Panchratna Industrial Estate, Sarkhej-Bavla Road Ahmedabad-Gujarat-India Phone- 9825024921 Pincode : 382213 Email : sales@pustron.com, pulin@pustron.com	Registered for FRP JB's AND METAL JB's. , Technical limit reviewed on 30.04.2014; ,
63	145-25000-A	JUNCTION BOX	F201	FLEXPRO ELECTRICALS PVT. LTD.	REGULAR	NA	Mr. Dineshbhai Zaveri C-1/ 27&37, GIDC, Kabilpore, Navsari-Gujarat-India Phone- 02637-265140,265003 Pincode : 396424 Email : flexpro@flexproltd.com	Technical limit reviewed on 12.10.2015; , ,
64	145-25000-A	JUNCTION BOX	A101	AJMERIA INDUSTRIAL & ENGINEERING WORKS	REGULAR	C	JIGNESH MAHENDRA AJMERIA DENA BANK BLDG.,SHREE NAGESH INDL. ESTATE,STATION ROAD, MUMBAI-MAHARASHTRA-INDIA Phone- 022 67973578 Pincode : 400 088 Email : ajmeria@ajmeria.net, jmajmeria@yahoo.com	Reviewed in MISCC dt. 21.07.2015 for non-response in 4 consecutive tender enquiry; , APPROVED FOR GALVANIZED AND FRP JUNCTION BOXES; Technical limit reviewed on 30.04.2014 ,
65	145-25000-A	JUNCTION BOX	K043	K.S.INSTRUMENTS PVT.LTD.	REGULAR	A	S Raghavan No. 72, 3rd Main, 1st Stage Industrial Suburb, Yeshwanthpur Bangalore-Karnataka-India Phone- 9880385770 Pincode : 560022 Email : sales1@ksinstruments.net	, ,
66	145-25000-A	JUNCTION BOX	S095	SUCHITRA INDUSTRIES	REGULAR	A	NO-2,OPP-27 AECS LAYOUT 2ND STG REJAMAHALVILAS EXTN 2ND STG BANGALORE -- Phone- Pincode : Email : suchitra.industriesblr@gmail.com	, ,
67	145-11000-A	LEVEL GAUGE	S008	SIGMA INSTRUMENTS CO.	REGULAR	NA	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI-MAHARASHTRA-INDIA Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.i	, ,
68	145-11000-A	LEVEL GAUGE	B077	BLISS ANAND PVT. LTD.	REGULAR	NA	Mr. Vikas Anand/ Mr.RGRajan 92B & 93 B , IMT MANESAR Gurgaon-Haryana-India Phone- 0124-4366000 TO 9 Pincode : 122001 Email : sales@blissanand.com	, ,
69	145-11000-A	LEVEL GAUGE	T001	TOSHNIWAL BROTHERS PVT.LTD.	REGULAR	NA	WORKS:TOSHNIWAL IND.PVT.LTD, INDUSTRIAL ESTATE MAKHUPURA, AJMER-RAJASTHAN-INDIA Phone- 441171 Pincode : 305002 Email : toshniwalprocess@gmail.com	, ,
70	145-35000-A	LEVEL SWITCH- CAPACITANCE TYPE	S123	Sapcon Instrument Pvt Ltd.	REGULAR	NA	131, PALSHIKAR COLONY Contact Person- Mr. Ashwin (9826080207) INDORE-MP-INDIA Phone- +91-731-4085751, Pincode : 452004 Email : sales@sapconinstruments.co	, ,

71	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	W017	Baumer Technologies India Pvt. Ltd.	REGULAR	NA	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI-Maharashtra-INDIA Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com	, NAME HAS BEEN CHANGED FROM M/S WAAREE INSTRUMENTS LTD. TO M/S BAUMER TECHNOLOGIES INDIA PVT. LTD. W.E.F. 12.06.2012
72	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	V040	V. AUTOMAT & INSTRUMENTS (P) LTD.	REGULAR	NA	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI-DELHI-INDIA Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com	, ,
73	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	B077	BLISS ANAND PVT. LTD.	REGULAR	NA	Mr. Vikas Anand/Mr.RGRajan 92B & 93 B , IMT MANESAR Gurgaon-Haryana-India Phone- 0124-4366000 TO 9 Pincode : 122001 Email : sales@blissanand.com	, ,
74	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	F033	Flow Star Engineering Pvt. Ltd.,	REGULAR	A1	MR. KHALID AKHTAR/MR. TAPAN KUMAR JANA Plot No- 7 F/2, Northern India Industrial 20/3, Mathura Road FARIDABAD-HARYANA-INDIA Phone- 9818176380 Pincode : 121005 Email : khalid@flowstar.co.in	VENDOR IS REGISTERED IN MSED (MICRO) W.E.F.30.11.2011 FOR FY 2011-12 , ,
75	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	S008	SIGMA INSTRUMENTS CO.	REGULAR	NA	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI-MAHARASHTRA-INDIA Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.i	, ,
76	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	S010	SOR INC.	REGULAR	NA	LARRY DEGARMO/Avdesh Chandra, 14685 W. 105TH STREET LENEXA-KANSAS-USA Phone- 09810905139, Pincode : 66215 Email : ldegarmo@sorinc.com, avdesh@sherman-jedia.com	, ,
77	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	L005	LEVCON INSTRUMENTS PVT. LTD.	REGULAR	NA	Mr Shayak Gupta/Badal Jana Rajkamal', 7th floor, 13, Camac Street KOLKATA- WEST BENGAL-INDIA Phone- 0 33 2283 2766 Pincode : 700017 Email : b_jana@levcongroup.com	, ,
78	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	P068	Pune Techtrol Pvt. Ltd.	REGULAR	NA	N.P.Khatan/Sudhakar Badiger S-18, MIDC Bhosari, Pune-Maharashtra-INDIA Phone- 9850560042 Pincode : 411 026 Email : ho@punetechtrol.com	, ,
79	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	N035	NIVO CONTROLS PVT. LTD.	REGULAR	NA	MR.PRAVEEN TOSHNIWAL/MR. NITIN TAMHANE 104-115, ELECTRONIC COMPLEX, INDORE-MAHARASHTRA-INDIA Phone- 07314081300 Pincode : 452010 Email : sales@nivocontrols.com	, ,
80	145-36000-A	LEVEL SWITCH-CONDUCTIVITY TYPE	L005	LEVCON INSTRUMENTS PVT. LTD.	REGULAR	NA	Mr Shayak Gupta/Badal Jana Rajkamal', 7th floor, 13, Camac Street KOLKATA- WEST BENGAL-INDIA Phone- 0 33 2283 2766 Pincode : 700017 Email : b_jana@levcongroup.com	, ,

81	145-36000-A	LEVEL SWITCH- CONDUCTIVITY TYPE	S010	SOR INC.	REGULAR	NA	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA-KANSAS-USA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdhesh@sherman-india.com	, ,
82	145-36000-A	LEVEL SWITCH- CONDUCTIVITY TYPE	S008	SIGMA INSTRUMENTS CO.	REGULAR	NA	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI-MAHARASHTRA-INDIA Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.i	, ,
83	145-36000-A	LEVEL SWITCH- CONDUCTIVITY TYPE	R047	RAMAN INSTRUMENTS PVT.LTD.	REGULAR	NA	Mr. N R Shenoy/Mr G B Vijh 8, First Floor.Plot : 160A Bait-Ush-Sharaf, 29th Road,Bandra(W) MUMBAI-Maharashtra-India Phone- 09892331381 Pincode : 400050 Email : ramanbhai@usol.com	Technical limit reviewed on 12.10.2015; , Technical limit reviewed on 30.04.2014; ,
84	145-36000-A	LEVEL SWITCH- CONDUCTIVITY TYPE	H047	HI-TECH SYSTEMS & SERVICES LTD.	REGULAR	NA	Mr. Vikash Agrawal/Mr. Tarun Debnath 119, PARK STREET , KOLKATA-West Bengal-India Phone- 033-22290045 Pincode : 700016 Email : saadnan@hitech.in	Technical limit reviewed on 12.10.2015; , Technical limit reviewed on 30.04.2014; ,
85	145-36000-A	LEVEL SWITCH- CONDUCTIVITY TYPE	B077	BLISS ANAND PVT. LTD.	REGULAR	NA	Mr. Vikas Anand/ Mr.RGRajan 92B & 93 B , IMT MANESAR Gurgaon-Haryana-India Phone- 0124-4366000 TO 9 Pincode : 122001 Email : sales@blissanand.com	, ,
86	145-36000-A	LEVEL SWITCH- CONDUCTIVITY TYPE	V040	V. AUTOMAT & INSTRUMENTS (P) LTD.	REGULAR	NA	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI-DELHI-INDIA Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com	, ,
87	145-36000-A	LEVEL SWITCH- CONDUCTIVITY TYPE	S123	Sapcon Instrument Pvt Ltd.	REGULAR	NA	131, PALSHIKAR COLONY Contact Person- Mr. Ashwin (9826080207) INDORE-MP-INDIA Phone- +91-731-4085751, Pincode : 452004 Email : sales@sapconinstruments.co	, ,
88	145-37000-A	LEVEL SWITCH-FLOAT TYPE	V040	V. AUTOMAT & INSTRUMENTS (P) LTD.	REGULAR	NA	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI-DELHI-INDIA Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com	, ,
89	145-37000-A	LEVEL SWITCH-FLOAT TYPE	W017	Baumer Technologies India Pvt. Ltd.	REGULAR	NA	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI-Maharashtra-INDIA Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com	, NAME HAS BEEN CHANGED FROM M/S WAAREE INSTRUMENTS LTD. TO M/S BAUMER TECHNOLOGIES INDIA PVT. LTD. W.E.F. 12.05.2013
90	145-37000-A	LEVEL SWITCH-FLOAT TYPE	B077	BLISS ANAND PVT. LTD.	REGULAR	NA	Mr. Vikas Anand/ Mr.RGRajan 92B & 93 B , IMT MANESAR Gurgaon-Haryana-India Phone- 0124-4366000 TO 9 Pincode : 122001 Email : sales@blissanand.com	, ,
91	145-37000-A	LEVEL SWITCH-FLOAT TYPE	D046	D.K. INSTRUMENTS PVT.LTD.	REGULAR	NA	N.SIKDAR/ SUMIT SIKDAR 76/2,SELIMPUR RD DHAKURIA Kolkata-West Bengal-India Phone- 033-2415-1310. Pincode : 700031 Email : dkiest@usol.net	, ,

92	145-37000-A	LEVEL SWITCH-FLOAT TYPE	G060	GENERAL INSTRUMENTS CONSORTIUM	REGULAR	NA	Mr. Amarendra Kulkarni 194/195, Gopi Tank Road, Off. Pandurang Naik Marg, Mahim Mumbai-Maharashtra India Phone- 9323195251 Pincode : 400016 Email : amarendra@general- gauges.com	Workas at- GAUGES BOURDON INDIA PVT. LTD. (A MFG. UNIT OF GENERAL INSTRUMENTS CONSORTIUM , PLOT NO-4, 5 & 6, JAWAHAR Co-op. INDUSTRIAL ESTATE, KAMOTHE, PANVEL- 410 209 , ,
93	145-37000-A	LEVEL SWITCH-FLOAT TYPE	S008	SIGMA INSTRUMENTS CO.	REGULAR	C	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI-MAHARASHTRA- INDIA Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.i n	Vendor shall source import contents of Level Switch (Conductivity Type) from Mobrey Measurement, an operating unit of Morbey Ltd., Slough, Berkshire, United
94	145-37000-A	LEVEL SWITCH-FLOAT TYPE	S010	SOR INC.	REGULAR	NA	LARRY DEGARMO/Avdesh Chandra, 14685 W. 105TH STREET LENEXA-KANSAS- USA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdesh@sherman- india.com	, ,
95	145-37000-A	LEVEL SWITCH-FLOAT TYPE	S106	SBEM PVT. LTD.	REGULAR	NA	MR.N.K. BEDARKAR/MR. VISHWANATH KARANDIK 39, ELECTRONIC CO.OP. ESTATE, PUNE SATARA ROAD PUNE,- MAHARASHTRA-INDIA Phone- 912041030100 Pincode : 411009 Email : sawdalkhi@sbem.co.in	, ,
96	145-37000-A	LEVEL SWITCH-FLOAT TYPE	L005	LEVCON INSTRUMENTS PVT. LTD.	REGULAR	NA	Mr Shayak Gupta/Badal Jana Rajkamal', 7th floor, 13, Camac Street KOLKATA- WEST BENGAL-INDIA Phone- 0 33 2283 2766 Pincode : 700017 Email : b_jana@levcongroup.com	, ,
97	145-37000-A	LEVEL SWITCH-FLOAT TYPE	P068	Pune Techtrol Pvt. Ltd.	REGULAR	NA	N.P.Khatan/Sudhakar Badiger S-18, MIDC Bhosari, Pune-Maharashtra-INDIA Phone- 9850560042 Pincode : 411 026 Email : ho@punetechtrol.com	, ,
98	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	F016	FORBES MARSHALL (HYD) LTD.	REGULAR	NA	MR SAIKESH PATALAY/MR. M K SRINIVASAN PLOT NO.A- 19/2, & T-4/2, IDA, NACHARAM, HYDERABAD- TELANGANA-INDIA Phone- 9849913704 Pincode : 500 076 Email : mksrinivasan@forbesmarshall.com	, ,
99	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	H040	H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	REGULAR	B	32,INDUSTRIAL SUBURB YESWANTHAPUR BANGALORE-KARNATAKA- www.hgurusouth.com Phone- 080-23370300, Pincode : 560022 Email : info@hgurusouth.com	, ,
100	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	H023	H.GURU INDUSTRIES	REGULAR	NA	Mr. G. D. Hazra/Mr. P. K. Mitra 10 B, HO-CHI-MINH SARANI, KOLKATA-WEST BENGAL-INDIA Phone- 033 2282 2463 / 1637 Pincode : 700071 Email : mguru@vscpl.net	, Financial limit reviewed on 05.06.2014; ,

101	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	G071	GAUGE BOURDON INDIA PVT. LTD.	REGULAR	NA	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai,- Maharashtra,-India, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general- gauge.com	Registered as per 26th MISCC- Electrical and C&I dtd. 06.03.2014. , ,
102	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	B083	BOSE PANDA INSTRUMENTS PVT.LTD.	REGULAR	NA	Mr. Partha Bose 44, Saheed Hemanta Kumar Bose, Sarani, Kolkata-West Bengal India Phone- +91 33 2548 7220 Pincode : 700074 Email : parthabosebpi@gmail.com; bosepanda@vsnl.net	Trial to Hold as per SEARP amd- 3,w.e.f. 15-09- 12 , Supplier registered in trial category on 30.10.2010 and was thereafter put in susp-hold category as per SEARP Amd-03 on 15.09.2012. Further, on evaluation put in permanent category on 20.08.2014; ,
103	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	A126	PRECISION MASS PRODUCTS PVT. LTD.	REGULAR	NA	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol- Gujarat,-INDIA Phone- 9999464663 Pincode : 382729 Email : sales@precisionmass.com	Registration of "M/s Ashcroft India Pvt. Ltd." substituted to "M/s Precision Mass Products Pvt. Ltd." as per MISCC dt. 15.02.2016 based on "Termination and business transfer agreement" submitted by
104	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	A010	A.N. INSTRUMENTS PVT. LTD.	REGULAR	C	MARKETING DIVISION, 5th FLOOR, 59-B, CHOWRINGHEE ROAD, KOLKATA-WEST BENGAL- INDIA Phone- 24757784,22472509 Pincode : 700020 Email : anidol@aninstrument.in	, ,
105	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	W017	Baumer Technologies India Pvt. Ltd.	REGULAR	NA	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI-Maharashtra-INDIA Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com	, NAME HAS BEEN CHANGED FROM M/S WAAREE INSTRUMENTS LTD. TO M/S BAUMER TECHNOLOGIES INDIA PVT. LTD. W.E.F. 15.06.2013.
106	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	A126	PRECISION MASS PRODUCTS PVT. LTD.	REGULAR	NA	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol- Gujarat,-INDIA Phone- 9999464663 Pincode : 382729 Email : sales@precisionmass.com	Registration of "M/s Ashcroft India Pvt. Ltd." substituted to "M/s Precision Mass Products Pvt. Ltd." as per MISCC dt. 15.02.2016 based on "Termination and business transfer agreement" submitted by
107	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	B085	Barksdale GmbH, Germany	REGULAR	NA	Michael Weileder Dorn Assenheimer, Strasse 27 Reichelsheim--Germany Phone- +91-9999107840 Pincode : D-61203 Email : msingh@barksdale.de	, ,

108	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	D021	DRESSER INDUSTRIES INC.	REGULAR	NA	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol-Gujarat-India Phone- 02764-233682 Pincode : 382729 Email : Nishit.patel@ashcroftindia.com	, ,
109	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	D003	INDFOS (INDIA) LIMITED	REGULAR	NA	MR.L.C.VENKATRANGAN/MR. B.KANNAN New No.17, II Floor, Adwave Towers, Dr.Sevalia Shivaji Salai, T.Nagar Chennai-TamilNadu-INDIA Phone- +91 44 24353407 Pincode : 600017 Email : delhi@indfos.com	, ,
110	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	G060	GENERAL INSTRUMENTS CONSORTIUM	REGULAR	C	Mr. Amarendra Kulkarni 194/195, Gopi Tank Road, Off. Pandurang Naik Marg, Mahim Mumbai-Maharashtra-India Phone- 9323195251 Pincode : 400016 Email : amarendra@general-gauges.com	Workas at- GAUGES BOURDON INDIA PVT. LTD. (A MFG. UNIT OF GENERAL INSTRUMENTS CONSORTIUM , PLOT NO-4, 5 & 6, JAWAHAR Co-op. INDUSTRIAL ESTATE, KAMOTHE, PANVEL- 410 209 , ,
111	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	K054	Kaustubha Udyog,	REGULAR	NA	S.No. 36/1/1, Sinhgad Road, Vadgaon Khurd, Near Lokmat Press, Pune,- Maharashtra,-India, Phone- 020-24393577, Pincode : Email : pressure@vsnl.com,	, ,
112	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	I041	INDFOS INDUSTRIES LIMITED	REGULAR	C	B-20-21, INDUSTRIAL AREA, MEERUT ROAD, GHAZIABAD-UP-INDIA Phone- 0120-2712016 Pincode : Email : mktn@indfos.com	, ,
113	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	S010	SOR INC.	REGULAR	NA	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA-KANSAS-USA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdhesh@sherman-india.com	, ,
114	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	S009	SWITZER PROCESS INSTRUMENTS PVT. LTD.	REGULAR	C	B Kannan/V S Jayaprakash 9, SOUTH BOAG ROAD, II FLOOR, PB NO-1423, T.NAGAR, CHENNAI-TAMIL NADU-INDIA Phone- 044-24340999 / 24344 Pincode : 600017 Email : marketing@switzerinstrument.com	Name changed from "M/s Switzer Instrument Ltd." to "M/s Switzer Process Instruments Pvt. Ltd." w.e.f. 27.07.2016; , ,
115	145-03000-A	PROGRAMMABLE LOGIC CONTROLLER	R021	ROCKWELL AUTOMATION INDIA LTD	REGULAR	NA	(ALLENBRADLEY),C-11, SITE-4, INDUSTRIAL AREA SHHIBABAD, GHAZIABAD-UP-INDIA Phone- 2895247-52 Pincode : 201010 Email : pmehrotra@rockwell.com	, ,
116	145-03000-A	PROGRAMMABLE LOGIC CONTROLLER	S001	SIEMENS LIMITED	REGULAR	NA	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai-Maharashtra-INDIA Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com	, ,
117	145-03000-A	PROGRAMMABLE LOGIC CONTROLLER	S083	SCHNEIDER ELECTRIC INDIA PVT.LTD.	REGULAR	NA	A-4, MOHAN CO-OP INDL AREA MATHURA ROAD NEW DELHI-DELHI-INDIA Phone- Pincode : 110044 Email : aditya.bawa@schneider-electric.com	, ,

118	145-03000-A	PROGRAMMABLE LOGIC CONTROLLER	M205	mitsubishi electric india pvt. ltd.	REGULAR	NA	Mr. Mehul Dholakia Emerald House, EL-3, J Block, M.I.D.C., Bhosari, Pune- Maharashtra-India Phone- 020-27102000 Pincode : 411026 Email : mehul.dholakia@asia.meap.com	, ,
119	145-03000-A	PROGRAMMABLE LOGIC CONTROLLER	H063	Honeywell Automation India Limited ,	REGULAR	NA	56 & 57, Hadapsar Industrial Estate, Pune,- Maharashtra,-India, Phone- 9689940949, Pincode : Email : amit.aglave@honeywell.com,	, ,
120	145-03000-A	PROGRAMMABLE LOGIC CONTROLLER	G035	GE Intelligent Platforms Private Limited	REGULAR	B	90/B, ELECTRONICS CITY, HOSUR ROAD, BANGLORE- KARNATAKA-INDIA Phone- 28528328 Pincode : 561229 Email : shivesh.k.iba@ge.com	, ,
121	145-34000-A	ROTAMETER	F033	Flow Star Engineering Pvt. Ltd.,	REGULAR	B	MR. KHALID AKHTAR/MR. TAPAN KUMAR JANA Plot No- 7 F/2, Northern India Industrial 20/3, Mathura Road FARIDABAD-HARYANA- INDIA Phone- 9818176380 Pincode : 121005 Email : khalid@flowstar.co.in	VENDOR IS REGISTERED IN MS&D (MICRO) W.E.F.30.11.2011 FOR FY 2011-12, ,
122	145-34000-A	ROTAMETER	E047	EUREKA INDUSTRIAL EQUIPMENTS PVT.LTD.	REGULAR	NA	Mr V. K. Pandit/Mr Ashish Shaha 17-20, Royal chambers, Paud Road Pune-Maharashtra-India Phone- 9370469466 Pincode : 411038 Email : caloc@eurekaflow.com	, ,
123	145-34000-A	ROTAMETER	I030	INSTRUMENTATION ENGINEERS PVT LTD	REGULAR	A	SH.N.V.RAM GOPAL/MS. N.NIHARIKA PLOTS 1,2,3, PHASE-III, IDA, JEEDIMETLA HYDERABAD- TELANGANA-INDIA Phone- 9848407365 Pincode : 500055 Email : jodolbi@ioflowmotors.com	, ,
124	145-34000-A	ROTAMETER	S158	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	REGULAR	NA	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec- 3, Ghansoli (East), Navi Mumbai,-Maharashtra,- INDIA Phone- 9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com	, ,
125	145-16000-A	SIGHT FLOW INDICATORS	S158	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	REGULAR	NA	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec- 3, Ghansoli (East), Navi Mumbai,-Maharashtra,- INDIA Phone- 9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com	, ,
126	145-16000-A	SIGHT FLOW INDICATORS	I030	INSTRUMENTATION ENGINEERS PVT LTD	REGULAR	A	SH.N.V.RAM GOPAL/MS. N.NIHARIKA PLOTS 1,2,3, PHASE-III, IDA, JEEDIMETLA HYDERABAD- TELANGANA-INDIA Phone- 9848407365 Pincode : 500055 Email : jodolbi@ioflowmotors.com	, ,
127	145-16000-A	SIGHT FLOW INDICATORS	S008	SIGMA INSTRUMENTS CO.	REGULAR	NA	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI-MAHARASHTRA- INDIA Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.i	Reassessed on 27.04.2016; , ,
128	145-16000-A	SIGHT FLOW INDICATORS	B077	BLISS ANAND PVT. LTD.	REGULAR	NA	Mr. Vikas Anand/ Mr.RG Rajan 92B & 93 B , IMT MANESAR Gurgaon- Haryana-India Phone- 0124- 4366000 TO 9 Pincode : 122001 Email : caloc@blissanand.com	Reassessed on 31.03.2016; , ,

129	~~145-16000-A~~	SIGHT FLOW INDICATORS	B068	B.K.EQUIPMENTS PVT.LTD.	REGULAR	A1	T. BALAKRISHNAN/S.VENKATES H 217 , ARCOT ROAD PORUR , CHENNAI-TAMIL NADU,INDIA Phone- 9444057761 Pincode : 600116 Email : bkravin@gmail.com	, ,
130	145-13000-A	TEMP. ELEMENT	G032	GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	REGULAR	NA	D2/5, Mapusa Industrial Estate, Mapusa, Goa,- MAHARASHTRA-INDIA Phone- 09326054551, Pincode : 403507, Email : sumukh@goainstruments.com,	GCC Rev.5 has been accepted in toto. , ,
131	145-13000-A	TEMP. ELEMENT	G071	GAUGE BOURDON INDIA PVT. LTD.	REGULAR	NA	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai,- Maharashtra,-India, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general- gauges.com	, ,
132	145-13000-A	TEMP. ELEMENT	I022	DETRIVE INSTRUMENTATION & ELECTRONICS LTD.	REGULAR	B	320, TV INDUSTRIAL ESTATE, OFF.DR.A.BESANT ROAD, BEHIND GLAXO, WORLI, MUMBAI-MAHARASHTRA-INDIA Phone- 24934125,24938403 Pincode : 400025 Email : trivtech@vsnl.com	, ,
133	145-13000-A	TEMP. ELEMENT	P061	PYRO ELECTRIC INSTRUMENTS GOA PVT.LTD.	REGULAR	B	M. D. BICHU/R. M. BICHU G.B. HILL CROWN APARTMENTS, COLLEGE ROAD, MAPUSA-GOA-INDIA Phone- 9326114601 Pincode : 403507 Email : priyanka.marketing@pyro- electric.in	, ,
134	145-13000-A	TEMP. ELEMENT	T106	TECHNO INSTRUMENTS	REGULAR	NA	Abhijit Gohel/Mr. Amit Pandya Plot No. 1145/1, Uma Convent Lane, Santej,Ta. Kalol, Gandhinagar-Gujarat-India Phone- 9909925223 Pincode : 382721 Email : amit@techno- instruments.com	, ,
135	145-13000-A	TEMP. ELEMENT	T107	Tempsens Instrument (I) Pvt Ltd	REGULAR	NA	MR. V.P.RATHI/MR. HEMANT RATHI B-188A ROAD NO.5 , M.I.A UDAIPUR-RAJASTHAN-INDIA Phone- 09352420069 Pincode : 313003 Email : info@tempsens.com	, ,
136	145-13000-A	TEMP. ELEMENT	T108	TM TECNOMATIC SPA	REGULAR	NA	MR. ANTONIO NOVIELLO/Mrs. Enrica Bazzoc VIA DELLE INDUSTRIE, 36 CREMONA-ITALY Phone- 39037221574 Pincode : 26100 Email : info@tmtcnomatic.com	, ,
137	145-13000-A	TEMP. ELEMENT	T115	Thermal Instrument India Pvt. Ltd.	REGULAR	NA	Mr. Raghavendra M. Kulkarni 194/195, Gopi Tank Road Behind Citylight Cinema,Mahim Mumbai-Maharashtra-India Phone- 09322664709 Pincode : 400016 Email : ramk@aicoindia.com	Registered as per 11th MISCC-Electrical and C&I (FY 2014-15) dt. 20.09.2014. , ,
138	145-13000-A	TEMP. ELEMENT	T111	TOSHNIWAL INDUSTRIES PVT. LTD.,	REGULAR	NA	Industrial Estate, Makhupura, Ajmer,- Rajasthan,-India, Phone- 9352009000, Pincode : 305002, Email : info@tinl.com	GCC Rev.5 has been accepted in toto. , ,
139	145-13000-A	TEMP. ELEMENT	W017	Baumer Technologies India Pvt. Ltd.	REGULAR	NA	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI-Maharashtra-INDIA Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com	, NAME HAS BEEN CHANGED FROM M/S WAAREE INSTRUMENTS LTD. TO M/S BAUMER TECHNOLOGIES INDIA PVT. LTD. W.E.F. 12.06.2012

140	145-10000-A	TEMPERATURE GAUGE	W017	Baumer Technologies India Pvt. Ltd.	REGULAR	C	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI-Maharashtra-INDIA Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com	, NAME HAS BEEN CHANGED FROM M/S WAAREE INSTRUMENTS LTD. TO M/S BAUMER TECHNOLOGIES INDIA PVT. LTD. W.E.F. 12.06.2012
141	145-10000-A	TEMPERATURE GAUGE	G071	GAUGE BOURDON INDIA PVT. LTD.	REGULAR	NA	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai,- Maharashtra,-India, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com	, ,
142	145-10000-A	TEMPERATURE GAUGE	H023	H.GURU INDUSTRIES	REGULAR	NA	Mr. G. D. Hazra/Mr. P. K. Mitra 10 B, HO-CHI-MINH SARANI, KOLKATA-WEST BENGAL-INDIA Phone- 033 2282 2463 / 1637 Pincode : 700071 Email : info@hgurusouth.com	, Financial limit reviewed on 05.06.2014; ,
143	145-10000-A	TEMPERATURE GAUGE	H040	H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	REGULAR	B	32,INDUSTRIAL SUBURB YESWANTHAPUR BANGALORE-KARNATAKA- www.hgurusouth.com Phone- 080-23370300, Pincode : 560022 Email : info@hgurusouth.com	, ,
144	145-10000-A	TEMPERATURE GAUGE	G032	GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	REGULAR	D	D2/5, Mapusa Industrial Estate, Mapusa, Goa,- MAHARASHTRA-INDIA Phone- 09326054551, Pincode : 403507, Email : sumukh@goainstruments.com,	GCC Rev.5 has been accepted in toto. , ,
145	145-10000-A	TEMPERATURE GAUGE	G047	GOA THERMOSTATIC INSTRUMENTS PVT.LTD.	REGULAR	B	FLAT -B , GF, HILL CROWN APTS., COLLEGE ROAD, MAPUSA-GOA-INDIA Phone- Pincode : 403525 Email : nhilworks@mvno-electric.in	, ,
146	145-10000-A	TEMPERATURE GAUGE	F016	FORBES MARSHALL (HYD) LTD.	REGULAR	NA	MR SAILESH PATALAY/MR. M K SRINIVASAN PLOT NO.A-19/2, & T-4/2, IDA, NACHARAM, HYDERABAD- TELANGANA-INDIA Phone- 9849913704 Pincode : 500 076 Email : mksrinivasan@forbesmarshall.com	, ,
147	145-10000-A	TEMPERATURE GAUGE	A126	PRECISION MASS PRODUCTS PVT. LTD.	REGULAR	NA	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol- Gujarat,-INDIA Phone- 9999464663 Pincode : 382729 Email : sales@precisionmass.com	Registration of "M/s Ashcroft India Pvt. Ltd." substituted to "M/s Precision Mass Products Pvt. Ltd." as per MISCC dt. 15.02.2016 based on "Termination and business transfer agreement" submitted by
148	145-10000-A	TEMPERATURE GAUGE	B014	BUDENBERG GUAGE CO.LTD.	REGULAR	NA	PO BOX-5, ALTRINCHAM CHESHIRE-UK-UK Phone- 0161-9285441 Pincode : WA14 4ER Email : dhhdelhi@vusol.net	, ,
149	145-10000-A	TEMPERATURE GAUGE	A010	A.N. INSTRUMENTS PVT. LTD.	REGULAR	C	MARKETING DIVISION, 5th FLOOR, 59-B, CHOWRINGHEE ROAD, KOLKATA-WEST BENGAL- INDIA Phone- 24757784,22472509 Pincode : 700020 Email : asidol@bol.net.in	, ,

150	145-15000-A	TEMPERATURE SWITCH	D003	INDFOS (INDIA) LIMITED	REGULAR	NA	MR.L.C.VENKATRANGAN/MR. B.KANNAN New No.17, II Floor, Adwave Towers, Dr.Sevalia Shivaji Salai, T.Nagar Chennai-TamilNadu-INDIA Phone- +91 44 24353407 Pincode : 600017 Email : delhi@indfos.com	, ,
151	145-15000-A	TEMPERATURE SWITCH	D021	DRESSER INDUSTRIES INC.	REGULAR	NA	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol-Gujarat-India Phone- 02764-233682 Pincode : 382729 Email : Nishit.patel@ashcroftindia.com	, ,
152	145-15000-A	TEMPERATURE SWITCH	S009	SWITZER PROCESS INSTRUMENTS PVT. LTD.	REGULAR	NA	B Kannan/V S Jayaprakash 9, SOUTH BOAG ROAD, II FLOOR, PB NO-1423, T.NAGAR, CHENNAI-TAMIL NADU-INDIA Phone- 044-24340999 / 24344 Pincode : 600017 Email : marketing@switzerinstrument.com	Name changed from "M/s Switzer Instrument Ltd." to "M/s Switzer Process Instruments Pvt. Ltd." w.e.f. 27.07.2016; , ,
153	145-15000-A	TEMPERATURE SWITCH	S010	SOR INC.	REGULAR	NA	LARRY DEGARMO/Avdesh Chandra, 14685 W. 105TH STREET LENEXA-KANSAS-USA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdesh@sherman-india.com	, ,
154	145-15000-A	TEMPERATURE SWITCH	T001	TOSHNIWAL BROTHERS PVT.LTD.	REGULAR	NA	WORKS:TOSHNIWAL IND.PVT.LTD, INDUSTRIAL ESTATE MAKHUPURA, AJMER-RAJASTHAN-INDIA Phone- 441171 Pincode : 305002 Email : toshniwalprocess@gmail.com	, ,
155	145-14000-A	TRANSMITTERS	T031	Honeywell Automation India Limited	REGULAR	NA	Mr. Ritwij Kulkarni 917, INTERNATIONAL TRADE TOWER, NEHRU PLACE, NEW DELHI-DELHI-INDIA Phone- 9890200584 Pincode : 110019 Email : rajesh.chaudhary@honeywell.com	, ,
156	145-14000-A	TRANSMITTERS	Y10	YOKOGAWA INDIA LIMITED,	REGULAR	NA	PLOT NO.96, ELECTRONICS CITY COMPLEX, HOSUR ROAD, BANGALORE,- KARNATAKA,-INDIA, Phone- 080-41586000, Pincode : Email : uday.shankar@in.yokogawa.com,	Subject to submission of renewed ISO certificate & compliance to GCC; Relevant documents (ISO 9001:2008 and GCC Rev-05) furnished on 18.06.2013. , ,
157	145-14000-A	TRANSMITTERS	T111	TOSHNIWAL INDUSTRIES PVT. LTD.,	REGULAR	NA	Industrial Estate, Makhupura, Ajmer,- Rajasthan,-India, Phone- 9352009000, Pincode : 305002, Email : info@tipl.com	GCC Rev.5 has been accepted in toto. , ,
158	145-14000-A	TRANSMITTERS	V040	V. AUTOMAT & INSTRUMENTS (P) LTD.	REGULAR	NA	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI-DELHI-INDIA Phone- 9810005826 Pincode : 110 020 Email : caloc@vautomat.com	Technical limit reviewed on 12.10.2015; , Technical limit reviewed on 30.04.2014 ,
159	145-14000-A	TRANSMITTERS	S039	SMART INSTRUMENTS LTD, BRAZIL	REGULAR	NA	Agents: Digital Electronic Ltd. 74/11 'C' Cross Road MIDC Andheri (East) MUMBAI-MAHARASHTRA-INDIA Phone- 28208477 Pincode : 400093 Email : corp@delbby.rpgms.ems.vsnl.net.in	Technical limit reviewed on 12.10.2015; , Technical limit reviewed on 30.04.2014 ,

160	145-14000-A	TRANSMITTERS	S106	SBEM PVT. LTD.	REGULAR	NA	MR.N.K. BEDARKAR/MR. VISHWANATH KARANDIK 39, ELECTRONIC CO.OP. ESTATE, PUNE SATARA ROAD PUNE,- MAHARASHTRA-INDIA Phone- 912041030100 Pincode : 411009 Email : newdelhi@sbem.co.in	Reviewed in MISCC dt. 21.07.2015 for non-response in 4 consecutive tender enquiry; , Technical limit reviewed on 30.04.2014 & 12.10.2015; ,
161	145-14000-A	TRANSMITTERS	S001	SIEMENS LIMITED	REGULAR	NA	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai-Maharashtra-INDIA Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com	Comm Add: Attn Mr K.K.Bedi/ Mr Sanjay Satpute, Siemens Ltd. EFIE, Plot no 6A, Sec-18, Maruti Industrial Area, Gurgaon - 122015, Ph 0124-3836250 , ,
162	145-14000-A	TRANSMITTERS	R002	EMERSON PROCESS MANAGEMENT (INDIA) PVT.LTD.	REGULAR	C	Mr. Amit Paithankar/Vikram Raj Singh 206- 210,BALARAMA BUILDING 2ND FLR. BANDRA EAST MUMBAI-MAHARASHTRA-INDIA Phone- 9619121500 Pincode : 400051 Email : vikramraj.singh@emerson.co	, ,
163	145-14000-A	TRANSMITTERS	P068	Pune Techtrol Pvt. Ltd.	REGULAR	C	N.P.Khatan/Sudhakar Badiger S-18, MIDC Bhosari, Pune-Maharashtra-INDIA Phone- 9850560042 Pincode : 411 026 Email : ho@punetechtrol.com	Technical limit reviewed on 12.10.2015; , Manufacturing works: J-52/7, MIDC, Bhosari, Pune , ,
164	145-14000-A	TRANSMITTERS	P082	PANAM ENGINEERS	REGULAR	NA	Mr. Santosh Shukla 203, Jaisingh Business,Parsiwada, Sahar road,Andheri(East), Mumbai,-Maharashtra,-India, Phone- 9892179529, Pincode : 400099, Email : santosh@panamengineers.com,	, ,
165	145-14000-A	TRANSMITTERS	N040	NIVO CONTROLS PVT. LTD.	REGULAR	C	Mr. Praveen Toshniwal 104-115, Electronic Complex, Indore-M.P.-India Phone- 0731-4081305 Pincode : 452010 Email : sales@nivocontrols.com	Registered in permanent category as per 11th MISCC-Electrical and C&I (FY 2014-15) dt. 20.09.2014. , Technical limit reviewed on 12.10.2015; ,
166	145-14000-A	TRANSMITTERS	M091	Moore Industries International Inc.	REGULAR	NA	Leonard.W. Moore/ Matt Moren 16650 Schoenborn St. North Hills-CALIFORNIA-USA Phone- +1 818 830 5548 Pincode : 91343 Email : mmoren@miinet.com	INDIAN REPRESENTATIVE: CHEMTROL INDUSTRIES LTD. , , ,
167	145-14000-A	TRANSMITTERS	E057	Endress + Hauser (India) Pvt. Ltd.,	REGULAR	NA	Mr. Prakash Vaghela 215-216, DLF Tower 'A', Jasola District Centre, New Delhi,- New Delhi,-India, Phone- 9717593001, Pincode : 110025, Email : prakash.vaghela@in.endress.com	For temperature transmitter only. , , ,

168	145-14000-A	TRANSMITTERS	B049	ABB LIMITED	REGULAR	A1	MR. RAJIV GOVIL 14, MATHURA ROAD, FARIDABAD-HARYANA-INDIA Phone- 09971085678 Pincode : 121003 Email : vipin.swami@in.abb.com	(1) A GROUP COMPANY OF ABB, NOW. (2) NAME OF VENDOR CHANGED FROM BIRLA-KENT TAYLOR LIMITED TO ABB LIMITED W.E.F. 27.06.2011 , Technical limit reviewed and changed on 05.06.2014; Technical limit further reviewed on
169	145-42000-A	ULTRASONIC FLOW METERS	N209	NIVUS GMBH	REGULAR	NA	Mr. Marcus Fischer Im Taele 2, D - 75031 Eppingen -- Germany Phone- 00491712233770 Pincode : Email : carolin.schuster@nivus.com	, ,
170	145-33000-A	VENTURI METER	M009	MICRO PRECISION PRODUCTS PVT. LTD.	REGULAR	NA	K.P. CHANDHOK/ATUL CHANDHOK 4, LINK ROAD, FARIDABAD-HARYANA-INDIA Phone- 9810265688 Pincode : 121002 Email : nal@microa1.com	, ,
171	145-33000-A	VENTURI METER	S044	STAR-MECH CONTROLS (I) PVT.LTD.	REGULAR	C	SUSHILLOTAM, SUSHILLOTAM, 29/3A/3, SASANE NAGAR, HADAPSAR, PUNE- MAHARASHTRA-INDIA Phone- 02026970450 Pincode : 411028 Email : sushil@star-mech.net	, ,
172	145-33000-A	VENTURI METER	T108	TM TECNOMATIC SPA	REGULAR	NA	MR. ANTONIO NOVIELLO/Mrs. Enrica Bazzoc VIA DELLE INDUSTRIE, 36 CREMONA- ITALY Phone- 39037221574 Pincode : 26100 Email : info@tmttecnomatic.com	AS PER DECISION OF MISCC-ELECT AND C&I HELD ON 19.10.2012 , ,
173	145-40000-A	VIBRATION MONITORING SYSTEM	S156	SKF INDIA LIMITED	REGULAR	NA	Mr. Shishir Joshipura SERVICE BUSINESS UNIT, CHINCHWAD, PUNE- MAHARASHTRA-INDIA Phone- +91 982 3161755 Pincode : 411033 Email : sandeep.gadre@skf.com	PARENT COMPANY: SKF CONDITION MONITORING INC, USA. ENTIRE RESPONSIBILITY OF ALL CONTRACTUAL OBLIGATIONS SHALL BE OF INDIAN VENDOR AS DECIDED BY 4TH MISCC (ELECT AND C&I) HELD ON
174	145-40000-A	VIBRATION MONITORING SYSTEM	R056	ROCKWELL AUTOMATION INDIA PVT LTD	REGULAR	NA	A-66, SEC- 64, NOIDA,- UP-India Phone- 0120-4671236 Pincode : 201301 Email : ra.india@ra.rockwell.com; asharma@ra.rockwell.com	PARENT COMPANY: ROCKWELL AUTOMATION INC, USA. ENTIRE RESPONSIBILITY OF ALL CONTRACTUAL OBLIGATIONS SHALL BE OF INDIAN VENDOR AS DECIDED BY 4TH MISCC (ELECT AND C&I) HELD ON

175	145-40000-A	VIBRATION MONITORING SYSTEM	M097	MEGGITT INDIA PVT. LTD.	REGULAR	NA	LJ Swaminathan/Gaurav Anand Unit-04A, Level-02, Bagmane Laurel Bagmane Tech Park, CV Raman Nagar Bangalore-Karnataka-India Phone- +91-9731577119 Pincode : 560093 Email : gaurav.anand@meggitt.com	PARENT COMPANY: MEGGITT SA, SWITZERLAND. ENTIRE RESPONSIBILITY OF ALL CONTRACTUAL OBLIGATIONS SHALL BE OF INDIAN VENDOR AS DECIDED BY 4TH MISCC (ELECT AND C&I) HELD ON
176	145-40000-A	VIBRATION MONITORING SYSTEM	F034	FORBES MARSHALL PVT. LTD.	REGULAR	NA	A - 34/35, MIDC ESTATE, H-BLOCK, PIMPRI, PUNE- MAHARASHTRA-INDIA Phone- 020-27442020, Pincode : 411 018 Email : mvyas@forbesmarshall.com	IN ASSOCIATION WITH SHINKAWA ELECTRIC CO. LTD., JAPAN (V.CODE S155) AS PER AGREED SCOPE MATRIX. ENTIRE RESPONSIBILITY OF ALL CONTRACTUAL OBLIGATIONS SHALL BE OF INDIAN VENDOR , ,
177	145-40000-A	VIBRATION MONITORING SYSTEM	G068	GE INDIA INDUSTRIAL PVT. LTD.	REGULAR	NA	Mr. Pramod Kaushik/Vijay Pal BUILDING NO-7A, 4TH FLOOR GURGAON- HARYANA-INDIA Phone- 0124-4808515 Pincode : 122002 Email : vijay.pal@ge.com	PARENT COMPANY: BENTLY NEVADA INC, USA. ENTIRE RESPONSIBILITY OF ALL CONTRACTUAL OBLIGATIONS SHALL BE OF INDIAN VENDOR AS DECIDED BY 4TH MISCC (ELECT AND C&I) HELD ON

Notes:- 1) The above sub-vendor list is tentative & reference only. However sub-vendor list is subject to BHEL/end user approval without any commercial/delivery implication. 2) New subvendor if proposed by vendor during contract stage shall be subject to BHEL/end user approval without any commercial implication.

90 SI No.	Package Name	Vendor Name	LOCATION
1	LOCAL CONTROL PANELS	C and S ELECTRIC LTD.	New Delhi
		PYROTECH ELECTRONICS PVT. LTD.	Udaipur
		PROCON INSTRUMENTATION PVT. LTD.	Chennai
		INDUSTRIAL CONTROLS & APPLIANCES PVT LTD	Mumbai
2	ANALYSERS (ALL TYPES)	ABB INDUSTRIES AG	SWITZERLAND.
		ROSEMOUNT ANALYTICAL INC	IRVINE
		ENDRESS + HAUSER INDIA PVT. LTD.	MUMBAI
		HACH LANGE S.A.R.L CH-1222,	VESENAZ
		SWAN Analytische Instrumente AG, CH-8340	Hinwii
		METTLER-TOLEDO INDIA PVT. LTD.,	MUMBAI
		THERMO ORION INC	BEVERLY
3	UPS	EMERSON NETWORK POWER,	AMBERNATH
		EMERSON NETWORK POWER	PUNE
		HITACHI-HIREL,	GANDHINAGAR
		KELTRON,	TRIVANDRUM
		CONSUL NEOWATT POWER SOLUTIONS,	PUNE
5	MOTORISED ACTUATOR	ROTARK	UK
		AUMA	Bengaluru
		WEIR BDK VALVES	Hubli
		LIMITORQUE	Faridabad
6	AIR FILTER REGULATOR	PLACKA	Chennai
		SHAVO-NORGREN	Mumbai
		SCHRADER SCHORILL DUNCAN LTD.	Mumbai
		FAIRCHILD	USA
		SMC PNEUMATICS	Noida
7	SOLENOID VALVE	ASCO	USA
		ROTEX	Vadodra
		SCHRADER	Pune
		AVCON	Mumbai
		HERION-NORGREN	Germany
		IMI-NORGREN	Germany
		JAFFERSON	Argentina

	TITLE 2X660 MW, ENNORE SEZ STPP TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT	SPECIFICATION NO. PE-TS-412-158-A001 SECTION-IA REV 00
1. THE SUB VENDOR LIST ABOVE IS INDICATIVE ONLY AND IS SUBJECT TO BHEL AND CUSTOMER APPROVAL DURING DETAILED ENGINEERING STAGE WITHOUT ANY COMMERCIAL & DELIVERY IMPLICATION TO BHEL. BIDDER TO PROPOSE SUB VENDOR WITHIN 4 WEEKS OF PLACEMENT OF LOI. THEREAFTER NO REQUEST FOR ADDITIONAL SUB-VENDOR SHALL BE ENTERTAINED. 2. DEALERS ARE NOT ACCEPTABLE FOR ANY ITEM OF THE PACKAGE. BIDDER SHALL PROCURE ALL ITEMS INCLUDING PLATES, STRUCTURAL, FLANGES; COUNTER FLANGES ETC. FROM APPROVED SUB VENDOR ONLY. 3. THE INSPECTION CATEGORY WILL BE INTIMATED AFTER AWARD OF CONTRACT BY BHEL/CUSTOMER. HOWEVER THE SAME WILL BE ADHERED BY THE BIDDER WITHOUT ANY COMMERCIAL AND DELIVERY IMPLICATION TO BHEL/ CUSTOMER.		



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

ANNEXURE III: FUNCTIONAL GUARANTEES AND LIQUIDATED DAMAGES



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

The Bidder shall guarantee that the equipment offered shall meet the rating and performance requirements stipulated for various equipment covered in this specifications.

The guaranteed performance parameters furnished by the bidder in his offer, shall be without any tolerance values and all margins required for instrument inaccuracies and other uncertainties shall be deemed to have been included in the guaranteed figures.

The bidder shall demonstrate all the guarantees covered herein during demonstration test / PG test.

The various tests which are to be carried out during demonstration tests are listed in the specification. The guarantee tests shall be conducted by the bidder at site in presence of BHEL/ CUSTOMER. All costs associated with the tests shall be included in the bid price.

In case during demonstration test /PG test, it is found that the equipment/system has failed to meet the guarantees, the bidder shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to the BHEL/ CUSTOMER and re-conduct the demonstration test(s) / PG test with BHEL/ CUSTOMER's consent.

I. TECHNICAL GUARANTEES

a) CLARIFIER

Each clarifier unit of PT plant shall be guaranteed for an effluent capacity of not less than 940 CU.M/ hr. meeting the effluent quality as mentioned below.

Effluent quality at the outlet of all clarifiers shall be guaranteed for the following:-

- Iron content: Less than 0.3 mg/ litre.
- Total Suspend Solids: Less than 10 ppm

Note: Organic matter shall be tested as per KMnO4 method

Each clarifier shall be tested to demonstrate the above mentioned Guarantees at site under Demonstration test. In addition, demonstration of satisfactory working of all the clarifiers, its drives, scrapper mechanism, operation of sludge blow-off etc., shall be demonstrated by bidder.

II. AUXILIARIES POWER CONSUMPTION GUARANTEES

Bidder to refer guaranteed auxiliary power requirement for pre- treatment plant drives listed on continuous basis. The total power consumption should be well within the values as mentioned below.

Liquidated damages shall be applicable during demonstration / PG test at site as per rate given in below on difference between actual power consumption of drives listed and guaranteed auxiliary power consumption.

Bidder to note that guaranteed auxiliary power consumption value for station (in KW) for PT plant shall be well within the values given below:

- a) PRE-TREATMENT PLANT – 100 KW (for all continuous drives considering two nos. clarifier working at a time)**

LIQUIDATED DAMAGES CRITERIA FOR AUXILIARY POWER CONSUMPTION DURING DEMONSTRATION / PG TEST

If the actual power consumption exceeds the guaranteed power consumption, liquidated damages shall be payable by the bidder at the rate of Rs. 3, 56,607 /- per KW (Rupees Three lacs fifty six thousand six hundred and seven per Kilowatt) excess power consumption, over the base guaranteed figure as indicated by BHEL above or indicated by bidder in "GUARANTEED AUXILIARY POWER CONSUMPTION FORMAT" for PT Plant.



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

ANNEXURE IV: DRAWING DOCUMENTS DISTRIBUTION PROCEDURE



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

DISTRIBUTION SCHEDULE

S. No	Description	TSGENCO										CONSULTANT			Equipment Vendor	Remarks
		Director Projects	Director Technical	CE/Civil Thermal Projects Hyd.	CE/TPC-1, Hyd	CE/O&M/ KTPS	SE/ Civil KTPS	SE/E&M / KTPS	DE Constr. KTPS	Kolkata	HYD	KTPS				
A	Letter Of Intent or Contract Documents	1	1	1	S	1	2	2	1	1	1	1	2			
B	Vendor Drawings															
1.	Preliminary	1	1	1	2	1	1	2	2	12	1	-	S			
2.	Return preliminary with comments	-	-	1	2	1	1	1	1	S	1	-	1			
3.	Final and any revision thereof															
	a. Civil	1	1	6+1T	1	1	6+1T	1	-	2+1T	1	1	S			
	b. E&M	1	1	1	6+1T	1	1	6+1T	1	2+1T	1	1	S			
C.	Design Drawings															
1.	Preliminary															
	a. Civil	1	1	2	1	1	2	1	1	4	1	1	S			
	b. E&M	1	1	1	2	1	1	2	1	4	1	1	S			
2.	Released for construction															
	a. Civil	1	1	2	1	1	6	1	1	1	1	2	S			
	b. E&M	1	1	1	1	2	1	6	1	1	1	2	S			
3.	Return marked 'As built'															
	a. Civil	-	-	1	-	-	1	-	-	1	1	S	1			
	b. E&M	-	-	-	1	-	-	1	1	1	1	S	1			
4.	As built drawings															
	a. Civil	-	-	1+1T	-	2+1T	5+1T	-	1	1+1T	-	1	S			
	b. E&M	-	-	1	2+1T	2+1T	-	5+1T	1+1T	1+1T	-	1	S			



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

S. No	Description	TSGENCO							CONSULTANT				Equipment Vendor	Remarks
		Director Projects	Director Technical	CE/Civil Thermal Projects Hyd.	CE/ TPC-I, Hyd	CE/ O&M/ KTPS	SE/ Civil KTPS	SE/E&M / KTPS	DE Constr. KTPS	Kolkata	HYD	KTPS		
D	Progress Report Monthly													
1.	Equipment vendor	1	1	1	2	1	1	2	1	1	1	1	S	
2.	M/s DCPL, Kolkata	1	1	2	2	1	1	2	1	S	1	1	Nil	
E	Test & Inspection Reports													
1.	Equipment manufacturer													
a. Civil		1	1	1	2	1	1	1	-	11	1	1	S	
b. E&M		1	1	-	2	1	-	1	1	11	1	1	S	
2.	M/s DCPL, Kolkata	1	1	-	2	1	-	1	1	S	-	1	-	
F	Instruction Manuals/Data Books													
1.	Equipment manufacturer													
a. Civil		1	1	1+1T	1	1	6+1T	1	1	2+1T	1	1	S	
b. E&M		1	1	-	3+1T	1	-	6+1T	2	3+1T	1	1	S	
2.	M/s DCPL, Kolkata	1	1	-	10+1T	1	-	15+1T	-	S	1	1	Nil	
G	M/s DCPL, Kolkata Criteria	1	1	1	8+1T	1	1	2	1	1	1	1	S	
H	Design Calculations	1	1	1	8+1T	1	1	2	1	1	1	1	S	
I	Final consulting Engineering Report	1	1	1	10	1	1	2	1	S	1	1	Nil	

S – Source, T – Transparency & Soft Copy on CD,



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

ANNEXURE V : PAINTING SPECIFICATION

CHAPTER - 6

PAINTING

1.0 SCOPE

This section defines the technical requirements for surface preparation, selection and application of paints on equipment, vessels, machinery, piping, ducts etc. However, manufacturers shall follow their standard procedures for painting their equipment. The bidder shall submit a detailed painting procedure for approval of owner/ owner's representative after the award of contract.

The following surface and material shall require painting:

- a. All un-insulated carbon steel and alloy steel equipment like columns, vessels, storage tanks, pumps, heat exchangers etc.
- b. All un-insulated carbon steel and low alloy piping, fitting and valves (including painting of identification marks).
- c. All pipe structural steel supports, walkways, platforms, handrails, ladders etc.

The following surfaces and materials shall not require painting :

- a. Non-ferrous materials
- b. Austenitic stainless steel
- c. Plastic and / or plastic coated materials
- d. Insulated surface of equipment and pipes except color coating wherever required.
- e. Painted equipment like blowers, pumps, valves etc. with finishing coats in good condition and with matching color code.

2.0 CODES AND STANDARDS

Painting of equipment shall be carried out as per the specifications indicated below and shall conform to the relevant IS specification for the material and workmanship.

The following Indian Standards may be referred to for carrying out the painting job :

IS:5	:	Colours for ready mixed paints and enamels
IS:1303	:	Glossary of terms relating to paints
IS:2379	:	Colour code for identification of pipelines
IS:1477	:	Code of practice for painting of ferrous metals in buildings (Parts I & II)
IS:2524	:	Code of practice for painting of non-ferrous metals in buildings (Parts I & II)
IS:2395	:	Code of practice for painting of concrete, masonry and plaster surfaces (Parts I & II)

IS:2338	:	Code of practice for finishing of wood and wood based materials (Parts I & II)
IS:158	:	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and heat resisting.
IS:2074	:	Ready mixed paint, air drying, red Oxide Zinc Chrome, priming
IS:104	:	Ready mixed paint, brushing, Zinc Chrome, priming
IS:2932	:	Enamel Synthetic exterior (a) Undercoating (b) finishing
IS:4682	:	Code of practice for lining of vessels & equipment
SIS 559000	:	Swedish standard for blasting
ISO 8504-2	:	Preparation of steel substrates before application of paints and related products. Surface preparation methods Part 2 Abrasive blast cleaning
ISO 8501-1	:	Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness. Part 1 : Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.
SIS 05 5800	:	Surface preparation by acid pickling
SSPC SP08	:	Surface preparation by acid pickling
IS 2629	:	Recommended practice for hot dip galvanizing of iron and steel
ASTM A780	:	Standard practice for repair of damaged galvanized coatings
SSPC	:	Steel structures painting council
NACE	:	National association of Corrosion Engineers
DIN	:	Deutsches Institut für Normung
BS	:	British Standard
ASTM	:	American Society for Testing material
AWWA	:	American Water works association

3.0 SURFACE PREPARATION

The surface shall be prepared in a manner suitable for coatings. Chemical derusters or rust converters shall not be applied. Acid cleaning is subject to approval of Purchaser/ Purchaser's representative.

3.1 BLASTING

The surface of the part/ component shall be blasted before the coating material is applied.

Compressed air supply for blast cleaning shall be free of water and oil. Air compressors shall not be allowed to deliver air above 1100C. Blasting activity shall be performed at temperatures 30C above dew point and substrate temperature between 50C & 500C and relative humidity not exceeding 85% shall be maintained during painting. Necessary safety precautions for equipment and operator shall be adhered to and shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertains to the work.

Abrasive used for blast cleaning carbon steel and alloy steel shall be as per ISO 8504-2 and SSPC painting manual. Suggested abrasives are chilled iron grit, shot steel, malleable iron grit and shots of non metallic abrasive (aluminum oxide, copper slag, garnet etc.).

The grade of blasting shall be performed in line with the approved painting scheme.

The nature, quality and grain size of abrasives and the parameter of their use are to be chosen to obtain the required surface profile depth and cleanliness.

Surfaces prepared for coating shall be coated the same day and before any visible rusting occurs (the time elapsed between blast cleaning and commencement of painting shall under no circumstances exceed 4 hours, but in any case must commence before signs of degradation occur).

The grades of surface finish

	ISO 8501-1	SIS 055900	SSPC	NACE
White metal	Sa3	Sa3	SP5	1
Near White metal	Sa 2½	Sa 2½	SP10	2
Commercial Blast	Sa2	Sa2	SP6	3
Brush off blast	Sa1	Sa1	SP7	4

Unless otherwise specified in the documents, the surface shall satisfy the following requirements after blasting

(a) Blasting according to SIS 055900, Grade Sa 2½

Primer paint shall be Zinc Silicate of approved brand. Dry film thickness of each primer coat shall be 15-25 µm.

3.2 Manual Rust Removal

Manual rust removal shall be allowed for welded zones and for touching up installed components.

3.3 Cleaning

Removal of impurity

	Impurity	Removal
a)	Dust, Loose deposits	Vacuum cleaning, brushing
b)	Adhesive deposits	Power brushing
c)	Oils, greasy impurities	Wet Blasting, Use of Detergent Additives by agreement
d)	Salt deposits	Rinsing
e)	Markings (eg felt up pen)	Organic solvents to manufacturer's specifications e.g. Trichloroethylene and solvents containing acetone (renew solvent and rag frequently)

3.4 Acid Pickling

Prior to galvanizing the surface preparation shall be done by acid pickling as per SSPC-SP-08.

4.0 PROCESSING

4.1 General Application Conditions

The primer shall be applied to properly prepared surfaces only. The specifications of the coating material manufacturers shall be observed. The minimum temperature shall be + 5°C and the relative humidity shall not exceed 80%. The temperature of the work piece shall be at least 3°C above dew point.

4.2 Application Procedure

The primer shall be applied by means of brush or by spray. The top coats shall be applied by means of brush, roller or spray.

At points where coating application is interrupted, the individual layers shall be adequately stepped to ensure proper layer sequence when coating operations are resumed.

4.3 Touching Up

Before each layer is applied, previous coating shall be touched up where necessary by way of rust removal and cleaning according coating manufacturers specification. The final top shall be reapplied completely.

4.4 Uncoated Surfaces

Moving parts of machines (e.g stems, shafts, sliding and locating bearings), nameplates, instruments and sealing surface shall not be coated. Welds shall be left free of coating upto a distance of 30 mm on each side of the weld edge until erection and weld examinations, if any, have been completed.

4.5 Bond Strength

The pull off stress determined using the pull off test method for adhesion shall not be less than 1.5 N/mm², according to ISO 4624.

5.0 SURFACE CONDITIONS OF COATING SURFACES

The coating surface shall have a uniform film thickness, shade and gloss and shall be free from inclusions, sags and wrinkles.

6.0 COATING SYSTEMS

6.1 General Requirements for Coating Systems

Coating materials according to SPC, BS 5493 or DIN 55928 shall be used. Intermediate coats are to be pigmented with micaceous iron oxide. The materials shall be matched with each other so that they are compatible. Coatings deviating this

specification shall be subject to approval. Standards of surface preparation and painting shall give a time to first maintenance of 10 years.

The colour and gloss of top coats shall be in accordance with sub clause suggested colour codes for painting (Sub Clause 6.8)

6.2 Standard Coating System (External Coatings)

(a) Steel Surfaces

- (i) All steel structures shall receive two primer coats and two sandwich coat of MIO Epoxy paint and one finish coat of painting. First coat of primer shall be given in shop after fabrication before dispatch to erection site after surface preparation as described below. The second coat of primer shall be applied after erection and final alignment of the erected structures. Two intermediate coats and one finished coat shall also be applied after erection.
- (ii) Steel surface which is to be painted shall be cleaned of dust and grease and the heavier layers of rust shall be removed by chipping prior to actual surface preparation. The surface shall be abrasive blasted as explained in clause 3.1 to Sa 2½ finish as per SIS05-5900. Primer paint shall be Zinc Silicate of approved brand. Dry film thickness of each primer shall be 60 microns.
- (iii) Two intermediate MIO Epoxy paint, and one top polyurethane coating of approved brand shall be applied. Dry film thickness of each intermediate coat shall be 90 microns and top polyurethane coating shall be 30 microns. The under coat and finish coat shall be of different tint to distinguish the same from finish paint. The total dry film thickness shall be 330 microns. All paints shall be of approved brand and shade as per owner's requirement.
- (iv) Joints to be site welded shall have weldable primer applied within 100 mm of welding zone. Similarly where friction grip fasteners are to be used removable anti corrosive coating shall be provided. On completion of the joint the surfaces shall receive the paint as specified.
- (v) Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly. Surfaces inaccessible after erection including top surfaces of floor beams, supporting gratings or chequered plate shall receive one additional coat of finish paint over the above number of coats specified before erection. Portion of steel member embedded/ to be encased in concrete shall not be painted.

(b) Gratings and Step Threads

(i) Surface Preparation

Gratings and step threads shall be cleared by acid pickling as per SSPC-SP-08

(ii) Hot Dip galvanizing

The hot dip galvanizing shall be done as per IS 2629. The average mass of coating shall be 610 gm/m².

(iii) Post Treatment

Immediately after galvanizing post treatment such as chromating shall be applied to retard white rust attack.

(iv) Touch up mechanical damages

The repair of damages coatings shall be done as per the recommended practice ASTM A780.

6.3 **Painting of Indoor components such as valves, pumps, motors, electrical parts, tanks etc.**

At Works

Surface Preparation

Blasting according to SIS 055900 grade Sa 2½. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 25 µm may be used.

Prime Coat

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

At Site

Thorough cleaning to remove oil, grease, dirt and any other contaminants. Derusting of all mechanical damages according to SIS 055900 Grade ST3. Touch up with dry film thickness 50 µm.

Finish Coat

Application of two (2) finishing coats of chlorinated rubber paint in approved shades at 30-40 microns DFT each coat in approved shades.

Remarks

Equipment coated with a standard application system can be accepted if the quality of this application system is corresponding with the quality of the above mentioned system.

6.4 **Painting of Outdoor equipment (external surfaces) such as piping, valves, pumps, motors, electrical parts, tanks etc.**

Weather exposure, weather resistance, temperature upto 120°C as per clause 6.1 & 6.3. However

Surface Preparation

Blasting according to SIS 055900 grade Sa 2½. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm may be used.

Prime Coat

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

Intermediate Coat

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

Finish Coat

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

6.5 Special Coating

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

(i) At Works

Surface Preparation

Blasting according to SIS 055900 grade Sa 2½ and ISO 8501-1:1958. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm may be used.

Prime Coat

Inorganic ethyl Zinc silicate, total dry film thickness 75µm.

(ii) At Site

Pretreatment

Removal of all mechanical damages, according to ISO 8501-1:1989, grade St 3 touch up with 1 pack inorganic ethyl zinc silicate, dry film thickness 50µm.

Intermediate Coat

1 pack silicon acrylic dry film thickness 35 µm.

Final Coat

1 pack silicon acrylic, dry film thickness as 35µm.
Total system dry film thickness 145µm.
Final coat according to colour code.

(b) **Parts exposed to temperatures above 200⁰C, upto 400⁰C, not insulated**

(i) **At Works**

Surface Preparation

Blasting according to ISO 8501 -1:1958 grade Sa-2½. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm may be used.

Prime Coat

Inorganic ethyl Zinc silicate, total dry film thickness 75µm.

(ii) **At Site**

Pretreatment

Derusting of all mechanical damages, according to standard Sa 2½ to ISO 8501-1:1988. Touch up with coating system according to manufacturer's recommendations.

(c) **Insulated parts continuously exposed to condensing water or parts exposed to temperatures**

For parts that are provided with insulation on site.

(i) **Insulated parts exposed to condensing water**

At Works

Surface Preparation

Blasting according to Sa 2½ to ISO 8501 -1:1988. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm shall be used.

Prime Coat

Inorganic ethyl Zinc silicate, total dry film thickness 75µm

(ii) **Insulated parts exposed to temperatures**

Parts exposed to temperatures upto < 400⁰C

Surface Preparation

Blasting according to Sa 2½ to ISO 8501 -1:1988. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm shall be used.

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

Temporary Primer

Varnish

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

(i) At Works

Surface Preparation

Blasting according to S a 2½ and ISO 8501 -1:1988. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm may be used.

Prime Coat

Two layers of Zinc phosphate primer, total dry film thickness 75µm.

(ii) At Site

Pretreatment

Removal of all mechanical damages, according to standard S a3 to ISO 8501-1:1988, touch up with 2 pack high build epoxy with volume solid content of more than 85%, 75µm.

Intermediate Coat

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

Finish Coat

2 pack silicon acrylic, dry film thickness of 50µm.

Total system dry film thickness 205µm.

When exposed to weathering, weather resistance finish coat shall be applied.

(e) Water Exposure

(i) At Site/ Works

Pretreatment

Removal of all welding pearls.

Blasting according to Sa 3 to ISO 8501-1:1988

Coat

4 coats 2 pack coal tar epoxy, dry film thickness 125 µm each.

Total system dry film thickness 500µm

Touch up after erection as required.

6.6 Painting of Pipes

6.6.1 Buried Piping

Internal surfaces

- (i) Surface cleaning by sand blasting.
- (ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.
- (iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 150 microns.

Note : All steel pipes carrying sea water shall be internally coated with corrocoat/ polyurea coating having thickness 1500 DFT.

Tests to be carried out after application : Bond/ Adhesion test, Holiday test

External surfaces

- (i) Surface cleaning by Sand Blasting.
- (ii) Coal tar primer compatible with coal tar enamel grade. The number of coats shall be two with a DFT of 35 microns each.
- (iii) Coal tar enamel shall be applied. A single spiral inner wrap of glass fibre tissues shall be applied overlapping at least 25 mm ensuring impregnation of glass fibre tissues in the first coat. The second coat of enamel and second outer wrap of glass fibre felt, Type – I to IS: 7193-1974 will be applied in the same way confirming to Table – 10 of IS – 10221 – 1982.

The total thickness of the coating will not be less than 4.0 mm

- (iv) Alternatively Wrapping with coal tar based anticorrosion tape conforming to IS 15337: 2003 is also acceptable in lieu of s.no. (iii) above. Wrapping thickness shall be 4.0 mm.

Tests to be carried out after application : Bond/ Adhesion test, Holiday test

6.6.2 Overground Piping

Internal surfaces

- (i) Surface cleaning by sand blasting.
- (ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.
- (iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 150 microns.

Note : All steel pipes carrying sea water shall be internally coated with corrocoat/ polyurea coating having thickness 1500 DFT.

External surfaces

- (i) Surface cleaning by Sand Blasting.
- (ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.
- (iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

6.7 Internal Coatings

6.7.1 Tanks (Internal surfaces) as specified in relevant sections of specification

Industrial deionised, demineralised and potable water upto 60°C pH range 4.5-9.5

Blasting according to Sa 2½ and ISO 8501-1:1988.

Prime Coat

Two layers of Zinc phosphate epoxy primer, total dry film thickness >75µm.

Pretreatment

Repairing of all mechanical damages, according to standard Sa3 to ISO 8501-1:1988, touch up with 2 pack high build epoxy with volume solid content of more than 85%, 75µm.

Intermediate Coat

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

Finish Coat

2 pack silicon acrylic, dry film thickness of 150µm per coat.

In case of service or potable water tanks, the coating material selected shall not taint the water. The paint system shall conform to regulations issued by Food & drug administration/ National Public Health service/ AWWA/ OSHA and comply with applicable laws, regulations, ordinances etc. of the local authority, state or the nation pertains to work.

QA/ QC Procedure including pinhole inspection, shall be submitted for approval by Owner/ Owner's representative.

6.6.2 Rubber Lining of Pipes, Valves and Tanks for DM Water

Pretreatment

Blasting according to Sa 2½ and ISO 8501-1:1988

Rubber Lining

Hard rubber 5 mm for DM water applications as IS – 4682

6.7 Painting for Electrical items

6.7.1 All the steel work shall be thoroughly cleaned of rust, scale, oil, grease, dirt and swarf by pickling, emulsion cleaning etc. The sheet steel shall be phosphated/ oven dried and then painted with two coats of zinc rich primer paint. After application of the primer, two coats of finishing epoxy paint shall be applied. The colour of the finishing coats inside shall be glossy white and exterior of the treated sheet steel shall be shade 631 of IS-5/ RAL 7032 for all switchboard/ MCC/ Distribution boards, control panels etc.

6.7.2 All electrical equipment shall be given tropical and fungicidal treatment and outdoor equipment shall be provided with rain hood to prevent entry of rain water into the equipment.

6.7.3 Painting of I & C equipment : Epoxy coating required for all I & C equipment.

6.8 SUGGESTED COLOUR CODES FOR PAINTING

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

SL. NO.	ITEM/SERVICE	COLOUR	IS-5	COLOUR (BAND)	IS-5
3.	Crane				
3.1	Crane structure	Golden Yellow	356	Black	-
3.2	Trolley & hook	Crimson	540	-	-
4.	Fans, pumps, motors, compressors	Light Grey	631	-	-
5.	Tanks (without insulation and cladding)				
5.1	Outdoor	Aluminium	-	-	-
5.2	Indoor	Light grey	631	-	-
6.	Vessels & all other proprietary equipment (without insulation & cladding)	Light grey	631	-	-
7.	Switchgear	Light grey (Powder coated)		-	-
8.	Control & relay panels	Light grey (Powder coated)	631/7078 of IS 1650	-	-
9.	Turbines	Light Grey	631	-	-
10.	Generators & Exciter	Light Grey	631	-	-
11.	Transformers	Aluminum	-	-	-
12.	Machinery guards	Signal red	537	-	-
13.	Piping (without insulation and cladding)				
13.1	Water System				
a	Boiler feed	Sea Green	217	-	-

SL. NO.	ITEM/SERVICE	COLOUR	IS-5	COLOUR (BAND)	IS-5
b	Condensate	Sea Green	217	Light Brown	410
c	DM Water	Sea Green	217	Light Orange	557
d	Soft Water	Sea Green	217	French Blue	166
e	Bearing Cooling Water	Sea Green	217	French Blue	166
f	Potable & filtered Water	Sea Green	217	French Blue	166
g	Service and clarified water	Sea Green	217	French Blue	166
h	Cooling water	Sea Green	217	French Blue	166
l	Sea Water	Sea Green	217	White	-
14.	Ash Transmitting Vessels and pipe lines	Aluminium	-	-	
15.	Air System				
15.1	Station air	Sky blue	101	-	-
15.2	Control air	Sky blue	101	White	-
16.	Oil system				
16.1	Fuel oil	Light brown	410	French	166
16.2	Light oil (HSD)	Light Brown	410	Brilliant green	221
16.3	Lubricating oil	Light brown	410	Light grey	631
16.4	Transformer oil	Light brown	410	Light orange	557
17.	Gas System				
17.1	Carbon dioxide	Canary yellow	309	Light grey	631
17.2	Hydrogen	Canary yellow	309	Signal red	537
18.	Fire services	Fire red	536	-	-
19.	Effluent pipes	Black	-	-	-
20.	Vacuum pipes	Sky blue	101	Black	-

Notes :

1. This colour code basically refers to IS:2379 for piping with necessary modifications

2. Where band colour is specified, same shall be provided at 30 meter intervals on long uninterrupted lines and also adjacent to valves and junctions.

Bidder shall furnish his painting specification to suit corrosive atmosphere of coastal area along with the bid. The specification shall in general be in line with the above requirements.



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

ANNEXURE VI : MANDATORY SPARES LIST



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

SL. No.	Equipment / Package name	Qty.
	PRETREATMENT PLANT	
1	CIRL DIAPHRAGM VALVE	
a.	Complete valve	Two (2) Nos. each of different size of valve in the system
b.	Diaphragm	Five (5) Nos. each of different sizes valves
c.	Valve spindle	Two (2) Nos. each of different sizes valves
2	Other type valve (except Control Valve)	
a.	Complete valve	One (1) No. each of different size of valve in the system
b.	Sampling & needle valve	Four (4) Nos. each type & size
3.	Pressure Gauge	Two (2) Nos. for each Range/Type
4.	Level Gauge	
a.	Glass Tube	Five (5) Nos. for each size
b.	Off-set value	Two (2) Nos. for each size
5	Level Switch (conductivity type)	
a.	Float & Rod Float & Rod	One (1) No. for each size
b.	Switch Assembly	One (1) No. for each size
6	Clariflocculator Bridge	
a.	Worm gearbox	One (1) No.
b.	Shaft for trailing wheel	One (1) No.
c.	Flocc. Drive head complete with bevel & pinion set.	One (1) No.
d.	Central bearing housing complete.	Two (2) Sets
e.	Current collectors.	One (1) Set
f.	Weir with stuffing box.	One (1) No.
g.	Bearing; Impeller with shaft & gear unit for each type and size of air blowers.	Two (2) Sets
h.	Floats for each size and type with links & levers	Two (2) Sets
i.	Bearings & brake linings for each type & rating of hoists.	Two (2) Sets
j.	Rope grid & complete length of wire rope for each type of hoists rating	One (1) No.
k.	Bearings; shaft sleeve; impeller; and mechanical seal for each type & duty parameters of pump sets.	One (1) set each
l.	Controller valve assembly complete.	Two (2) No.
m.	Periphery drive worm gearbox coupling.	Two (2) No.



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SECTION-IA

REV 00

7.0	415 V Motors	
	Terminal plates	10 Nos. each for small motors upto 30 kW & 4 Nos. each for more than 30 kW
	Heaters	2 sets
	Greasing arrangements	4 sets each type of motor
	Motor of each type and rating	10% of the installed quantity or minimum 1 number whichever be higher
	Bearings (DE and NDE) for each type and rating of motor	4 sets
8.0	BATTERY	
	Battery cell	10 nos.
	MT cell container of each type	10 nos.
	Level indicator	6 nos.
	Vent plugs	12 nos.
	Inter-cell connector	10 nos.
	Set of nuts, bolts and washer	12 nos.

2x660 MW ENNORE SEZ PROJECT OF TANGEDCO					
MANDATORY SPARES					
III.	CONTROL & INSTRUMENTATION PACKAGES				
TANGEDCO				Total Ex-Works price	*Remarks
SI no	Name of spares	Unit	Qty	in INR	
1.0.0		INSTRUMENTATION			
(I)	Each type of lamps, PBs, ILPBs, fuse, MCB, MCCB used in the equipment/system.	Nos.	20 % of Installed of each type.		
1.00.01	Measuring Instruments				
1.00.01.01	Indicators, Recorders, Electrical Metering and Skid Mounted Instruments				
(i)	Indicators, recorders and meters offered from each model for the project. These instruments shall be supplied with three sets of blank scales.	Nos.	10 % of Installed of each type/Model or a minimum of one number for each model and type, whichever is more		
(ii)	For skid mounted instruments	Nos.	10% of total number of instruments for each Type and model or a minimum of one number for each model and type, whichever is more		
1.00.01.02	Temperature Elements and Thermowells				

TANGEDCO				Total Ex-Works price	*Remarks
SI no	Name of spares	Unit	Qty	in INR	
(i)	Thermocouple/RTD elements	Nos.	10% spare for each type and length of element furnished with thermocouple/RTD assemblies, or a minimum of one number of each type & length, whichever is more.		
(ii)	Thermowells	Nos.	10% for each type of temperature sensors or a minimum of one for each type, whichever is more		
1.00.01.03	Temperature, Transmitters and Electronic Transmitters (For Pressure, DP, Temp, Flow, Level), Temperature, Pressure, Flow & Level Switch, safety switches, Gauges, meters, Transducer or any other instrument etc.	Nos.	10% of total number of Instruments/transducers offered for each model and type for the project or a minimum of one number, whichever is more.		
~~1.00.01.04~~	~~Flue Gas Analyzers & CEMS (Spareparts shall be furnished in accordance with manufacturer's recommendations for five years continuous operation or minimum quantities indicated as below (whichever is more))~~				

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TANGEDCO				Total Ex-Works price	*Remarks
SI no	Name of spares	Unit	Qty	in INR	
a)	Electronic Module/Mother Board	Nos.	10% of installed or at Least one number of each type of module for each analyser type.		price included at s.no. 1.00.01 above
b)	Cooling and purging air blower unit	Nos.	One No. for each analyser type		price included at s.no. 1.00.01 above
c)	Light source and detector unit for smoke density analyser.	Set	One set for each analyser type		price included at s.no. 1.00.01 above
d)	Infrared source and detector unit for CO analyser	set	One set for each analyser type		price included at s.no. 1.00.01 above
e)	Zirconia Cell, ceramic filters, heater & thermo couple assembly for flue gas oxygen analyzer.	Nos.	Two Nos. of each type		price included at s.no. 1.00.01 above
f)	of chopper motor, two nos. protection window, one no. of heater cartridge for CO analyser	Nos.	Two No. of each type		price included at s.no. 1.00.01 above price included at s.no. 1.00.01 above
g)	Power supply module	Nos.	1 no. of each type for each analyser type.		price included at s.no. 1.00.01 above
h)	UV Lamp with adopter with SO2 analyser	Nos.	2 no. of each type.		price included at s.no. 1.00.01 above
i)	Light source and detector unit for SPM, and NOX/SOX analyser.	Nos.	1 no. of each type for each analyser type.		price included at s.no. 1.00.01 above
j)	Set of filters	Nos.	1 No. of each type for each analyser type.		price included at s.no. 1.00.01 above
k)	Analysers spares like transmitter lens and receiver lens, protection windows for transmitter & receiver, intergral pressure and temperature sensors, signal processing unit, electronic modules	Nos.	1 No. of each type for each type of flue gas analyser.		price included at s.no. 1.00.01 above
1.00.02	DDCMIS/PLC system, Master slave clock system, Hart Management System, Vibration Monitoring system, CAAQMS, ERP/MIS/LAN/Simulator/ WAN, CCTV, Microprocessor based control system, and other Control System/Sub-systems/electronic system listed in NIT.				price included at s.no. 1.00.01 above

TANGEDCO				Total Ex-Works price	*Remarks
SI no	Name of spares	Unit	Qty	in INR	
1.00.02.01	I/O cards				
a.	Analog Input module	Nos.	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)		
b.	Analog output module	Nos.	10% of qty Installed of each category/ model or at least 2 No. of each type/model (Whichever is more)		
c.	RTD/TC cards/modules	Nos.	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)		
d.	Digital input module	Nos.	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)		
e.	Digital output module	Nos.	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)		
1.00.02.02	All types of electronic modules, controllers, function modules, cards, terminal boards, relay boards, power supply cards etc for above mentioned system and other Control System/Sub- systems and any other type of PCB not covered above	Nos.	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)		

TANGEDCO				Total Ex-Works price	*Remarks
SI no	Name of spares	Unit	Qty	in INR	
1.00.02.03	Electronic Cards/modules	Nos.	10% of number for each type or minimum of 2 number for each type whichever is high.		
1.00.02.04	Auto/Manual stations, set-point/bias stations etc	Nos.	10% of the number of stations offered for the project from each type or a minimum of 2 number from each model, whichever is more.		
1.00.02.05	Control logic power supply fuses, MCB,MCCB, at each current rating required for the project.	Nos.	20% spare for each type/Model		
1.00.02.06	Electronic cards of each type used for each type of Servers supplied with any control system	Nos.	Ten (10) percent or 2 no. (Whichever is more)		
1.00.02.07	Electric to pneumatic converters of each type utilized with automatic control system using pneumatic drives	Nos.	Ten (10) percent of each type or a minimum of one of each type, whichever is more.		
1.00.02.08	Plug-in type keyboard	Nos.	Not Applicable for this package		
1.00.02.09	Control OWS	Nos.			
1.00.02.10	Utility/Engineering OWS	Nos.			
1.00.02.11	DVD/CD	Nos.			
1.00.02.12	Data highway cable with adequate connectors of each type	set.	200 mts. each		
1.00.02.13	Hard disc drive unit	Nos.	Not Applicable for this package		
1.00.02.14	Prefab cable connectors	Nos.			
1.00.02.15	Cubicle power supply power supply modules	Nos.	10% or 5 nos (whichever is more) of each type of Installed		
1.00.02.16	Interposing/coupling relays.	Nos.	Ten (10) percent or 5 nos (whichever is more) of Installed of each type and rating		
			Ten (10) percent Installed of each type and rating		

TANGEDCO				Total Ex-Works price	*Remarks
Sl no	Name of spares	Unit	Qty	in INR	
1.00.02.17	Ethernet Switches, Routers & other communication hardware	Nos.	10% of qty Installed of each type or a minimum of 2 numbers from each model, whichever is more.		
1.00.02.18	Sensors with special cables, Power supply modules, Relay, Interface Module, and electronic modules used for vibration monitoring system.	Nos.	10% of qty installed or Five no. (Whichever is more) of each type)		
1.00.02.19	Printer toners for all printers	Nos.	Not Applicable for this package		
1.00.02.20	DMP printer head of the total quantity	Nos.			
1.00.02.21	Drum for A3 sized scanner cum copies, printer	Nos.			
1.00.02.22	24" LED monitor,	Nos.			
1.00.02.23	29" LED monitor	Nos.	Not Applicable. OWS shall be supplied as per applicability.		
1.00.02.24	22" LED monitors.	Nos.			
1.00.02.25	RJ 45 connector with box of each type	Nos.			
			Twenty (20) percent or 2 no. (Whichever is more)		
1.00.02.26	Hooters, Buzzers, Cooling fans of each type.	Nos.	Ten (10) percent or 2 no. (Whichever is more)		
1.00.02.27	Interface cables	Set	2 sets of each type/model		
1.00.02.28	Power supply modules (AC to DC convertors)	Nos.	10% or Five no. (Whichever is more) of each type/model		
1.00.02.29	DVD/CD drive unit of each type	Nos.	Not Applicable for this package		

TANGEDCO				Total Ex-Works price	*Remarks
SI no	Name of spares	Unit	Qty	in INR	
1.00.02.30	Mouse	Nos.	Not Applicable for this package		
1.00.03	Steam and Water Analysis System (SWAS)			50,56,170	Lot price has been given for items under SI no. 10.00.03
1.00.03.01	High pressure reducing elements for sample flow.	Nos.	10% spare of qty installed.		
1.00.03.02	Ion exchange columns with resin as utilized with cation conductivity analysers	Nos.	Four No		
1.00.03.03	Conductivity cells as utilised with conductivity monitors	Nos.	Two nos of each type		
1.00.03.04	pH flow-through type cells used with pH monitors	Nos.	Two nos. of each type		
1.00.03.05	Chemical reagents for all analysers	Set	12 months continuous operation of all analysers from date of taking over.		
1.00.03.06	Chemical reagents for colorimetric silica analyzers	Set	12 months continuous operation of all analysers from date of taking over.		
1.00.03.07	Electronic Modules	Nos.	One (1) no. for each type of Analyser.		
1.00.03.08	Pressure gauge, solenoid valves, temperature gauge, Back Pressure regulating valves, 3 way grab valves, needle valves, isolation valves, PRV, flow switch, flow indicator and temperature switch, erection hardware's, valves in SWAS.	Nos.	Two (2) no. of each type		
1.00.03.09	Primary coolers/secondary coolers.	Nos.	Three (3) No of each type		
1.00.04	Relay based Control Panels				
1.00.04.01	LEDs for indicating lights	Nos.	10% of qty installed.		
1.00.04.02	Control circuit fuses/MCB/MCCB/ Semiconductor Fuses	Nos.	300% of installed of each type, current rating.		
1.00.04.03	Relays modules & contactors.	Nos.	20% spare of qty Installed of each type & rating.		

TANGEDCO				Total Ex-Works price	*Remarks
SI no	Name of spares	Unit	Qty	in INR	
1.00.05	Alarm Annunciation System				r 2
1.00.05.01	logic modules, group card modules, power supply modules, Hooters and any other electronic module.	Nos.	20% spares of each type installed		
1.00.05.02	un-engraved window boxes complete with LED etc.	Nos.	5% spares of each size installed		
1.00.05.03	LEDs for annunciation facia windows and LEDs box assemblies offered for the project	Nos.	20% of qty installed		
1.00.05.04	Annunciator hooter	Nos.	One (1) No. of each type		
1.00.06	Un-interrupted Power Supply System and DC Control Power Supply System				
1.00.06.01	As per Manufacturer's Recommendation for Three Years Continuous Operation or minimum quantities indicated as below (whichever is more)				
1.00.06.02	Fuses/Semiconductor Fuses	Nos.	300% of installed of each type, current rating with each panel /board		
1.00.06.03	Miscellaneous parts for the power supplies such as SCRS, transistors, resistors, diodes, light bulbs, static switches, blocking diodes etc	Nos.	Minimum of 10% or atleast two (which ever is more) of each type		
1.00.06.04	Battery cells complete with contactor,cover plates etc	Nos.	10% of qty installed		
1.00.06.05	Electronic Modules like Rectifier control card, inverter control card, Driver card, IGBT Module, DC-DC converter card or any other card as listed in approved BOM for UPS, AC supply & 24 V DC supply etc.	Set	1 Set of each type & rating		

TANGEDCO				Total Ex-Works price	*Remarks
SI no	Name of spares	Unit	Qty	in INR	
1.00.06.06	Miniature Circuit breakers for AC and DC supply.	Nos.	20 % of installed or 10 Nos of each type (which ever is more) for ACDB and DCDB.		
1.00.06.07	Digital/analog panel meters/indicators	Nos.	5% or 2 no. of each type (whichever is more)		
1.00.06.08	CT's, CVT's VT's chokes, AC/DC isolators, contactors, timers, relays.	Nos.	10% or 2 nos. of each type and rating, (whichever is more)		
1.00.06.09	Cooling Fans in UPS & 24 V DC charger panels	Nos.	10% or 2 nos. of each type and rating, (whichever is more)		
1.00.06.10	following accessory equipment for the battery shall be furnished : a) Cell lifting facilities b) Assembly wrenches c) Vent plug hydrometer d) Vent plug thermometer e) Supply of corrosion-preventive grease. f) 10% spare cells.	Set	Two sets		
1.00.06.11	Electronic modules of each type & rating for UPS and DC control power supply system.	Set	One set of with each set consisting of at least one number of each type of electronic module for inverters, chargers, static switch, stabiliser etc. as per approved BOM.		
1.00.06.12	MCCB for UPS & 24 V DC charger panels, ACDB, DCDB.	Nos.	20 % of installed or 5 Nos of each type (which ever is more)		
1.00.07	Erection hardware				
1.00.07.01	Instrument valves	Nos.	Ten (10) percent of each type & Size installed		

TANGEDCO				Total Ex-Works price	*Remarks
SI no	Name of spares	Unit	Qty	in INR	
1.00.07.02	Condensate pots of each type & Size installed	Nos.	Ten (10) percent of total number of Installed or four numbers whichever is higher.		
1.00.07.03	Manifold	Nos.	Ten (10) percent of each type & Size installed		
1.00.07.04	Fittings	Nos.	Ten (10) percent of each type & Size installed		
1.00.08	LVS			8,58,305	EDN-Lot price has been given for items SI no 1.00.08
1.00.08.01	LEDs	Nos.	20% (Installed) spares of each type & size.		
1.00.08.02	LVS Filters	Nos.	50% spare or min 6 nos.		
1.00.08.03	Electronic cards of each type for LVS	Nos.	3 nos. or 20% whichever is more		
1.00.08.04	Interfacing cables	Set	Two Set of each type & size.		
1.00.08.05	Power supply modules of each type for LVS	Nos.	3 nos. or 20% whichever is more		
1.00.08.06	Cooling modules of each type for LVS	Nos.	3 nos. or 20% whichever is more		
1.00.08.07	LVS Controller of each type for LVS	Nos.	2 nos.		
1.00.09	Master Slave Clock system			1,45,950	EDN-Lot price has been given for items SI no 1.00.09
(i)	As per Manufacturer's Recommendation for Three Years Continuous Operation or minimum quantities indicated as below (whichever is more)	Set			
(ii)	Electronic cards	Nos.	One No. of each type & model		
(iii)	Signal Conditioner cards	Nos.	One No. of each type & model		
(iv)	Slave clocks of each type used for Master slave clock system	Nos.	Two No. of each type & model		
(v)	Cubicle power supply power supply modules	Nos.	Ten (10) percent or 2 nos (whichever is more) of Installed of each type and rating		
1.00.10	Plant Security and surveillance system			5,10,020	EDN-Lot price has been given for items SI no 1.00.10

TANGEDCO				Total Ex-Works price	*Remarks
Sl no	Name of spares	Unit	Qty	in INR	
1.00.10.01	As per Manufacturer's Recommendation for Three Years Continuous Operation or minimum quantities indicated as below (whichever is more)				
1.00.10.02	Electronic cards	Nos.	One No. of each type		
1.00.10.03	PTZ controller	Nos.	One No. of each type		
1.00.10.04	Electronic modules used for server system	Nos.	10% or Two No. of each type (whichever is more)		
1.00.10.05	Special cables & connector	Set	(5 sets) of each type		
1.00.10.06	Cartridges for air filter	Nos.	Two No. of each type		
1.00.10.07	Relay	Nos.	5 nos. of each type		
1.00.10.08	Power supply modules of each type	Nos.	5 nos. of each type		
1.00.10.09	Camera of each type used for Plant Security and surveillance system.	Nos.	Two no. of each type		
1.00.10.10	Automatic door sensors	Nos.	10% or 2 nos. min whichever is more		
1.00.10.11	Card reader.	Nos.	10% or 2 nos. min whichever is more		
1.00.11	AAQMS			27,12,500	Lot price for applicable items
1.00.11.01	As per Manufacturer's Recommendation for Three Years Continuous Operation or minimum quantities indicated as below (whichever is more)				
1.00.11.02	Electronic cards/Module/Mother Board /Signal Processing Unit for each type of Analyzer	Nos.	One no. of each type		
1.00.11.03	Power supply module	Nos.	One no. of each type for each analyser		
1.00.11.04	UV Lamp with adopter with SO2 analyser.	Nos.	One no. of each type		
1.00.11.05	Light source and detector unit for SPM, and NOX/SOX analyser.	Nos.	One no. of each type for each analyser		
1.00.11.06	Pump for SPM Analyser	Nos.	One no. of each type		
1.00.11.07	Conference hall mic.	Nos.	Two no. of each type		
1.00.11.08	Conference hall speakers.	Nos.	Two no. of each type		
1.00.12	HMS			90,475	
1.00.12.01	As per Manufacturer's Recommendation for Three Years Continuous Operation	Set			
1.00.12.02	Electronic cards	Nos.	One no. of each type		

TANGEDCO				Total Ex-Works price	*Remarks
Sl no	Name of spares	Unit	Qty	in INR	
1.00.13	Mandatory Spares for Control valves, Power Cylinder, Control Dampers, Actuators and Accessories				
(A)	Following spares shall be furnished for control valves, Power Cylinder, Control Dampers as applicable.				
	One set of spare control valve stem packing for each control valve.				
	Two moulded rubber diaphragms for each control valve.				
	One sets of each of O-rings and rubber gaskets for each control valve.				
d)	100 percent qty. of lubricants for gaskets for each control valve on one year consumption basis.				

TANGEDCO				Total Ex-Works price	*Remarks
Sl no	Name of spares	Unit	Qty	in INR	
	2 sets of limit switches and 1 set of valve positioner for each control valve.				
f)	20 percent of position transmitter (4-20mA) for total qty. of control valve.				
g)	One (1) set of valve trims (such as plug, stem, seat ring /cage, guide bushing, stem lock pin, packing retaining ring, etc) for each control valve.				
h)	One completes actuator of each type or min 10% for each type and size whichever is more.				
i)	20 percent of Solenoid valves or min 2 no. of each type for total qty. of control valves.				
j)	20% of I to P converters, Pressure regulators.				
B)	Mandatory spares for each critical applications special control valves as specified in NIT			1,17,72,635	PEM-For APRDS AND For Fuel Oil Unloading System, included under clause Fuel oil system of Mech. List of mandatory spares AND For Air Conditioning system, price included under clause Air Conditioning system of Mech. List of mandatory spares
C)					

TANGEDCO				Total Ex-Works price	*Remarks
Sl no	Name of spares	Unit	Qty	in INR	
a.	Soft Goods Kit Valve	1 set		65,16,048	PEM-For Fuel Oil Unloading System, included under clause Fuel oil system of Mech. List of mandatory spares AND For Air Conditioning system, price included under clause Air Conditioning system of Mech. List of mandatory spares HYD-Lot price has been given for items under SL no.1.00.13 (C) Items applicable for Pumps shall be supplied. For C&I control valves included above under clause no A1 -1.0013 of C&I list AND For Fuel Oil Unloading System, included under clause Fuel oil system of Mech. List of mandatory spares AND For Air Conditioning system, price included under clause Air Conditioning system of Mech. List of mandatory spares
b.	Metal seat	1 set			
c.	Seat Ring	1 set			
d.	Spindle	1 set			
e.	Actuator Soft Goods kit	1 set			
i.	Feed back transmitter unit	2 Nos.			
ii.	Electronic Position Transmitter	2 Nos.			
iii.	Solenoid valves	2 Nos.			
iv.	Air filter regulators	2 Nos.			
v.	Air Lock Relay	2 Nos.			
vi.	Complete Actuator for each type and model	1 set			
C)	Following spares shall be supplied for each of the HP/LP By Pass & Spray control valves				TRY-V: Price already Quoted in Mechanical section under HP BYPASS SYSTEM
i)	Stem	1 NO.			
ii)	Jet Cage	1 NO.			
iii)	Nozzle Body	1 NO.			
iv)	Seat	1 NO.			
v)	Guide bushing	1 NO.			
vi)	Valve Packing	1 Set			
vii)	Valve Gaskets	1Set			
viii)	Actuator seal set	1 Set			
D)	Common spares for HP/LP By Pass & Spray control valves:				TRY-V: Price already Quoted in Mechanical section

TANGEDCO				Total Ex-Works price	*Remarks
SI no	Name of spares	Unit	Qty	in INR	
i)	Feedback transmitter	2 NOS.			under HP BYPASS SYSTEM
ii)	Electronic positioner	2 NOS.			
iii)	Proportional Valve	2 NOS.			
iv)	Quick opening device	2 NOS.			
v)	Seal sets	4 Sets			
vi)	Solenoid Valves	2 NOS.			
vii)	Filters for Oil Units	1 set			
viii)	Supply manifold for oil units	1 No			
ix)	Hose for each service	1 each			
x)	Seal set for oil unit	1 Set			
	Complete actuator for each type and model	1 set			
E)	1 NO of Nozzle for each PRDS De Super heater & Spray water desuperheater and orifice plate for CEP flow.				1 No. Nozzle for Spray water Desuperheater is included in our price. Rest of the flow nozzles not included in our offer as 'Mandatory spares' are provided for items or components that require replacement during plant operation. Flow nozzles and orifice plates do not require replacement and hence are not provided as mandatory spares. We have never supplied nozzles and orifice plate as mandatory spares in any of the existing as well as previous projects.
1.00.14	Mandatory Spares for Boiler Tube leak Detection System			17,81,920	LOT PRICE FOR THE APPLICABLE ITEMS UNDER THIS SERIAL NO 1.00.14
	Following mandatory spares along with their individual price required for maintaining boiler tube leak detection system to supply along with the package.				
1)	2nos. acoustic transducer with rear connector sealed to IP-65				
2)	2 nos. flexible high temperatures lead, 3metre long for acoustic transducer.				
3)	2 nos. acoustic s field amplifier / processor mounted in a die cast aluminum or polycarbonate box sealed to IP-65 with mounting brackets, pairs.				
4)	1 no. A/D Convertor cards/field signal interface module for 32 or more channels.				
5)	1 no. Alarm relay output card.				

TANGEDCO				Total Ex-Works price	*Remarks
Sl no	Name of spares	Unit	Qty	in INR	
6)	Consumables like batteries, fuses etc. for two years operation of boiler tube leak detection system.				
1.00.15	Mandatory spares not covered above				
	Bidder to supply 10% or 1 no. (whichever is more) of each type of sensor/instrument, instrumentation/mechanical fittings etc for any other electronic system, feeder control cabinets, hydrastep (EWLI), Vibration Monitoring System, CCTV, C&I Lab Instruments, On line Carbon in Ash analyser system, On line Coal mass flow/speed measurement system, On line secondary air flow measurement system Mass Flow meter, Solid flow meter, 3 D Acoustic type level transmitters, Nucleonic & non nucleonic density transmitter etc.				
1.00.16	OTHER RELATED CONTROL AND INSTRUMENTATION SYSTEMS/EQUIPMENTS				
1.00.16.01	Other SG related sub-systems				
	1 Flame Monitoring System				
(i)	Complete Flame Scanner Assembly including scanner head assembly, scanner housing, and fibre optic cables.	20% or 4 nos. whichever is more.		39,05,356	
(ii)	Flame Scanner Lens.	100%		1,08,570	
(iii)	Electronic cards for scanners	10% or 2 nos. of each type whichever is more.		17,69,852	
(iv)	Power Supply Modules	10% or 2 nos. of each type whichever is more.			INCLUDED IN SL NO (III) ABOVE
	2 Coal Feeders				
(i)	Calibration Motor	10% or 2 nos. whichever is more.			NOT APPLICABLE
(ii)	Correction Motor	10% or 2 nos. whichever is more.			NOT APPLICABLE



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

Notes:-

1. Whenever the quantity is mentioned in "sets" the bidder has to give the item details and prices of each item.
2. Wherever quantity is specified both as a percentage and a value, the Bidder has to supply the higher quantity until and unless specified otherwise.
3. In case spares indicated in the list are not applicable to the particular design offered by the bidder, the bidder should offer spares applicable to offered design with quantities generally in line with the approach mentioned above.



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

ANNEXURE VII : DRAWING/DOCUMENTS SUBMISSION SCHEDULE



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

SI No	DOCUMENT / DRAWING NO.	DRAWING / DOCUMENT TITLE	No. of weeks for document submission after placing LOI/PO	SIZE
PT PLANT				
1.	PE-V0-412-158-A009	QAP FOR HORIZONTAL / VERTICAL CENTRIFUGAL PUMPS WITH MOTOR	10	A4
2.	PE-V0-412-158-A030	MECH. GA FOR CLARIFIER	10	A1
3.	PE-V0-412-158-A051	PLC DOCUMENTS FOR PT PLANT--PLC CONFIGURATION DIAGRAM, DATA SHEET FOR PLC, GA & WIRING DETAILS FOR PLC PANEL, I/O LIST, BOM, MIMIC DIAGRAM, SCADA SCREEN, LIST FOR SIGNALS EXCHANGE WITH DDCMIS (BOTH HARDWIRED & SERIAL INTERFACE IN BHEL	10	A4
4.	PE-V0-412-158-A015	TECHNICAL DATASHEET FOR BUTTERFLY VALVES	10	A4
5.	PE-V0-412-158-A003	HYDRAULIC FLOW DIAGRAM & HYDRAULIC LEVEL CALCULATIONS	4	A1
6.	PE-V0-412-158-A004	PROCESS SIZING CALCULATION	4	A4
7.	PE-V0-412-158-A023	PIPING SUPPORT DRAWING FOR PT PLANT	10	A1
8.	PE-V0-412-158-A044	CABLE SCHEDULE & INTERCONNECTION DRG.	10	A4
9.	PE-V0-412-158-A065	REINFORCEMENT DRAWING FOR CLARIFIER	12	A0
10.	PE-V0-412-158-A024	PIPING SPECIFICATION	10	A4
11.	PE-V0-412-158-A036	MECH. GA FOR SLUDGE SUMP	10	A1
12.	PE-V0-412-158-A098	QAP for Control Cable & screened control cables	10	A4
13.	PE-V0-412-158-A018	TECHNICAL DATASHEET FOR NON RETURN VALVES	10	A4
14.	PE-V0-413-158-A039	MECHANICAL GA FOR TRENCHES, PIPE SUPPORTS PEDESTALS AND FOR ANCHOR PLATES	10	A1
15.	PE-V0-412-158-A060	CIVIL DESIGN CALCULATION FOR STILLING CHAMBER, FLASH MIXER AND PARSHALL FLUME	12	A4
16.	PE-V0-412-158-A002	LAYOUT FOR PT LANT	10	A0
17.	PE-V0-412-158-A066	CIVIL DESIGN CALCULATION FOR PT CLARIFIER	12	A4
18.	PE-V0-412-158-A042	TECHNICAL DATASHEET FOR MOTORS (HORIZONTAL CENTRIFUGAL PUMPS, METERING PUMPS, BLOWERS, AGITATORS)	10	A4
19.	PE-V0-412-158-A012	TECHNICAL DATA SHEET FOR BLOWERS	10	A4
20.	PE-V0-412-158-A033	MECH. GA AND DATA SHEET FOR CLARIFIER BRIDGE MECHANISM	10	A4
21.	PE-V0-412-158-A064	CIVIL GA FOR CLARIFIER	12	A1
22.	PE-V0-412-158-A076	CIVIL GA FOR SLUDGE SUMP.	12	A1
23.	PE-V0-412-158-A021	VALVE SCHEDULE	12	A4
24.	PE-V0-412-158-A020	QAP FOR VALVES	10	A4
25.	PE-V0-412-158-A095	O&M MANUAL COVERING CATALOGUE FOR ALL ITEMS.	26	A4
26.	PE-V0-412-158-A011	QAP FOR METERING PUMPS WITH MOTOR	10	A4



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

27.	PE-V0-412-158-A006	SUB VENDOR LIST AND INSPECTION CATEGORY	4	A4
28.	PE-V0-412-158-A091	CIVIL GA DRAWING FOR TRENCHES, PIPE SUPPORT PEDESTAL AND FOR ANCHOR PLATES.	12	A1
29.	PE-V0-412-158-A016	TECHNICAL DATASHEET FOR DIAPHRAGM VALVES	10	A4
30.	PE-V0-412-158-A014	TECHNICAL DATASHEET FOR BALL VALVES	10	A4
31.	PE-V0-412-158-A013	QAP FOR BLOWERS WITH MOTOR	10	A4
32.	PE-V0-412-158-A055	QAP AND FAT FOR PLC	10	A4
33.	PE-V0-412-158-A094	PG TEST	20	A4
34.	PE-V0-412-158-A058	CIVIL GA FOR CASCADE AERATOR, STILLING CHAMBER, FLASH MIXER AND PARSHALL FLUME FOR CLARIFIER	12	A1
35.	PE-V0-412-158-A035	MECH. GA FOR CHEMICAL HOUSE INCLUDING ALL DOSING TANKS	10	A0
36.	PE-V0-412-158-A077	REINFORCEMENT DRAWING DARWING FOR SLUDGE SUMP, THICKENED SLUDGE SUMP AND FILTER BACKWASH SUMP	12	A1
37.	PE-V0-412-158-A046	TECHNICAL DATSHEET AND HOOK UP DRAWING FOR LOCAL INSTRUMENTS	10	A4
38.	PE-V0-412-158-A063	CIVIL DESIGN CALCULATION FOR CLARIFIER	12	A4
39.	PE-V0-412-158-A056	CIVIL DESIGN BASIS REPORT	12	A4
40.	PE-V0-412-158-A057	CIVIL DESIGN CALCULATION FOR CASCADE AERATOR, STILLING CHAMBER, FLASH MIXER AND PARSHALL FLUME FOR CLARIFIER	12	A4
41.	PE-V0-412-158-A019	TECHNICAL DATASHEET FOR SOLENOID VALVES	10	A4
42.	PE-V0-412-158-A097	Data sheet Control Cable & screened control cables	10	A4
43.	PE-V0-412-158-A025	3D MODEL FOR PT PLANT	15	A0
44.	PE-V0-412-158-A085	CIVIL GA FOR THICKENER	12	A1
45.	PE-V0-412-158-A043	ELECTRICAL LOAD LIST	10	A4
46.	PE-V0-412-158-A001	P&I DIAGRAM FOR PT PLANT	4	A1
47.	PE-V0-412-158-A022	PIPING LAYOUT FOR PT PLANT	10	A1
48.	PE-V0-412-158-A007	CONTROL PHILOSOPHY	6	A4
49.	PE-V0-412-158-A050	TECHNICAL DATA SHEET AND GA FOR JUNCTION BOX	10	A4
50.	PE-V0-412-158-A010	TECHNICAL DATA SHEET FOR METERING PUMPS	10	A4
51.	PE-V0-412-158-A027	TECHNICAL DATA SHEET HOIST, WEIGHING SCALE , TROLLEY AND CHAIN PULLEY BLOCK	10	A4
52.	PE-V0-412-158-A048	TECHNICAL DATSHEET AND HOOK UP DRAWING FOR ANALYSERS	10	A4
53.	PE-V0-412-158-A026	TECHNICAL DATA SHEET FOR AGITATOR	10	A4
54.	PE-V0-412-158-A047	TECHNICAL DATSHEET AND HOOK UP DRAWING FOR TRANSMITTERS	10	A4
55.	PE-V0-412-158-A017	TECHNICAL DATASHEET FOR GATE VALVES	10	A4
56.	PE-V0-412-158-A059	REINFORCEMENT DRAWING FOR CASCADE AERATOR, STILLING CHAMBER, FLASH MIXER AND PARSHALL FLUME FOR CLARIFIER	12	A1
57.	PE-V0-412-158-A093	ERECTION PROCEDURE	20	A4
58.	PE-V0-412-158-A052	UPS AND BATTERY SIZING CALCULATION, DATA SHEET AND GA FOR UPS	10	A4
59.	PE-V0-412-158-A008	TECHNICAL DATA SHEET FOR HORIZONTAL / VERTICAL CENTRIFUGAL PUMPS	10	A4



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

60.	PE-V0-412-158-A041	QAP for PT PLANT (BALANCE ITEMS)	10	A4
61.	PE-V0-412-158-A090	FABRICATION DETAIL DRAWING FOR PUDDLE PIPES	12	A1
62.	PE-V0-412-158-A075	CIVIL DESIGN CALCULATION FOR SLUDGE SUMP.	12	A4
63.	PE-V0-412-158-A053	QAP FOR UPS	10	A4
64.	PE-V0-412-158-A005	PRESSURE DROP CALCULATIONS	4	A4
65.	PE-V0-412-158-A054	QAP / CHECK LIST FOR ALL INSTRUMENTS	10	A4
66.	PE-V0-412-158-A096	ENGINEERING BOQ	20	A4
67.	PE-V0-412-158-A028	MECH. GA FOR CASCADE AERATOR, STILLING CHAMBER, FLASH MIXER AND PARSHALL FLUME FOR CLARIFIER	10	A1
68.	PE-V0-412-158-A049	INSTRUMENT SCHEDULE	10	A4
69.	PE-V0-412-158-A092	PAINTING SCHEDULE	15	A4
70.	PE-V0-412-158-A045	CABLE TRAY/TRENCH & CONDUIT ROUTING DIAGRAM FOR PTP	10	A1
71.	PE-V0-412-163-A027	DATA SHEET OF INSTRUMENTS FOR DM PLANT	10	A4

Notes:

1. The above drawing list is tentative and shall be finalized with the successful bidder after placement of order. While some of the drawings indicated above may not be applicable, some additional drawings may also be required based on scope of work.
2. Drawings shall be prepared in Auto-Cad latest edition. Required no. of hard and soft copies (editable) of the drawings shall be furnished as per requirement specified elsewhere in the specification.
3. Only manual calculation with authentic supporting literature (e.g. extracts of hand Book/ standard/codes) shall be acceptable. All design calculations and drawings shall be in SI system only.
4. All the drawings and documents including general arrangement drawing, data sheet, calculation etc. to be furnished to the customer during detailed engineering stage shall include / indicate the following details for clarity w.r.t. Inspection, construction, erection and maintenance etc.:-
 - a) All drawings and documents shall indicate the list of all reference drawings including general arrangement.
 - b) All drawings shall include / show plan, elevation, side view, cross - section, skin section, blow - up view; all major self-manufactured and bought out items shall be labeled and included in BOQ / BOM in tabular form.
 - c) Painting schedule shall also be made as a part of general arrangement drawing of each equipment / items indicating at least 3 trade names.
 - d) All the drawings required to be furnished to customer during detailed engineering stage shall include technical parameters, details of paints and lubrication, hardness and BOQ / BOM in tabular form indicating all major components including bought out items and their quantity, material of construction indicating its applicable code / standard, weight, make etc.
 - e) Drawings/ documents to be submitted for purchasers review/ approval shall be under Revision A, B, C... etc. while drawings /documents to be submitted thereafter for customer's approval after purchaser's approval shall be under R-0, 1, 2, 3 etc.
 - f) Drawings and documents not covered above but required to check safety of machines/ system, shall be submitted during detailed engineering stage without any commercial implication.



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

- g) All drawings shall include "B.O.M" and indicate quantity, material of construction, make along with IS/BS No., Technical parameters, dimensions, hardness, machining symbol and tolerance, requirement of radiography and hydraulic tests, painting details, elevation, side view, plan, skin section and blow-up view for clarity.
- h) All drawings shall be prepared as per BHEL's title block and shall bear BHEL's drawing No.
- i) Schedule of drawings submissions, comment incorporations & approval shall be as stipulated in the specifications. The successful bidder shall depute his design personnel to BHEL's/ Customer's/ Consultant's office for across the table resolution of issues and to get documents approved in the stipulated time.
- j) Bidder to follow the following the drawing submission schedule:
- k) 1st submission of drawings from date of LOI as per the submission schedule.
- l) Every revised submission incorporating comments – within 7 days.
- m) Bidder to submit revised drawings complete in all respects incorporating all comments. Any incomplete drawing submitted shall be treated as non-submission with delays attributable to bidder's account. For any clarification/ discussion required to complete the drawings, the bidder shall himself depute his personal to BHEL for across the table discussions/ finalizations/ submissions of drawings.
5. Bidder to note that the successful bidder, during detail engineering, will submit the drg/doc through web based Document Management System in addition to hard copies to be submitted as per the Annexure III of this specification. 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:
- 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>

TITLE

SPECIFICATION NO.

PE-TS-412-158-A001



2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SECTION-IA

REV 00

ANNEXURE VIII : WATER ANALYSIS



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

S.No.	Parameter	Unit	Value (Range)
1	General		
a	pH		7.94-8
b	Conductivity	millisiemens/cm	43.8-44.1
c	Temperature	Deg C	25-32
d	Turbidity	NTU	40
e	Total Organic carbon (total/ dissolved)	PPM of C	2.4-2.84
f	CO ₂	Mg/l	<2
g	TDS	Mg/l	39600-39740
h	BOD	Mg/l	10-12
i	COD	Mg/l	88-96
j	Oil & Grease	Mg/l	<10
k	Phenols	Mg/l	0.08-0.09
l	Free Residual Chlorine	Mg/l	<0.2
2	Cations		
a	Calcium	Mg/l	459-478
b	Magnesium	Mg/l	1510-1516
c	Sodium	Mg/l	10100-12000
d	Potassium	Mg/l	358-450
e	Ammonia	Mg/l	4.43-5.42
f	Strontium	Mg/l	12.9-12.4
g	Barium	Mg/l	1.55-1.58
h	Aluminum Total	Mg/l	1-1.8
i	Aluminum Dissolved	Mg/l	0.8-1.0
j	Manganese Total	Micro g/l	0.2-0.6
k	Manganese Dissolved	Micro g/l	0.1-0.2
l	Iron total	Micro g/l	220-260
m	Iron Dissolved	Micro g/l	Below detectable limit (detectable Limit : 10)
3	Anions		
a	Chloride	Mg/l	18994-19194
b	Sulphate	Mg/l	3710-3949
c	Nitrate	Mg/l	136-152
d	Nitrite	Mg/l	0.46-0.62
e	Bicarbonate	Mg/l	144-148
f	Carbonate	Mg/l	Nil
g	Fluoride	Mg/l	2.64-2.8
h	Boron	Mg/l	0.14-0.17
i	Phosphate	Micro g/l	240-380
j	Sulphide	Micro g/l	Below detectable limit (detectable Limit : 100)



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

k	Silica Dissolved	Micro g/l as SiO ₂	200-250
4	Heavy Metals		
A	Arsenic	Micro g/l	Below detectable limit (detectable Limit : 2)
B	Mercury	Micro g/l	Below detectable limit (detectable Limit : 1)
C	Cadmium	Micro g/l	120-130
D	Copper	Micro g/l	200-220
E	Nickel	Micro g/l	470-490
F	Molybdenum	Micro g/l	Below detectable limit (detectable Limit : 100)
5	Suspended Particle Size Range		
A	10 micron & above	Mg/l	Below detectable limit(detectable Limit : 10)
B	5 micron to 10 micron	Mg/l	Below detectable limit(detectable Limit : 10)
C	1 micron to 5 micron	Mg/l	Below detectable limit(detectable Limit : 10)
D	0.1 micron to 1 micron	Mg/l	20-26
6	Colloidal Particle Size Range		
A	SDI (10 Minutes)	-	10-20
B	SDI (5 Minutes)	-	20-40
7	Density of sea water	Kg/ cum	1030



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

ANNEXURE IX: LIST OF TOOLS & TACKLES (AS APPLICABLE)

Bidder to consider necessary tools and tackles for mechanical, electrical and control & instrument as per their system requirement. In addition bidder to adhere relevant clauses of tender specification also. List of tools and tackles to be furnish by bidder during bid submission.

**TITLE**

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

ANNEXURE X: FORMAT FOR OPERATION AND MAINTENANCE MANUAL



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

Bidder to submit operation and Maintenance manual with minimum information as listed in below check list during contract stage.

Check List for Operation & Maintenance Manual

Project name :
Project number :
Package Name :
PO reference :
Document number :
Revision number :

Sl.no. & Section s	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
1.	Cover page				
1.1	Project Name				
1.2	Customer/consultant Name				
1.3	Name of Package				
1.4	Supplier details with phone, FAX ,email address , Emergency Contact number				
1.5	Name and sign of prepared by , checked by & approved by				
1.6	Revision history with approval Details				
2.0	Index				
2.1	showing the sections & related page nos All the pages should be numbered section wise				
3.0	Description of Plant/System				
3.1	Description /write up of operating principle of system equipment/ associated sub-systems & accessories/controls system , operating conditions, performance parameters under normal , start up and special cases				
3.2	Equipment list and basic parameter with Tag numbers				
3.3	Data sheets approved by Customer/for information and catalogues provided by original manufacturer				
3.4	Associated other packages and Interface /terminal points				
3.5	P&ID & Process Diagrams				
3.6	GA Layout drawings, As-built drawings , Actual photograph of items/system (Drawings of A2 & bigger sizes are to be attached in the last)				



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

3.7	Single line/wiring diagrams				
3.8	Control philosophy /control write-ups				
4.0	Commissioning Activities (if not covered in separate document i.e. erection manual, commissioning manual)				
4.1	Pre-Commissioning Checks				
4.2	handling of items at site				
4.3	Storage at site				
4.4	Unpacking & Installation procedure				
5.0	Operation Guidelines for plant personal/user/operator				
5.1	Interlock & Protection logic along with the limiting values of protection settings for the equipment along with brief philosophy behind the logic, drawings etc. to be provided.				
5.2	Start up, normal operation and shut down procedure for equipments along with the associated systems in step by step mode. Valve sequence chart, step list, interlocks etc. with Equipment isolating procedures to be mentioned.				
5.3	Do's & Don't of the equipments.				
5.4	Safety precautions to be taken during normal operation. Safety symbols, Emergency instructions on total power failure condition/lubrication failure/any other condition				
5.5	Parameters to be monitored with normal values and limiting values				
5.6	Trouble shooting with causes and remedial measures				
5.7	Routine operational checks, recommended logs & records				
5.8	Changeover schedule if more than one auxiliary for the same purpose is given				
5.9	Painting requirement and schedule				
5.10	Inspection, repair , Testing and calibration procedures				
6.0	Maintenance guidelines for plant personal				
6.1	List of Special Tools and Tackles required for Overhaul/Trouble shooting including special testing equipment required for calibration etc.				
6.2	Stepwise dismantling and re-assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained, clearances etc. to be mentioned. Tolerances for fitment of various components to be given.				
6.3	Preventive Maintenance & Overhauling schedules linked with running hours/calendar period along with checks to be given				
6.4	Long term maintenance schedules especially for				



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

	structural, foundations etc.				
6.5	Consumable list along with the estimated quantity required during commissioning, normal running and during maintenance like Preventive Maintenances and Overhaul. Storage/handling requirement of consumables/self-life.				
6.6	List of lubricants with their Indian equivalent, Lubrication Schedule, Quantity required for each equipment for complete replacement is to be given				
6.7	List of vendors & Sub-vendors with their latest addresses, service centres ,Telephone Nos., Fax Nos., Mobile Nos., e-mail IDs etc.				
6.8	List of mandatory and recommended spare parts list				
6.9	Tentative Lead time required for ordering of spares from the equipment supplier				
6.10	Guarantee and warranty clauses				
7.0	Statutory and other specific requirements considerations.				
8.0	List of reference documents				
9.0	Binding as per requirement				

TITLE

SPECIFICATION NO.

PE-TS-412-158-A001



2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SECTION-IA

REV 00

ANNEXURE XI: SITE STORAGE AND PRESERVATION

	TITLE 2X660 MW, ENNORE SEZ STPP TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT	SPECIFICATION NO. PE-TS-412-158-A001
		SECTION-IA
		REV 00

CONTENT

- 1 SCOPE OF THE DOCUMENT
- 2 PURPOSE OF STORAGE & PRESERVATION
- 3 MEASURES TO BE TAKEN FOR STORAGE AND PRESERVATION
 - a) GENERAL STORAGE REQUIREMENTS
 - b) GENERAL PRESERVATION REQUIREMENTS
 - c) GENERAL INSPECTION REQUIREMENTS
- 4 TYPE OF STORAGE FOR VARIOUS EQUIPMENT
5. CONCLUSION
6. STACKING ARRANGEMENT FOR PLATES AND STRUCTURAL STEEL



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

1. SCOPE OF THE DOCUMENT

This guideline is prepared in intent to provide proper site storage and preservation of the Mechanical, Electrical and C & I items / equipment supplied under various bought out packages/items. This storage procedure shall be followed at different power plant sites by concerned agency for storage and preservation from the date of equipment received at site until the same are erected and handed over to the customer.

2. PURPOSE OF STORAGE & PRESERVATION

Many of the items may be required to be kept in stores for long period. It shall therefore be essential that proper methods of storage and preservation be applied so that items do not deteriorate, loose some of their properties and become unusable due to atmospheric conditions and biological elements.

3. MEASURES TO BE TAKEN FOR STORAGE, HANDLING & PRESERVATION**a) GENERAL STORAGE REQUIREMENTS**

1. To the extent feasible, materials should be stored near the point of erection. The storage areas should have adequate unloading and handling facilities with adequate passage space for movement of material handling equipment such as cranes, fork lift trucks, etc. The storage of materials shall be properly planned to minimise time loss during retrieval of items required for erection.
2. The outdoor storage areas as well as semi-closed stores shall be provided with adequate drainage facilities to prevent water logging. Adequacy of these facilities shall be checked prior to monsoon.
3. The storage sheds shall be built in conformity with fire safety requirements. The stores shall be provided with adequate lights and fire extinguishers. 'No smoking' signs shall be placed at strategic locations. Safety precautions shall be strictly enforced.
4. Adequate lighting facility shall be provided in storage areas and storage sheds and security personnel positioned to ensure enforcement of security measures to prevent theft and loss of materials.
5. Adequate number of competent stores personnel and security staff shall be deployed to efficiently store and maintain the equipment / material.
7. The equipment shall be stored in an orderly manner, preserving their identification slips, tags and instruction booklets, etc., required during erection. The storage of materials shall be equipment-wise. Loose parts shall be stored in sheds on racks,



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

preserving the identification marks and tags in good condition. The group codes shall be displayed on the racks

6. At no time shall any materials be stored directly on ground. All materials shall be stored minimum 200 mm above the ground preferably on wooden sleepers

b) GENERAL PRESERVATION REQUIREMENTS

1. All special measures to prevent corrosion shall be taken like keeping material in dry condition, avoiding the equipment coming in contact with corrosive fluid like water, acid etc.
2. Materials which carry protective coating shall not be wrapped in paper, cloth, etc., as these are liable to absorb and retain moisture. The material shall be inspected and in case of signs of wear or damages to protective coating, that portion shall be cleaned with approved solution and coated with an approved protective paint. Complete record of all such observations and protective measures taken shall be maintained.
3. Generally equipment supplied at site are properly greased or rust protective oil is applied on machined/ fabricated components. However periodic inspection shall be carried out to ensure that protection offered is intact.
4. While handling the equipment, no dragging on the ground is permitted. Avoid using wire rope for lifting coated components. Use polyester slings (if possible) otherwise protective material (e.g. clothes, wood block etc.) should be used while handling the components with rope / slings
5. For Equipment supplied with finished paint, touch paint shall be done in case any surface paint gets peeled off during handling. Otherwise such surfaces shall necessarily be wrapped with polythene to avoid any corrosion. Further for equipment wherein finish coat is to be applied at site, site to ensure that equipment is received with primer coat applied.
6. It shall be ensured by periodic inspection that plastic inserts are intact in tapped holes, wherever applicable.
7. Pipes shall be blown with air periodically and it shall be ensured that there is no obstruction.
8. Silica gel or approved equivalent moisture absorbing material in small cotton bags shall be placed and tied at various points on the equipment, wherever necessary.
9. Heavy rotating parts in assembled conditions shall be periodically rotated to prevent corrosion/jamming due to prolonged storage.



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

10. All the electrical equipment such as motors, generators, etc. shall be tested for insulation resistance at least once in three months and a record of such measured insulation values shall be maintained.

11. Following preservatives/preservation methods can be used depending upon type of equipment

- a. Rust preventive fluid (RPF)
- b. Rust protective paints
- c. Tarpaulin covers, in case of outdoor storage
- d. De-oxy aluminate for weld-ments

c) GENERAL INSPECTION REQUIREMENTS

1. Period inspection of materials with specific reference to –

- Ingress of moisture and corrosion damages.
- Damage to protective coating.
- Open ends in pipes, vessels and equipment -
 - In case any open ends are noticed, same shall be capped.

2. Any damages to equipment / materials.

- In case of any damages, these shall be promptly notified and in all cases, the repairs / rectification shall be carried out.
- Any items found damaged or not suitable as per project requirements shall be removed from site. If required to store temporarily, they shall be clearly marked and stored separately to prevent any inadvertent use.



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

4. TYPE OF STORAGE FOR VARIOUS EQUIPMENT

The types of storage are broadly classified under the following heads:

i Closed storage with dry and dust free atmosphere. (C)

The closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated asbestos sheets / galvanised iron sheets for roofing. Brick walls / asbestos sheets can be used to cover all the sides. The floor of the shed can be finished with plain cement concrete suitably glazed. The shed shall be provided with proper ventilation and illumination.



ii Semi-closed storage. (S)

The semi closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated / asbestos sheets for roofing. The floor shall be brick paved. If required a small portion of sides can be covered to protect components from rainwater splashing onto the components.





TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00



iii Open storage (O)

The open yard shall be levelled, well consolidated to achieve raised ground with the provision of feeder roads for crane approach along with access roads running all sides. One part of the open yard shall be stone pitched, levelled and consolidated with raised ground suitable for storing / stacking heavier and critical components with due space to handle them by cranes etc . Adequate number of sleepers, concrete block etc. to be provided to make raised platforms to stack critical materials.

A separate yard to be identified as "scrap yard" slightly away from main open yard to store wooden/steel scraps, which are to be disposed off. This is required to avoid mix up with regular components as well as to avoid fire hazard.

Some of the components, which are having both machined & un-machined surfaces and are bulky, shall be stored in open storage area on a raised ground and suitably covered with water proof / fire retardant tarpaulin.





TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

The equipment listed below shall be stored and inspected as per requirement mentioned in the table below.

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
Raw material /mechanical items like pipes, plates, structure sections etc.)				
1.	Steel pipes (lined/unlined)	S	Damage , paint, corrosion, rubber lining peeling	Provide end cap
2.	MS Plates	S	Damage, paint, corrosion	
3.	SS Plates	S	Damage	
4.	Non-metallic pipes	S	Damage, cracks	Provide end cap
5.	Stainless steel pipes	S	Damage ,	Provide end cap
6.	MS sections, beams	S	Damage, paint, corrosion	
7.	Cable trays	S	Damage, condition of preservations	
8.	Insulation sheets	S	Damage	
9.	Insulation	C	Damage, packing	
10.	Hangers Rods	S	Damage, paint, packing	
11.	Tubes	S	Damage, paint , packing	Provide end cap
12.	Hume pipes	O	Damage	
13.	Castings	O	Damage, paint, corrosion	
Fabricated mechanical items (pressure vessels, tanks etc.)				
14.	Pressure vessels (unlined)	O	Damage, paint, corrosion,	Covered nozzles
15.	Atmospheric storage tanks (unlined)	O	Damage, paint, corrosion	Covered nozzles



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
16.	Pressure vessels (lined)	S	Damage , paint, corrosion, rubber lining	
17.	Atmospheric storage tanks(lined)	S	Damage , paint, corrosion, rubber lining	
18.	Support structures	O	Damage , paint, corrosion	
19.	Flanges	C	Damage , paint, corrosion	
20.	Fabricated pipes	S	Damage , paint, corrosion	Provide end cap
21.	Vessels internals	C	Damage , paint, corrosion ,packing	
22.	Grills	S	Damage , paint, corrosion	
23.	Angles	S	Damage , paint, corrosion	
24.	Bridge mechanism/clarifier mechanism	O	Damage , paint, corrosion	
25.	Cranes, rails	S	Damage , paint, corrosion	
26.	Stair cases	O	Damage , paint, corrosion	
27.	Ladders/handrails	O	Damage , paint, corrosion	
28.	Fabricated ducts	S	Damage , paint, corrosion	
29.	Isolation Gates	O	Damage , paint, corrosion	
30.	Fabricated boxes/panels	S	Damage , paint, corrosion	
Mechanical components like valves, fittings, cables glands, spares etc.)				
31.	Valves	S	Damage , packing	



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
32.	Fittings	S	Damage , packing	Provide end cap
33.	Cable glands	C	Damage , packing	
34.	Tools & tackles	C	Damage , packing	
35.	Nut , bolts, washers,	C	Damage , packing	
36.	Gasket & Packings	C	Damage , packing	
37.	Copper tubes	C	Damage , packing, corrosion	Provide end cap
38.	SS tubing	C	Damage , packing	Provide end cap
Rotating assemblies (pumps, blowers, stirrers, fans, compressors etc.)				
39.	Pumps	S	Damage , packing, corrosion	Shaft rotation
40.	Blowers/Compressors	S	Damage , packing, corrosion	Shaft rotation
41.	Agitators/stirrers/radial launders	C	Damage , packing, corrosion	Shaft rotation
42.	Rollers for chlorine tonner mounting	C	Damage , packing, corrosion	
43.	Centrifuge	S	Damage , packing,	
44.	Gear box	C	Damage , packing, corrosion	
45.	Bearings	C	Damage , packing, corrosion	
46.	Fans	S	Damage , packing, corrosion	
47.	Dosing skids	S	Damage , packing, corrosion	
48.	Pump assemblies	S	Damage , packing, corrosion	
49.	Air washers(INTERNALS)	S	Damage , packing	
50.	Air conditioners (split)	C	Damage , packing	



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
51.	Elevators(CONTAINERIZED)	O	Damage , packing, corrosion	
52.	Chillers/VA machines	S	Damage , packing	
53.	Air handling Unit/Package unit	S	Damage , packing	
54.	Chlorinators & Evaporators	C	Damage , packing	
55.	Ejectors	C	Damage , packing	
56.	Electrolyser	C	Damage , packing	
Miscellaneous items like chain pulley blocks, hoists etc.				
57.	Chain pulley blocks	S	Damage, Packing	
58.	Electric hoists	S	Damage, Packing	
59.	Fire extinguishers	C	Damage, expiry date	
60.	Fork Lift Truck	S	Damage, Packing	
61.	Hydraulic Mobile Crane	O	Damage, Packing	
62.	Mobile Pick Up & Carry Crane	O	Damage, Packing	
63.	Motor boats	O	Damage, Packing	
64.	Safety showers	S	Damage, Packing	
65.	Diffusers/dampers	S	Damage, Packing	
Chemicals and consumables (acid, alkali, paints, oils, reagents and special chemicals)				
66.	Hydro Chloric Acid (HCl)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical
67.	Sulphuric acid (H ₂ SO ₄)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
68.	Sodium hydroxide (NaOH)	Store in canes/ storage tank in dyke area	Date of production/ leakage/ fumes/ breather	hazardous chemical ,breather to be checked for air ingress
69.	Sodium hypo chlorite	To be stored under shed	Date of production/ leakage/ fumes	hazardous chemical ,self-life normally 15-30 days after which strength of chemical decays
70.	Ammonia	S	Date of production/ leakage/ fumes	Store in closed storage tanks, hazardous chemical
71.	CW treatment chemicals	S	Date of production , Self-life	Store in closed canes
72.	RO/UF cleaning chemicals	S	Date of production , Self-life	Store in closed canes
73.	Lime	C	Damage to packing , seepage	Prevent moisture, rain
74.	Alum bricks	C	Damage to packing	Prevent moisture, rain
75.	Poly electrolyte	S		Store in closed storage tanks
76.	Laboratory chemicals(powder)	C	Damage, Packing self-life	
77.	Laboratory chemicals(liquid)	C	Damage, Packing self-life	
78.	Lubrication oils	C	Leakage	
79.	Paints	S	Leakage ,air tightness	
80.	Sand	O	Damage of packing	No hooks
81.	Salt (NaCl)	C	Damage of packing, water ingress	Prevent moisture, rain
82.	Anthracite	S	Damage of packing	
83.	Activated carbon	S	Damage of packing	



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
84.	Thermal insulation	S	Damage of packing	
85.	Cement	C	Damage of packing	Prevent moisture, rain
86.	Gravels	O	Damage of packing	
87.	ION exchange resins	C	Damage , packing	Refer manufacturer guidelines
88.	RO membranes	C	Damage , packing	Refer manufacturer guidelines
89.	UF membranes	C	Damage , packing	Refer manufacturer guidelines
90.	Cleaning chemicals	C	Damage , packing	Refer manufacturer guidelines
91.	Chemicals for analysers/calibration	C	Damage , packing	Refer manufacturer guidelines
Electrical and C & I items (motors, cables etc.)				
92.	Motors	C	Damage , packing	
93.	Cable drums	O	Damage	
94.	Control Panel /control desk, UPS ,JB	S	Damage, Packing	
95.	Instruments(gauges/analysers)	C	Damage	
Special items		As per Manufacturer's item, like Hydrogen cylinders, Ozonator, Analyser, Chlorine dioxide generators etc.		



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

5. CONCLUSION

Concerned storage agency at site should make sure that loss in equipment performance and wear & tear are minimised through proper storage and preservation. The above are broad guidelines and cover major equipment / materials. However specific storage practices shall be followed as per manufacturer recommendation. All the necessary measures even in addition to the ones mentioned above, if found necessary, should be taken to achieve the objective.

TITLE

SPECIFICATION NO.

PE-TS-412-158-A001



2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SECTION-IA

REV 00

ANNEXURE VIII : RAW WATER ANALYSIS



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

S.No.	Parameter	Unit	Value (Range)
1	General		
a	pH		7.94-8
b	Conductivity	millisiemens/cm	43.8-44.1
c	Temperature	Deg C	25-32
d	Turbidity and TSS	NTU / ppm	500
e	Total Organic carbon (total/ dissolved)	PPM of C	2.4-2.84
f	CO2	Mg/l	<2
g	TDS	Mg/l	39600-39740
h	BOD	Mg/l	10-12
i	COD	Mg/l	88-96
j	Oil & Grease	Mg/l	<10
k	Phenols	Mg/l	0.08-0.09
l	Free Residual Chlorine	Mg/l	<0.2
2	Cations		
a	Calcium	Mg/l	459-478
b	Magnesium	Mg/l	1510-1516
c	Sodium	Mg/l	10100-12000
d	Potassium	Mg/l	358-450
e	Ammonia	Mg/l	4.43-5.42
f	Strontium	Mg/l	12.9-12.4
g	Barium	Mg/l	1.55-1.58
h	Aluminum Total	Mg/l	1-1.8
i	Aluminum Dissolved	Mg/l	0.8-1.0
j	Manganese Total	Micro g/l	0.2-0.6
k	Manganese Dissolved	Micro g/l	0.1-0.2
l	Iron total	Micro g/l	220-260
m	Iron Dissolved	Micro g/l	Below detectable limit (detectable Limit : 10)
3	Anions		
a	Chloride	Mg/l	18994-19194
b	Sulphate	Mg/l	3710-3949
c	Nitrate	Mg/l	136-152
d	Nitrite	Mg/l	0.46-0.62
e	Bicarbonate	Mg/l	144-148
f	Carbonate	Mg/l	Nil
g	Fluoride	Mg/l	2.64-2.8
h	Boron	Mg/l	0.14-0.17
i	Phosphate	Micro g/l	240-380
j	Sulphide	Micro g/l	Below detectable limit



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

			(detectable Limit : 100)
k	Silica Dissolved	Micro g/l as SiO ₂	200-250
4	Heavy Metals		
A	Arsenic	Micro g/l	Below detectable limit (detectable Limit : 2)
B	Mercury	Micro g/l	Below detectable limit (detectable Limit : 1)
C	Cadmium	Micro g/l	120-130
D	Copper	Micro g/l	200-220
E	Nickel	Micro g/l	470-490
F	Molybdenum	Micro g/l	Below detectable limit (detectable Limit : 100)
5	Suspended Particle Size Range		
A	10 micron & above	Mg/l	Below detectable limit(detectable Limit : 10)
B	5 micron to 10 micron	Mg/l	Below detectable limit(detectable Limit : 10)
C	1 micron to 5 micron	Mg/l	Below detectable limit(detectable Limit : 10)
D	0.1 micron to 1 micron	Mg/l	20-26
6	Colloidal Particle Size Range		
A	SDI (10 Minutes)	-	10-20
B	SDI (5 Minutes)	-	20-40
7	Density of sea water	Kg/ cum	1030

TITLE

SPECIFICATION NO.

PE-TS-412-158-A001



2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SECTION-IA

REV 00

DATASHEET FOR PRETREATMENT PLANT



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

1.0	INLET VALVES	
1.1	Inlet valves	One (1) number motorized butterfly flow control valve, located at inlet to aerator, with manual upstream and downstream isolation valves along with by-pass manual butterfly flow valve. Control valve shall have "auto manual" selection option, position indicator with "open-close" push buttons. Inching operation of valve shall be possible from PLC based control panel.
1.2	Inlet control valve size	Suitable to cater to total flow
1.3	Code	AWWA – C 504 for butterfly valve
1.4	Control	Under " Auto" mode of flow control valve, valve shall automatically maintain the level of water in the clarified water reservoir, i.e valve shall automatically close when reservoir level becomes high.
2.0	AERATOR	
2.1	Nos.	One (1) [common for two clarifier].
2.2	Material of construction	RCC
2.3	Surface flow rate	0.045 m ² / hr/ m ³
2.4	Riser	Min 250 mm.
2.5	Tread	Max 400 mm.
2.6	Number of steps	7 Nos (Min).
3.0	STILLING CHAMBER	
3.1	No.	One (1) [common for two clarifier].
3.2	Purpose	To dampen out any turbulence of the incoming water.
3.3	Retention time and capacity	60 seconds and 75 Cum.
3.4	Material of construction	RCC
3.5	Drain arrangement	Suitable draining arrangement shall be provided for the stilling chamber and drain lines shall be connected to sludge sump.
4.0	PARSHALL FLUME	
4.1	No.	One (1) [common for two clarifier].
4.2	Purpose	To measure flow.
4.3	Material of construction	RCC
5.0	FLASH MIXER	
5.1	Nos.	One (1)
5.2	Retention time	60 seconds
5.3	Capacity	Minimum 75 cum.
5.4	MOC of Flash Mixer Pit	RCC
5.5	Agitator (MOC: Duplex Stainless Steel)	One (1) for each flash mixer
5.6	Free board	500 mm (min)
5.7	Motor rating for agitator	DDE (During Detail Engineering).
5.8	Drain arrangement	Suitable draining arrangement shall be provided for the stilling chamber and drain lines shall be connected to sludge sump.
6.0	CLARIFLOCCULATOR	
6.1	Number	Two (2X50%)
6.2	Capacity (Net output)	940 cum/hr.
6.3	Type	Radial, conventional.
6.4	Effluent water quality	Turbidity and TSS shall be less than 10 NTU/PPM.
6.5	Side Water Depth (SWD)	Minimum 4.5 meter.
6.6	Rise rate	1.2 CuM/Hr/SqM (maximum).
6.7	Retention Time	Flocculation zone 30 min, Clarifier zone-150 min.
6.8	Sludge Blow Off	By gravity through telescopic stand-pipe for continuous discharge and through manual operated blow-off valve for intermittent.
6.9	Platform with hand railing	Shall be provided (1 meter wide all along Clariflocculator)
6.10	Rake bridge (Half Bridge)	Shall be provided (MOC: MS as per IS 2062 corrocoated or FRP coated). Gearbox for scraper drive shall be of oil-free type.
6.11	Flocculation agitator (MOC: Duplex Stainless Steel)	Two (2) Numbers. Vertical slow speed motor reduction gear driven.
6.12	Velocity in launder	0.4 m/s (max).



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

6.13	Free board b in launder and channel	Minimum 300 mm.
6.14	MOC of inlet Pipe	MS internally coated with Corrocoat
6.15	Surface flow rate of clarifier zone	Not more than 1.2 cum/hr/ m2.
7.0	CLARIFIER SCRAPPERS	
7.1	Type	Designer's Design Specific (shall be furnished DDE).
7.2	Number required	One per clarifier.
7.3	Material	Mild steel (MS) with FRP coated.
7.5	Traction drive	Slow speed motor driven.
8.0	SUITABLE ACCESSORIES	
8.1	Access ladder, platform, staircase, hand railings etc.	Shall be provided of structural steel.
8.2	Walkway	Shall be provided with hand railings around launder periphery of width 1000 mm.
8.3	Electrical requirements	For each clariflocculator, one (1) Distribution Board to be located on clariflocculator bridge for all drives of clariflocculator bridge assembly.
9.0	SLUDGE SUMP	
9.1	Number	One (1) with two compartments.
9.2	Capacity (effective)	300 Cum (each compartment).
9.3	Dimension	Suitable
9.4	Material	RCC with FRP/PP lining.
9.5	Location	Shall be finalized during Detailed Engineering (DDE).
9.6	Isolation gates with hand wheel and penstock	Two number per compartment.
9.7	Instrument	As per Flow Diagram.
9.8	Air Agitation facility	Air Agitation with pipe grid by 2x100 Air Blower (Twin Lobe Positive Displacement Type, MOC-Casing-CI IS-210 FG 260, Shaft-CS to EN8 (BS 970), Lobe-CI IS 210 FG 260) and sludge recirculation line shall be provided in sludge sump.
10.0	CHEMICAL HOUSE	
10.1	Number	One (1).
10.2	Type	Two storied building of civil construction.
10.3	Building dimensions	DDE
10.4	Ground floor	Storage of chemical required for FeCl ₃ , Lime, Poly Electrolyte and NaOCl dosing (for Potable water) for 30 days storage capacity and MCC.
10.5	First floor	Location of all chemical dosing tanks and pumps and Control room for PLC for entire PT Plant.
11.0	WEIGHING SCALE FOR CHEMICAL	
11.1	Type	Platform, dial type.
11.2	Number	One (1)
11.3	Capacity	0-1000 Kgs
12.0	HOIST	
12.1	Type	Electric in monorail on ground and first floor of chemical house
12.2	Number	Two (2).
12.3	Capacity	1 T
13.0	OVERHEAD CLARIFIED WATER STORAGE TANK	
13.1	Capacity (Net)	To suit water requirement for chemical preparation for one day requirement+ flushing requirement of dosing lines +20 % margin.
13.2	Location	Top of Chemical House.
13.3	Nos.	One (1)
13.4	Material	RCC
13.5	Free board over the maximum water level	300 mm
13.7	Instruments	As per flow diagram.
19.1	POLYMER DOSING SYSTEM (@ 1 ppm) **	
	a) Tank –	Number-Two (2) numbers. Capacity- 12 Hrs storage capacity (each) for minimum 0.5% (w/v)



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

		solution. Type – vertical. Material- RCC+FRP/PP lining. Instrument- As per Flow Diagram. Motorized Stirrer (MOC-SS316)- One (1) number per tank vertical type. Dissolving Basket- 1 no per tank (MOC SS 316 L). Free board- 300 mm (min).
	b) Pump -	Number-Two (2) numbers. Type – Plunger Type positive displacement pump. Capacity (each)- 1000 LPH (minimum). Material- SS-316 (all wetted parts). Instrument- As per Flow Diagram. Suction strainer (MOC:CPVC Sch 10) -2X100 %.
19.2	FeCl₃ DOSING SYSTEM (@ 40 ppm) **	
	a) Tank –	Number-Three (3) numbers Capacity- 12 Hrs storage capacity (each) for minimum 10% (w/v) solution. Type – vertical. Material- RCC+FRP/PP lining. Instrument- As per Flow Diagram. Motorized Stirrer (MOC-SS316)- One (1) number per tank vertical type. Dissolving Basket- 1 no per tank (MOC SS 316 L). Free board- 300 mm (min).
	b) Pump-	Number-Two (2) numbers (1W+1S) Type – Plunger Type positive displacement pump. Capacity (each)- 2000 LPH (minimum). Material- SS-316 (all wetted parts). Instrument- As per Flow Diagram. Suction strainer (MOC:CPVC Sch 10) -2X100 %.
19.3	LIME DOSING SYSTEM (@ 10 ppm)**	
	a) Tank –	Number-Two (2) numbers Capacity- 12 Hrs storage capacity (each) for minimum 5% (w/v) solution. Type – vertical. Material- RCC+FRP/PP lining. Instrument- As per Flow Diagram. Motorized Stirrer (MOC-SS316)- One (1) number per tank Horizontal type. Dissolving Basket- 1 no per tank (MOC SS 316 L). Free board- 300 mm (min).
	b) Pump-	Number-Two (2) numbers (1W+1S) Type – Screw Type positive displacement pump. Capacity (each)- 1000 LPH (minimum). Material- SS-316 (all wetted parts). Instrument- As per Flow Diagram. Suction strainer (MOC:CPVC Sch 10) -2X100 %.
19.4	NaOCl DOSING SYSTEM FOR POTABLE WATER (@ 2 ppm)**	
	a) Tank –	Number-One (1x100%). Capacity- 500 Ltrs (considering 7-10% commercial grade NaOCl). Type – vertical cylindrical. Material-FRP with 6mm thickness. Instrument- As per Flow Diagram. Free board- 300 mm (min).
	b) Pump-	Number-Two (2) numbers (1W+1S) Type – diaphragm type positive displacement pump. Capacity (each)- 5 LPH (minimum).



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

			Material- PVDF and PTFE (all wetted parts). Instrument- As per Flow Diagram. Suction strainer (MOC:CPVC Sch 10) -2X100 %.		
20.0	MOC and type of the pumps shall be as per the following details.				
	Pump Description	Quantity	Pump Type	Capacity	Material of Construction
20.1	Sludge transfer pump	Three (3X100%)	Vertical, Non clot type. Impeller – semi open. Lubrication-Self lubricated.	500 CuM/Hr. (each).	Casing – Duplex SS 2205 UNS 31803. Impeller- Duplex SS 2205 UNS 31803. Shaft- Duplex SS 2205 UNS 31803. Shaft sleeves- Duplex SS 2205 UNS 31803. Packing-Braided Impregnated Teflon. Flexible coupling- Duplex SS 2205 UNS 31803. Nuts and Bolts-SS 316L.
21	VALVES		Material of Construction		
i.	Gate (All gate valves shall have flanged end connections, it shall be outside screw rising stem type with hand wheel)		Body/Bonnet – Super duplex stainless steel, ASTM A890-5A (CE3MN). Stem – stainless steel AISI 410/ 13% chrome steel. Disc/Gate – Super duplex stainless steel, ASTM A890-5A (CE3MN). Seat & seat rings – Duplex Stainless Steel. Hand wheel- Cast iron.		
ii.	NRV (All NRV shall have flanged end connection. For bore greater than 50 mm valves shall be swing check type. For bore smaller than or equal to 50 mm it shall be piston type).		<u>Swing Check type</u> Body – Super duplex stainless steel, ASTM A890-5A (CE3MN). Disc/door – Super duplex stainless steel, ASTM A890-5A (CE3MN). Hinged pin – Duplex Stainless Steel. <u>Piston type</u> Body – Super duplex stainless steel, ASTM A890-5A (CE3MN). Hinge pin – SS316 Piston – Super duplex stainless steel, ASTM A890-5A (CE3MN).		
iii	Ball valve		Type :Full bore Rating: PN 10 (min). Body: Super duplex stainless steel, ASTM A890-5A (CE3MN). Ball: Super duplex stainless steel, ASTM A182-F53 or ASTM A890-5A (CE3MN). Seat ring: PTFE Stem: Super duplex stainless steel, ASTM A890-5A (CE3MN) or Zeron 100 Seat: Nitrile rubber,PTFE		
iv	Globe valve		Type: Double flanged. Rating: PN 10 (min). Body: Super duplex stainless steel, ASTM A890-5A (CE3MN). Plug: Super duplex stainless steel, ASTM A890-5A (CE3MN). Seat ring: Super duplex stainless steel, ASTM A890-5A (CE3MN).		
v	Plug Valve		Type :Full bore Rating: PN 10 (min). Body: Super duplex stainless steel, ASTM A890-5A (CE3MN). Plug: Super duplex stainless steel, ASTM A890-5A (CE3MN). Sleeve: PTFE.		



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IA

REV 00

vi	Butterfly valve	Butterfly valves shall be of double flanged type of low leakage rate confirming to AWWA-C-504 class 150 (min.) or BS:5155 PN 10 (min.) Body: ASTM A995 Gr. 5A - CE3MN (Duplex Stainless Steel). Disc: ASTM A995 Gr. 5A - CE3MN (Duplex Stainless Steel). Shaft: ASTM A276 S31803 (Duplex Stainless Steel). Seat rings: Nitrilerubber, EPDM, Hypalon All the butterfly valves shall be provided with Hand wheel or lever as per the requirements. All the butterfly valves shall be provided with an indicator to show the position of the disc. Flanges shall conform to ANSI B 16.5 Cl.150 (min).
vii	Diaphragm valve	The Diaphragm shall conform to following requirement i) Design standard: BS:5156 or equivalent of required rating/class. (minimum rating of valves shall be PN 10). ii) Type: Flanged and lined body ends, sealed bonnet, weir pattern, tight shut off type iii) Material of Construction a. Body , Bonnet: Cast iron IS 210 Gr. FG 260 or equivalent or Cast steel ASTM A-216 Gr. WCB b. Body lining : Soft natural rubber, ebonite , Polypropelene c. Handwheel : Cast Iron d. Compressor : Duplex Stainless steel. e. Stem and Bush : Duplex Stainless steel.
21	PIPE	Refer P&I Diagram.
22	SAFETY EQIPMENTS	Four sets of safety equipment comprising PVC protection suits with hoods, rubber boots, face visors and thick PVC gauntlets shall also be provided. A personnel water drench shower and eye bath shall be provided.

Bidder to note that this is a sea water application plant. Bidder to select MOC to suit sea water application wherever required and not indicated in technical specification.

TITLE

SPECIFICATION NO.

PE-TS-412-158-A001



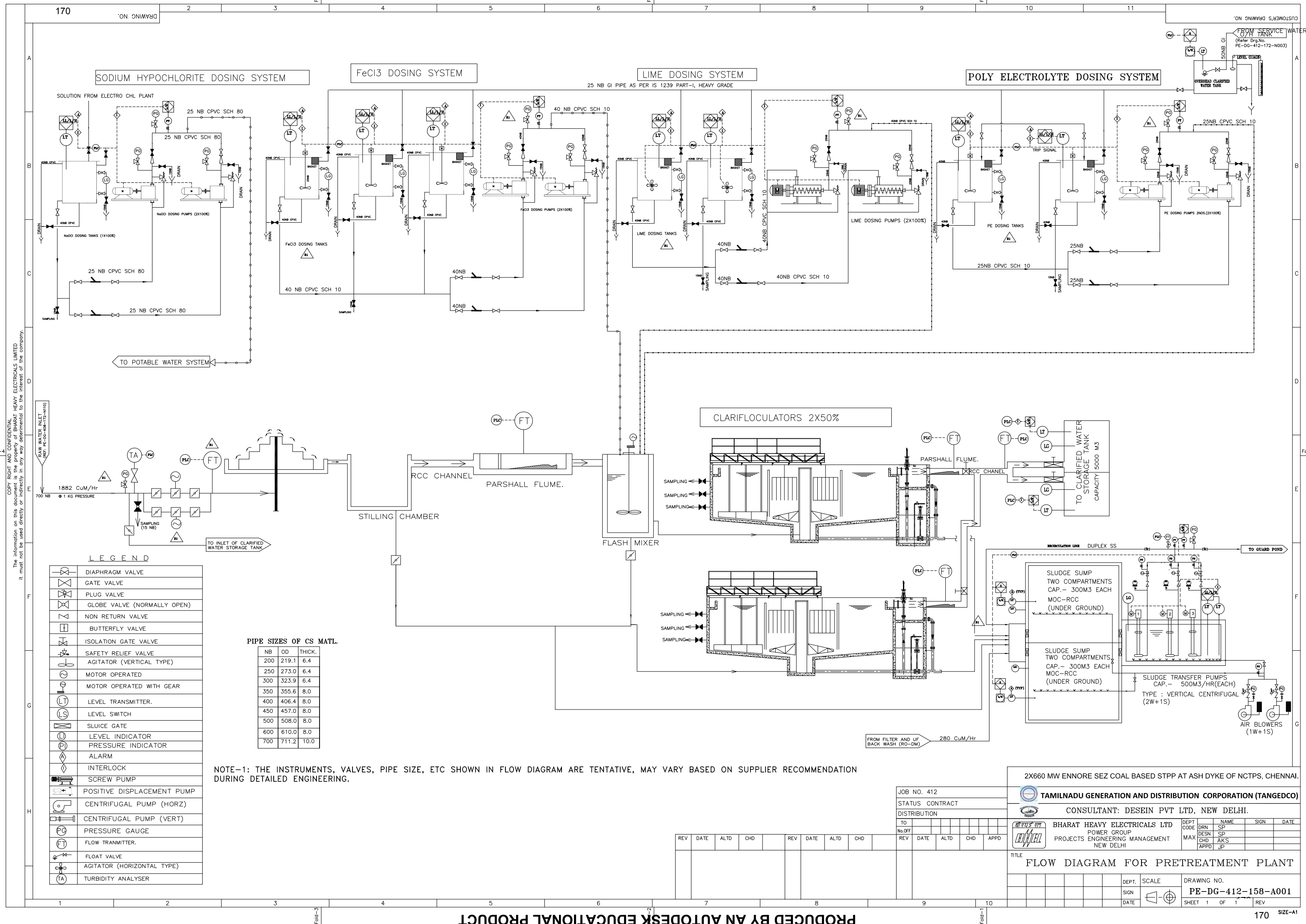
2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

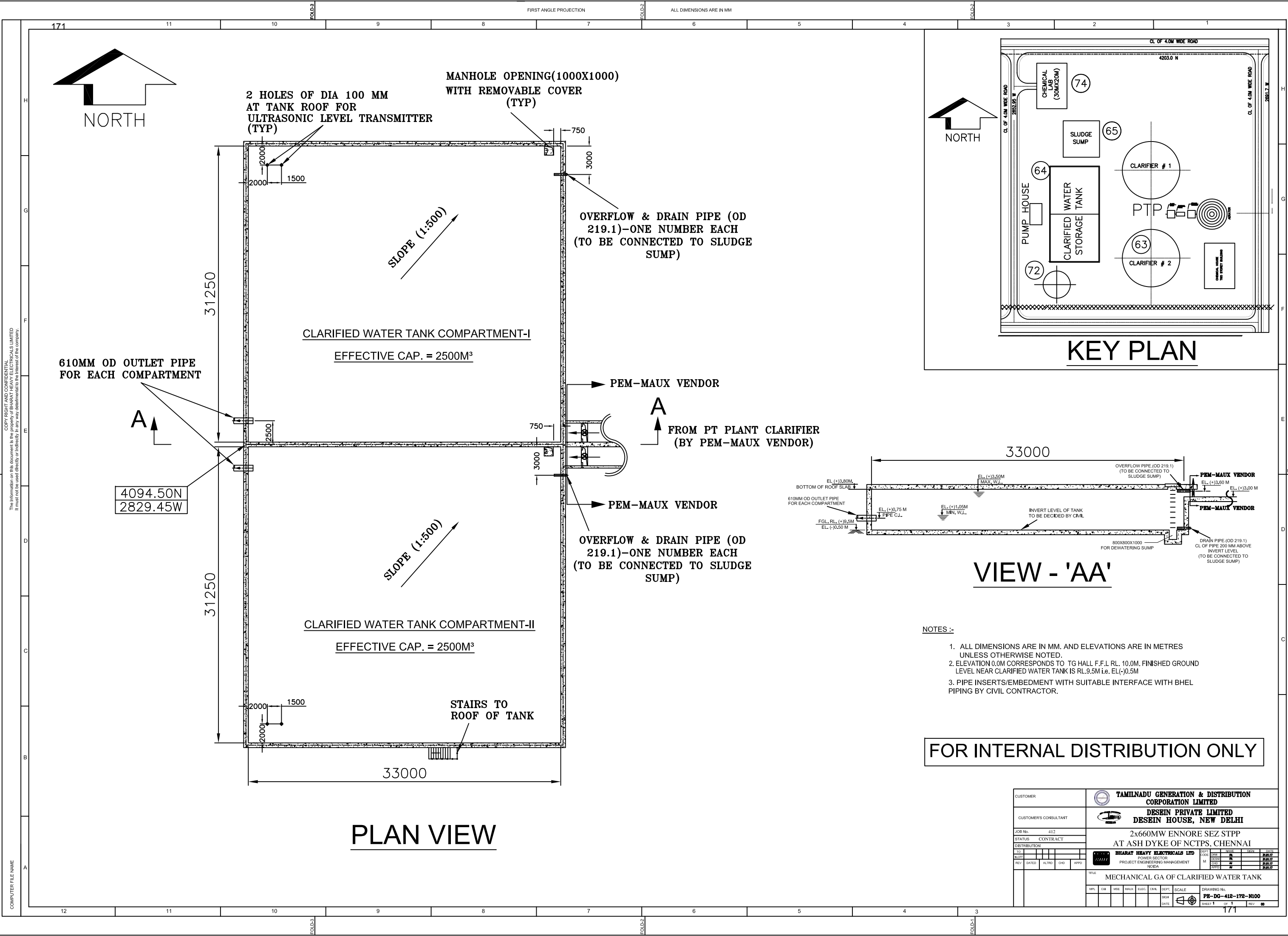
SECTION-IA

REV 00

P&ID FOR PRETREATMENT PLANT

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TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IB

REV 00

SECTION – IB
SPECIFIC TECHNICAL REQUIREMENTS
ELECTRICAL

**TITLE**

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IB

REV 00

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:

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

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

Refer “Electrical Scope between BHEL and Vendor”.

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

3.1 The electrical specification without any deviation from the technical/quality assurance requirements stipulated shall be deemed to be complied by the bidder in case bidder furnishes the overall compliance of package technical specification in the form of compliance certificate/No deviation certificate.

3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc. is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

4.0 List of enclosures :

- a) Electrical scope between BHEL & vendor
- b) Technical specification for motors.
- c) Datasheets & quality plan for motors.
- d) Electrical Load data format
- e) BHEL cable listing format

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR(FOR EPC PROJECTS)

PACKAGE : PRE TREATMENT PLANT

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

PROJECT: 2X660 MW ENNORE SEZ COAL BASED STPP

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	240 V AC (supply feeder)/415 V AC (3 PHASE 4 WIRE) supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	BHEL BHEL BHEL	BHEL Vendor BHEL	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	Vendor	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 10-12 mtrs) and trunk cable.
5	Any special type of cable like compensating, co-axial, prefab, MICC, optical fibre etc.	Vendor	Vendor	Refer C&I portion of specification for scope of fibre Optical cables if used between PLC/ microprocessor & DCS.
6	Cable trays, accessories & cable trays supporting system 100/ 50 mm cable trays/ Conduits/ Galvanised steel cable troughs for local cabling	BHEL BHEL	BHEL BHEL	Local cabling from nearby main route cable tray (BHEL scope) to equipment terminal (vendor's scope) shall be through 100/ 50 mm. cable trays/ conduits/ Galvanised steel cable troughs, as per approved layout drawing during contract stage.
7	Cable glands ,lugs and bimetallic strip for equipment supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power and control cables.
8	Conduit and conduit accessories for cabling between equipment supplied by vendor	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537.
9	Lighting	BHEL	BHEL	
10	Equipment grounding (including electronic earthing) & lightning protection	BHEL	BHEL	Refer note no. 4 for electronic earthing
11	Below grade grounding	BHEL	BHEL	

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR(FOR EPC PROJECTS)

PACKAGE : PRE TREATMENT PLANT

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

PROJECT: 2X660 MW ENNORE SEZ COAL BASED STPP

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
12	LT Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
13	Mandatory spares	Vendor	-	Vendor to quote as per specification.
14	Recommended O & M spares	Vendor	-	As specified elsewhere in specification
15	Any other equipment/ material/ service required for completeness of system based on system offered by the vendor (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
16	a) Input cable schedules (Control & Screened Control Cables) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for Control and Instrumentation Cable and electronic earthing cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
17	Electrical Equipment & cable tray layout drawings	Vendor	-	For ensuring cabling requirements are met, vendor shall furnish Electrical equipment layout & cable tray layout drawings (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipment requiring cabling, and shall incorporate cable trays routing details marked on the drawing as per PEM interface comments. Cabling arrangement of the same (wherever overhead cable trays, trenches, cable ducts, conduits etc.) shall be decided during contract stage. Electrical equipment layout & cable tray layout drawing shall be subjected to BHEL/ customer approval without any commercial implications to BHEL.
18	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

NOTES:

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
3. In case the requirement of Junction Box arises on account of Power Cable size mis-match due to vendor engineering at later stage, vendor shall supply the Junction Box for suitable termination.
4. Vendor shall indicate location of Electronic Earth pit in their Civil assignment drawing.

THIS IS A PART OF TECHNICAL SPECIFICATION NO. PE-TS-412-158-A001

REV: 00 DATE:

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

**PACKAGE: ELECTRIC HOIST FOR PRE-TREATMENT
PLANT**

PROJECT :2X660 MW ENNORE STPP

JG OF VENDOR'S EQUIPMENT

<u>S. NO</u>	<u>DETAILS</u>	<u>SCOPE SUPPLY</u>	<u>SCOPE E&C</u>	<u>REMARKS</u>
1	Isolating Switch	Vendor	Vendor	BHEL will provide one number 415 V(3ph, 4W) supply feeder only up to isolating switches for cranes. Any other voltage level (AC/DC) required will be derived by the vendor. Motor starter shall be part of crane control panel.
2	Power cables, control cables, screened control cables and any special cables (if required) between equipment supplied by vendor.	Vendor	Vendor	Cable from supply feeder to isolating switch shall be in BHEL scope.
3	Cabling material (cable trays, accessories, cable tray supporting system, conduits etc).	Vendor	Vendor	
4	Equipment Earthing	Vendor	Vendor	All equipment metallic enclosures / frames, metal structure etc. shall be grounded at two points each to the nearest grounding points / risers provided by BHEL.
5	Motors	Vendor	Vendor	
6	Cable glands and lugs for equipment supplied by vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power & control cables.
7	a) Input cable schedules (C & I) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for Control and Instrumentation Cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
8	Equipment layout drawings	Vendor	-	
9	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

Sl.No.	UNITCABLENO	FROM	TO	PURPOSE	REMARKS	CABLESIZE	PATHCABLENO	LOCATION	TENTATIVE LENGTH



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IC

REV 00

**SECTION – IC
SPECIFIC TECHNICAL REQUIREMENTS (CONTROL &
INSTRUMENTATION)**

Specific Technical Requirements (C&I):

The control of Pre Treatment Plant shall be through PLC based control system having redundant hot standby processor. The operation of the Pre-Treatment Plant shall be done from PLC based Control Panel envisaged to be located in Chemical House of Pre Treatment Plant. The operation and control philosophy of Pre Treatment Plant has been elaborated in separate section in the specification. Two no. OWS with 24" LED monitor with anti-glare coating, one no. Operating cum engineering station (OWES) with one no. A3/A4 size color LJP and Redundant hot standby processor with One (1) no Digital copier cum Laserjet printer A3 size B/W & one no. A3 DMP. In addition Backup control desk with coloured Mimic, H.W. Annunciator, P.B. Ammeters, parameters Indicators, recorders and indication Lamps, Ammeters etc. shall also be provided by the bidder. Bidder shall ensure the provision of necessary software / hardware required at PT Plant PLC end for redundant softlink communication with PLC of DM and RO stage-II plant.

Additional laptop shall be provided with the Pretreatment Plant individually.

1. The communication between PLC and Main plant DCS shall be OPC compliant (Data Access 2.0) TCP/IP on Fibre Optic link. The communication link between PLC and Main plant DCS shall be redundant. The necessary hardware/software including LIU (Light Interface unit) at PLC end shall be in Bidder's scope. Repeaters if required for interfacing shall also be provided by the bidder. For communication between main plant DCS and PLC, the PLC end shall be considered as server and DCS shall be considered as client. For details, please refer PLC Configuration Diagram.
2. PLC control system shall be time synchronized with the Master clock system of the main plant to ensure uniform time indication throughout the Plant. The required provision (IRIG-B) shall be made by the bidder at the PLC end to achieve the same.
3. Bidder to note that all type of hardware's & electronic modules like controllers, I/O cards, communication modules and interface modules etc. used in PLC shall be of same family and sourced/supplied from their Principal's works.
4. Remote I/O panels with push buttons, indication lamps and annunciation shall be provided for subsystems where manned local operation is required.
5. The software and hardware for offered PLC system shall be of latest version and shall be upgradable. Bidder to ensure the availability of spares and

service support for the offered PLC system for minimum 15 years after guarantee period.

6. All motorised valves of 200NB or more than 200NB size shall be provided with integral motorized bypass valves on all process lines.
7. All electrical actuators shall be conventional type of integral starter.
8. Components of instruments, control devices, accessories, piping etc. which contact with steam, condensate or boiler feed water shall be manufactured from copper free materials which do not react with media at operating parameters.
9. Valve end position (Open & Close) shall be monitored for the manual critical valves, wherever provided.
10. Interface of MCC, HT SWGR, Actuators etc. with PLC based control system shall be as per Drive Control Philosophy attached in the specification. The attached philosophy is for DCS based control system. However, the same is applicable for PLC as well.
11. All the instruments/drives shall be terminated on JB's/Panels in field. JB's/Panels shall be in Bidder's scope.
12. Scope of Instrumentation cables (Screened Control Cables), Fibre Optic cable & Control cables shall be as per Electrical Cable scope matrix in Electrical portion of specification.
13. UPS for PLC & OWS shall be in bidder's scope with 2X100% configuration. UPS shall have 2X100%, Ni-Cd type battery bank with 60 min back up. Battery Health Monitoring System (BHMS) shall be provided.
14. Bidder shall provide Customer training on the proper application and maintenance on PLC Hardware & Software at Vendor's work or at Ennore SEZ site. Duration of the training, number of persons & the topics to be covered shall be discussed & mutually agreed during contract finalization stage.
15. Following documents to be furnished by the bidder along with the bid:
 - Proposed PLC system configuration drawing with write-up
 - Duly stamped and signed copy of Quality Plan.
 - Product catalogues and specifications for PLC as well as HMI application.

- Requirement of electronic earthing, if any, for PLC based control system.
16. Complete Industrial grade furniture required for placing OWS, swivel chairs, printers, keyboards, computers etc. shall also be furnished by bidder. The exact details shall be finalized & approved by owner/purchaser during detailed engineering.
 17. Bidder to comply with codes and standards as mentioned in the specification.
 18. Bidder shall provide the necessary hardware & software required for connecting the PLC system to Bidder's remote service centre, through which the diagnostics & fault analysis of the PLC system can be carried out. The method of connection shall be as per Bidder's standard practice. However, it is preferred to have the connection through a single point in the PLC system.
 19. Bidder shall provide an unlimited warranty on all equipment and software for three years after the start of the warranty period, i.e. after satisfactory completion of initial operations. This warranty shall include repair, replacement or correction of identified software or hardware discrepancies at no cost to OWNER.
 20. PLC network shall have Intrusion Detection System (IDS) and Intrusion Prevention System (IPS) activity and identify suspicious patterns that may indicate a network or system attack from someone attempting to break into or compromise a system on the Station LAN Network, the recommended IDS/IPS should contain the following combined features. Any feature can be selected depending on whether it is to be configured as IPS or IDS.
 21. All local gauges, transmitters and switches shall be mounted on suitable enclosures, racks subject to owner's approval. All transmitters shall be HART compatible.
 22. Bidder to delegate /depute their persons/experts as per owner/consultants' requirement.
 23. Bidder must offer general tools and tackles and special calibration instruments required during start-up, trial run, operation and maintenance of the system.
 24. The above given scope is indicative & minimum. Any item/ equipment not indicated above however required for the completeness of the system is to

be supplied by bidder without any technical, commercial and delivery implication to BHEL.

25. Bidder shall provide Cable Schedule in BHEL excel format provided in Electrical portion of the specification. Also, Cable Interconnections details for Complete System shall be in Bidder's scope.
26. 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.
27. Each communication Network shall be industrial grade and shall be provided with industrial grade managed type Ethernet switches, external surge protection system/devices and industrial firewall. Industrial grade managed type Ethernet switches shall be provided with in built diagnostic features, 20% spare parts & in built redundant power supply.
28. All approval/Inspection are to be carried out by Owner or owner appointed agency only.
29. Bidder shall offer latest system available at the time of supply / dispatch & shall also confirm that DDCMIS/PLC system/microprocessor based control system, MIS, ERP system etc. hardware / software shall be upgraded free of cost (for hardware up to commissioning of the project and software up to handing over of the project), whenever at later stage such up gradation takes place for his system offered by him or by his collaborator.
30. The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial implication in this regard shall be acceptable. In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with.
31. Temperature transmitters shall be provided, wherever Temperature measurement is required for monitoring purpose.
32. The instrumentation to be provided for each of the plant auxiliary & Off Site Plant systems shall be as per the technical specification document / drawings wherever provided for the respective systems as a minimum requirement for bidding purpose. However, for completeness of each of the plant auxiliary & Off Site system and its associated equipment, Bidder shall also provide all the

necessary instruments to the process requirement even if it is not specifically indicated in the given technical Specification document /drawings.

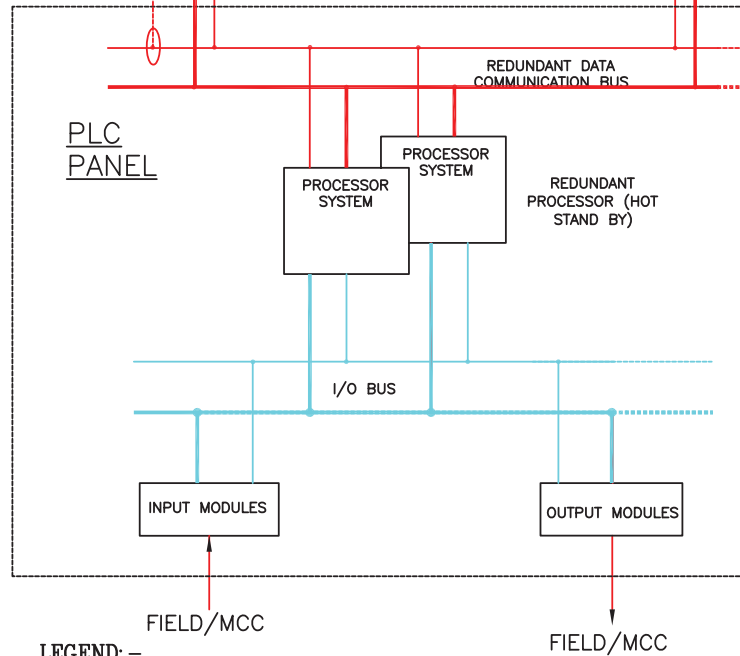
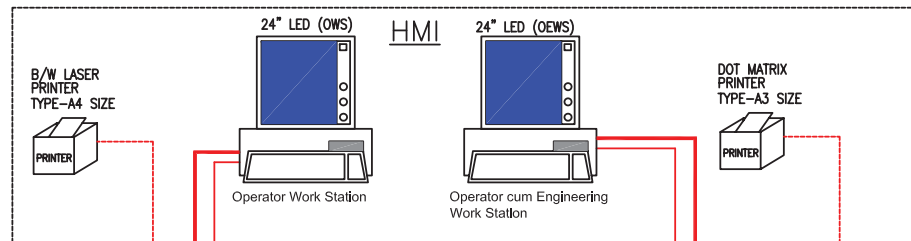
33. The quantity of instruments for auxiliary system shall be as per tender P & ID wherever provided of the respective system as a minimum, for bidding purpose. However, Bidder shall also include in his proposal all the instruments and devices that are needed for the completeness of the plant auxiliary system/ equipment supplied by the bidder, even if the same is not specifically appearing in the P & ID. During detail engineering if any additional instruments are required for safe & reliable operation of plant, bidder shall supply the same without any price implication.
34. Measuring instruments/equipment and subsystems offered by the bidder shall be from reputed experienced manufacturers of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Further all the instruments shall be of proven reliability, accuracy, and acceptable international standards and shall be subject to employer's approval. All instrumentation equipment and accessories under this specification shall be furnished as per technical specification, ranges, makes/ numbers as approved by the employer' during detail engineering.
35. The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifold and all the other accessories required for mounting/ erection of these local instruments shall be furnished, even if not specifically asked for, on as required basis. The contacts of equipment mounted instruments; sensors, switches etc for external connection including spare contacts shall be wired out to suitably located junction boxes.
36. In case of sea Water applications, material of Instrument's wetted parts, impulse pipes, impulse tubes, erection hardware, fittings, sampling pipes, tubes, fittings, and all type of erection hardware etc. shall be "super duplex SS" suitable for sea water.
37. The customer specification attached as Specific Technical Requirement will supersede the Data Sheets, if there is any mismatch.

Bidder to use following below mentioned cables while preparing Cable schedule of PTP Package.

Cable type
G-TYPE
4PX0.5sqmm
8PX0.5sqmm
12PX0.5sqmm
F-TYPE
2PX0.5sqmm
4PX0.5sqmm
8PX0.5sqmm
12PX0.5sqmm
24PX0.5sqmm
CONTROL CABLE
3CX2.5sqmm
5CX1.5sqmm
12Cx1.5sqmm

NOTES:

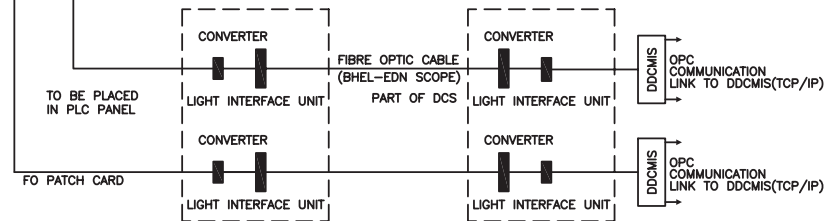
- 1) TABLE TOP OWS/OEWS SHALL BE OF LED 24" OR AVAILABLE INDUSTRY STANDARD.
- 2) PLC SYSTEM SHALL HAVE REDUNDANCY IN PROCESSOR, COMMUNICATION SYSTEM AND POWER SUPPLY.
- 3) UPS POWER SUPPLY SHALL BE PROVIDED FOR PLC PANEL(S), OWS/OEWS AND NETWORK COMPONENTS.
- 4) UPS POWER SUPPLY SHALL BE IN LINE WITH UPS SCHEME FOR OFFSITE PACKAGES DOCUMENT No.: PE-DG-412-145-1004.
- 5) PLC PANEL SHALL HAVE PROVISION TO ACCEPT REDUNDANT TIME SYNC. SIGNAL (IRIG-B) FROM MASTER CLOCK SYSTEM (PLANT AREA).
- 6) PLC PANEL SHALL HAVE PROVISION FOR REDUNDANT DATA EXCHANGE (OPC) WITH PLANT DCS.
- 7) ANNUNCIATOR MOUNTED ON PLC BASED LCP.
- 8) PLC SYSTEM SHALL BE SUPPLIED AS PER TECHNICAL SPECIFICATION.
- 9) REDUNDANCY OF I/O CARD SHALL BE AS PER SPECIFICATION REQUIREMENT.



LEGEND: -

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

ETHERNET SWITCH WITH FIBRE OPTIC PORT



	TITLE:-		DRG. NO.	
	PLC SYSTEM CONFIGURATION		REV. No.	DATE
	PRETREATMENT PLANT		SHEET	1 OF 1

TITLE

SPECIFICATION NO.

PE-TS-412-158-A001



2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SECTION-II

REV 00

SECTION – II
GENERAL TECHNICAL REQUIREMENT



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IIA

REV 00

**SECTION – IIA
GENERAL TECHNICAL REQUIREMENT (MECHANICAL)**



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IIA

REV 00

1. The Clarification Plant shall have 2x50% capacity clarifiers. Design net output capacity of each Clarifier shall be 940 m³/hr. Pl. refer Datasheet – A for pretreatment plant. The Raw water analysis to be adopted for design of pre- treatment Plant shall be as indicated in Annexure – III.
2. The proposed schematic arrangement of the Pre-treatment Plant is detailed out in tender drawing titled flow diagram for pre-treatment plant.
3. Stilling chamber, parshall fumes, Clarifiers etc. shall be of RCC construction unless otherwise mentioned.
4. The hydraulic circuit of the complete Pre-treatment plant shall be designed in such a way that Water from stilling chamber shall flow by gravity upto the clarified water tank under various flow rates upto maximum flow.
5. The system shall be designed so that the Top water level in the clarified water distribution chamber shall be at least 4 M from the finished ground level or higher.
6. The effluent water from the PT-plant shall meet the guaranteed parameters specified elsewhere.
7. Plant shall be designed considering the available head at the terminal point water level of clarified water storage tank and the head loss between the aerator to Filtered water sump.
8. Hydraulics of the Complete Pre-treatment Plant shall be designed to take an occasional over loading of 20% over the design flow.
9. Complete Pre-treatment Plant shall design to run continuously.
10. Layout for pre-treatment plant shall be designed in such a way that all units (e.g., stilling chamber, clarifier, flash mixer, chemical house first floor) shall be interconnected by at least 1.2 M wide walkway at appropriate elevations with hand-railing on both sides and pathway at ground level.
11. Capacity of monorail hoists/E.O.T crane or chain pulley block wherever required / specified indicated in datasheet – A are minimum and capacity of such hoists/ cranes etc. shall be suitable for handling 125% of maximum weight to be handled during erection and maintenance of the equipment in the chemical house buildings etc. as the case may be.
12. Operating platforms shall be provided for all the structures such as, stilling chamber, clarifier, sludge chamber etc. along with ladders and hand railing.
13. One no. clarified water overhead tank (RCC) in twin compartment will in bidder's scope (civil construction by BHEL) as indicated in plant water flow diagram including all instrumentations.
14. All the sumps, tanks, reservoirs and other water retaining structures shall be provided with access ladders/rungs from operating platforms/ground level as the case may be and de-watering pits one for each section. Hand railing will be provided by bidder for safety purpose in all civil structures. Supply and erection of Hand railing as desired for safety purpose will be in bidder's scope.
15. All the tanks shall be provided with vent, overflow, drain and sample connections. Effective capacity for chemical tanks & water retaining structures/ tanks/sumps means the capacity between the bottoms of the overflow nozzle to the top of the outlet nozzle. Outlet nozzle centre line shall be kept at least 200 mm from the Invert Level of the chemical tanks / water retaining structures / tanks/sumps. A minimum free board of 300 mm shall be provided in all the water retaining structures of PT Plant (such as stilling chamber, all the channels, Clarifiers, Overhead water tank, etc) above the maximum water level / overflow level as the case may be excluding the thickness of the slab / beam thickness if any.
16. For all pumps, while calculating the pump head, 10% margin shall be considered on frictional losses.
17. All centrifugal pumps shall have recirculation lines.
18. Pipe routing shall be decided during detailed engineering, however bidder will consider 12 m static head + 10% margin during pump selection.
19. Max. support length in meters for MS pipe shall be as follows:-

a)	PIPE DIAMETER (MM)	1200	1000	800
b)	SPAN (METERS)	12	10	8



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IIA

REV 00

For pipe sizes less than 800 NB, span shall be as per ANSI B31.1.

1.1 AERATOR

The aerator shall be of stepped design and shall allow water to flow downward after spreading over inclined thin sheets and the turbulence is secured by allowing the water to pass through a series of steps and baffles. Exposure time shall be suitably designed by providing adequate number of steps in the aerator. Water from aerator launder shall be led into the Stilling Chamber.

1.2 STILLING CHAMBER

The stilling chamber shall be provided with a baffle wall so that water shall enter the chamber from the bottom and velocity of water rise through the stilling chamber shall be 0.05 m/sec to avoid any turbulence of the incoming water and volume of stilling chamber shall have a retention time of 1 minute min. Draining arrangement with a valve shall be provided for the stilling chamber.

1.3 CLARIFIERS

The type of clarifier shall be High Rate Solid Contact type with integral variable speed impeller/ turbine to internally re-circulate water and sludge at adjustable rate to produce consistent water quality at varying hydraulic load and turbidity.

- i) The unit shall be designed with a minimum retention time of Flocculation zone 30 min, Clarifier zone-150 min. Larger retention time may be provided to meet the equipment guarantee.
- ii) The overall area of the unit shall be based on an average flow velocity not more than 3 M3/hr/m².
- iii) Weir loading shall not exceed 300 M3/m/day. For uniform overflow over weirs, triangular notches (saw tooth weir) shall be provided as necessary.
- iv) Clear width of the bridge shall not be less than 1200 mm.
- v) The clarifier unit shall be circular, central feed type with concentric recirculation zone (rapid mixing) with sampling points at different elevation, reaction zone (slow mixing) and clarification zone in RCC construction.
- vi) Bridge type rake arm and suitable equipment such as turbine/ impeller shall be provided for internal sludge recirculation.
- vii) Design of the sludge removal system should be such as to reduce loss of water during sludge blow off within 3% of rated flow. Inlet portion of the unit, (i.e. pumps, stilling chamber, inlet channel and clarifier) shall be designed to handle excess water to make good for water loss during sludge blow-off.
- viii) The clarifier periphery (all around) shall have sufficient width (minimum 850 mm) to have an easy walkway for general inspection. This walkway shall be provided with handrail along with periphery access ladders (at least from two locations) with platforms and hand railing for the clarifier for good approach. Permanent ladders shall also be provided (not rungs) for approaching the sludge pipeline valves for maintenance. (However the sludge valves shall be operation able from the top of the sludge chamber through head stock and extended spindle arrangement.
- ix) The sludge blanket shall be suspended and maintained in the lower portion.
- x) The design of the turbine/impeller shall be such as not to break the flocks during recirculation.
- xi) Suitable mechanism for varying the recirculation rate shall also be provided such that the reactor clarifier shall be capable of operating at varying hydraulic load and turbidity with consistent effluent quality.
- xii) Clarifiers shall be provided with radial launders.
- xiii) The bottom of clarifier shall be sloped towards the center and mechanically driven sludge scraper and collector shall be used to remove the settled sludge down the sloping bottom to the



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IIA

REV 00

- central sludge area. Rubber squeezer pads shall be provided on sludge scraper and skimmer. Sludge removal system design shall consist of central sludge area with rotating pickets and back flush arrangement for proper control of sludge accumulation at the bottom.
- xiv) Suitable scum collecting arrangement shall be provided in the clarifying section for removal of floating debris, foam etc. if possible. The scraper shall consist of blades (Mild steel with rubber inserts with bitumastic paint protective coating) which are inclined to the radius in the opposite direction to that of the floor scraper.
- xv) The rake bridge and agitators shall be constructed of structural steel and suitably braced to provide rigidity.
- xvi) Sludge blow off shall be effected by the static head of water in the clarifier unit. Sludge outlet pipes from the concentrated sludge hopper shall be branched into main disposal line and continuous sludge disposal line. Main sludge disposal line, which includes a blow-off valve, shall drain sludge to the sludge collection pit. This is an intermittent operation. Continuous sludge disposal line consists of telescopic stand pipe, the top of which is maintained at a desired elevation to ensure trickle flow of water or sludge water mixture to the sludge sump. Alternate proven system of sludge disposal is also acceptable, subject to Employer approval. The de-sludging of clarifiers shall be done twice in a shift. The de-sludging of one (1) Clarifiers shall not exceed one (1) hour. All equipment / sumps shall be designed accordingly.
- xvii) Suitable sampling connections from the various levels and zones of clarifier and at the outlet shall be provided for performance monitoring.
- xviii) Generally each of the clarifier shall be provided with a gate at the outlet for isolation of any of the clarifier for maintenance.
- xix) Arrangement of clarifier sludge pit/ sump shall be as indicated in data sheet and schematic drawings. Minimum capacity of each section of the pit shall be referred in the data sheets. Bidder shall supply all necessary piping, valves and other accessories as required. Each section of the pit shall be provided with agitation by recirculation (jetting nozzles) systems and air agitation system.

1.4 Clarified Water Overhead Tank

The overhead tank (civil work by BHEL) shall have approach from chemical house through permanent staircases (RCC) and door. The water level in the tank shall be maintained by means of a float operated valve. The tank shall be provided with an overflow and drain connection with valve. The capacity of the overhead water tank shall 150% of total water requirement such as chemical preparation, flushing etc.

1.5 Chemical House

- i) The civil construction of the Chemical House shall be in scope of BHEL. However, all the other civil inputs like foundation of the equipment etc. shall be in scope of bidder. Chemical house storage area, tanks, dosing pumps etc. equipment of PT Plant shall be sized for the following minimum dosing Requirements. Chemical storage area in ground floor of Chemical house shall be designed to store these chemicals (except chlorine) for 15 days period considering working of all the clarifiers:
- Polymer Dosing System for Flash Mixer (@ 1 ppm) on 100% basis.
 - Alum Dosing System for Centrifuge (@ 40 ppm) on 100% basis.
 - Lime Dosing System for Centrifuge (@ 10 ppm) on 100% basis.
- i) The storage rooms (civil work by BHEL) shall have suitable bins/partitions sufficiently large enough to accommodate storage requirement of PE lime and alum. The chemical house shall have sufficient unloading space, wide corridors for movement of chemicals, office, toilet etc.
- ii) In the first floor of chemical house, all chemical preparation tanks and respective dosing pumps shall be located. Suitable staircases, walkways, platforms shall be in scope of Vendor. Suitable space for maintenance of pumps, valves etc. shall be provided to have clear access to different units.
- iii) Alum, lime and PE solution shall be dosed by positive displacement type pumps with facility for



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IIA

REV 00

- adjusting the dosages rate of alum solution by changing the stroke length of the pump.
- iv) The chemical house shall be equipped with one weighing scales of platform & dial type suitable for chemicals being handled. Range of weighing scale shall be suitable for weighing 0-1000 Kg. Technical requirements of weighing scale shall be as specified in Datasheet – A.
 - v) Suitable pressurized water connections shall be provided in PE lime and alum piping network for flushing purpose. Flushing connections should be provided at regular interval.
 - vi) Two numbers of electrically operated monorail hoist to be provided in chemical house and capacity of the same shall be minimum 1 Ton.
 - vii) Slow speed Agitators with reduction gear units for each lime, alum and PE solution preparation tank.
 - viii) Each of the chemical tanks shall be provided with dissolving chamber of SS-316 grade. Overflow sampling and drain connections shall be provided for all the tanks.
 - ix) Water required for preparation of chemical solution shall be taken from the clarified water overhead tank located on top of Chemical House.

ii) Overflow & Drain Disposal System

Overflow & drains from the various chemical tanks and floor wash drains of chemical house building (except overflow from O/H water storage tank) shall be led to the PT Plant sludge sump.

Overflow from water overhead tank shall be led to the inlet channel of clarifiers. Concrete sewerage pipe/Hume pipe shall not be used for any of the drain disposal system. Ductile/ Cast Iron pipes or Carbon steel (mild steel pipes) pipes may be used for drain disposal system.

iii) Weighing Scales

- a) The weighing scale shall be of platform type, consisting of compound levers, food receptacle in the form of a platform and coupled to a direct reading, dial type indicator and BSI standard/approved.
- b) The platform will be provided with a locking arrangement which will permit placement of the load continuously on it without its weight being transferred to the levers and measuring system. The lock will be released only during taking a reading on the machine.
- c) The platform shall be capable of accepting concentrated loading.
- d) The weighing scale shall be suitable for weighing miscellaneous chemicals like alum, PE, lime etc.
- e) All graduations in weighing instruments shall consist of notches or uniform lines, sharply defined which may be painted, incised or embossed so that the position of all pointers or sliding poles is easily readable. All number graduations and their subdivision shall be marked by line longer than the minor graduation and the minimum distance between any two considered graduations shall be 1.5 mm. The knife edges shall be of agate or of suitable quality steel.
- f) Marking sealing and testing shall be line with IS: 1432. The manufacturer shall conduct all test required to ensure equipment conform to the requirements of the applicable Codes/standards. All material test certificates shall be made available to the owner.
- g) Least account of the dial limits of sensitiveness and greatest error for platform weighing scales shall be as follows:

Capacity	Least count	Sensitiveness when fully loaded	Greatest error allowed in excess or deficiency when fully loaded	Greatest error allowed in excess or deficiency when quarter of full load is loaded
100 kg	200gm	10 gm	A weight corresponding to one half of the internal minimum	Within half the limits of error prescribed for full load.
300 kg	500gm	60 gm		
500 kg	1 kg	100 gm		
2000 kg	2kg	250		



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IIA

REV 00

			graduation.	

- h) Knife edges and bearings shall be accurately and firmly secured preferably by shanks and nuts or by bolts and nuts or by set screws. The knife edges and bearings shall be protected against corrosion and dirt. Racks and pinions shall be suitable hard wearing materials and shall be finished smooth.

iv) Metering Pumps

- a) Pumps shall be Plunger Type positive displacement pump, driven by electric motor through suitable speed reduction unit. Maximum pump stroke speed shall not exceed 100 per minute.
- b) The stroke shall be continuously adjustable to give a capacity variation 10-100% range while the pumps are running or stopped. Adjustment of capacity shall be done by automatically from remote location and / or manually (micrometric adjusting type) locally for each of the pump as described elsewhere.
- c) Capacity variation may be effected by changing eccentricity of the driving crank or by suitable hydraulic circuit. Pump accuracy shall be industry standard + 1% of capacity setting.
- d) Pumps shall be provided with an integral relief valve, spring operated, to release pressure when delivery line blockage occurs. Crank case shall be constructed of high quality cast iron which will also house the gear box and guides for cross head. Guided, controlled travel, double-ball check valves or equivalent, shall be provided both on the suction and discharge sides. Suitable gland seal be provided to prevent leakage.

CHAPTER 4

4.0 SEA WATER TREATMENT PLANT

4.1 The sea water intake pumps shall supply sea water to the sea water treatment plant dedicated for the proposed 2x660 MW plant and located in the proposed plant site through adequately sized pipeline, control station and cascade aerator.

Refer composite water scheme enclosed in Vol VII for this system. However the water quantities indicated are only tentative. The exact quantities will have to be worked out by the contractor.

4.2 Sea water analysis is enclosed in this chapter.

4.3 Pretreatment & Filtration Plant

- a) Flow control station upstream of cascade aerator consisting of a throttling type motorized butterfly valve with isolation valves and by pass valve.
- b) One (1) Cascade type aerator to oxidize ferrous to ferric and to remove dissolved carbon dioxide
- c) One (1) stilling chamber with retention time of min. 1 minute. Drainage to be connected with sludge sump.
- d) One (1) flow measuring element (Parshall flume) and 2 nos. flow transmitter, one at the inlet channel to flash mixer and the other at the outlet channel of clarifier.
- e) One (1) flash mixer with retention time of min. 1 minute and slow speed agitator or baffles, isolation gates etc. Drainage to be connected with the sludge sump.
- f) Two (2) clariflocculators (over ground), complete with rake mechanism, flocculator mechanism alongwith drive and drive motors, telescopic type continuous sludge discharge arrangement, intermittent timer operated by- pass sludge disposal system, flushing arrangement etc.
- g) Coagulant (Alum) Dosing system consisting of 2 nos. dosing tank and 2 x 100% capacity dosing pumps complete with associated piping and valves.
- h) Coagulant aid (Polyelectrolyte) Dosing system consisting of 2 nos. dosing tank and 2 x 100% capacity dosing pumps complete with associated piping and valves.
- i) Lime dosing system consisting of 2 nos. dosing tanks and 2 x 100% capacity dosing pumps complete with associated piping and valves.
- i) Clarified water storage tank (above ground) of RCC construction and effective capacity 5000 m³, with two compartments and a common sump and a pumphouse. This tank shall be covered.
- j) The Clarified water pumphouse shall house 3 x 50 % Filter feed Pumps.
- k) One (1) - Chemical house (two storeyed) for housing various chemical solution tanks and chemicals (30 days chemical storage space) with toilet block.

The various chemical handling and dosing equipment in the plant shall be designed for the following dosing rates:

i)	Coagulant (FeCl ₃)	:	40 ppm (max.)
ii)	Lime	:	10 ppm (max.)
iii)	Polyelectrolyte	:	1 ppm (max.)
iv)	Chlorine for Pre- Treatment	:	5 ppm (max.)

A minimum of 300 mm freeboard shall be provided for all the units and chemical solution tanks etc.

All pipes shall be routed through pipe racks only.

- l) One (1) complete sludge handling system consisting of reject sump of 2000 cum. effective capacity, three(3) nos. vertical sludge pumps (2Working+1Stand-by) , each of 1000 cum/hr capacity , sludge flushing arrangement etc.
- m) One(1) no. platform dial type weighing scale of 0-500 kg capacity and an electric hoist of suitable capacity in the chemical house.
- n) All RCC channels/ ducts and hume pipes as required for sea water PT plant.
- o) All pipe, or RCC channels/ ducts and hume pipes required for sludge disposal drain/ filter backwash water shall be led to sludge/ reject sump.
- p) Necessary flushing arrangement for the sludge pipes and filter back wash water disposal pipes.
- q) Two nos. (1W+1S) twin section dual media filters with inlet channels, flow controller, filter media, internals complete with associated piping and valves.
- r) Seven nos (6W+1S) Ultra filter modules complete with filter media, internals complete with associated piping and valves. Backwash provision of the UF shall consist of UF backwash pumps 2(1W+1S), dozing skids with dedicated pumps 2(1W+1S). Filter backwash from the filter outlet shall also be led to guard pond.
- s) One (1) no. RCC UF Permeate Water Storage tank of effective capacity 2000 cum in two compartments. Tank shall be covered.
- t) Seven (6W +1S) Cartiridge filters.
- u) 3 x 50% Cartridge Filter Feed Pumps.
- v) 2 x 100% UF Backwash Pumps
- w) Other civil works as specified.
- x) Isolating gates and shutters as detailed below:
 - i. Isolation gates with hand wheel at inlet to clariflocculator
 - ii. Isolation gates with hand wheel at outlet of clariflocculator

DATA SHEET – SEA WATER TREATMENT PLANT

S. No.	Description	Units	Parameter
1.0	Sea Water Inlet Pipe and Valves		
a.	Size of inlet pipe	Mm	By bidder as per specification criteria
b.	Material of Construction of Pipe		Refer Chapter 13
c.	Inlet valves		
	i) Type		Electric motor actuated type butterfly valve long body as per AWWA–C-504.
	ii) Size	Mm	By bidder
	iii) Isolating & By pass valve		
	ii) Type		Butterfly valve with suitable gear boxes.
	iii) Size	mm	By bidder
d.	Ends		Flanged, flat serrated faced as per ANSI B - 16.5 class 150
e.	<u>Material of construction</u>		
	i) Body & disc		ASTM A 182 F 316L
	ii) Shaft		ASTM A 182 F 316L
	iii) Bearing & Gland packing		Teflon
	iv) Valve seat		SS 316L
	v) Disc seat		Renewable Nitrile rubber 70 to 75A shore hardness.
	vi) Seal retaining ring		ASTM A 182 F 316L
	vii) Bolts and nuts		ASTM A 182 F 316L
	viii) Gear casing		ASTM A 182 F 316L
	ix) Gears		Phosphor Bronze
	x) Pinions		Nickel molybdenum steel.
	xi) Pinion screw hardware		ASTM A 182 F 316L
2.0	Cascade Aerator		
a.	Number required	No.	One (1)
b.	Number of steps		Min. 7
c.	Surface loading	m ² /m ³ /hr	0.045
d.	Material of construction		R.C.C
e.	Time	sec.	2
f.	Riser	mm	> 250
g.	Tread	mm	< 400
3.0	Stilling Chamber		
a.	Number required	No.	One (1)
b.	Construction		RCC
c.	Capacity	Cum	75
d.	Detention time	Sec.	Sixty (60)
4.0	Parshall Flume		
a.	Number required		One (1)
b.	Construction		RCC
c.	Capacity	Cum/hr.	1.2 times of clariflocculator
5.0	Flash mixer		
a.	Number required	No.	One (1)
b.	Construction		Radial, RCC
c.	Capacity	Cum	75 (min)
d.	Detention time (approx.)	Sec.	Sixty (60)

S. No.	Description	Units	Parameter		
	e. Free-board	Mm	Minimum 500		
	f. Agitator		Centrifugal type ac electric motor operated thru reduction gear, MOC : SS-316L		
	g. Protective cover of GI construction for motors and gear drives.		Required – protection for motors – IPW-55 (outdoor duty)		
6.0	Clariflocculator				
	a. MOC of inlet pipe		MS internally coated with Corrocoat/ Polyures/ GRP – please refer chapter 13. Pipe shall be selected for 10 Kg/cm ² (g) Pressure Class		
	b. Number required	No.	Two (2) nos 50% duty		
	c. Type & Construction		Radial, RCC		
	d. Rated Effluent Capacity	Cum/hr	By bidder		
	e. Effluent quality	NTU	<10		
	f. Detention period:				
	i. Flocculation zone	minutes	Thirty (30) (minimum)		
	ii. Clarifier zone	minutes	One hundred fifty (150) (min.)		
	g. Rise rate	Cu.M/hr/m ²	1.2		
	h. Surface flow rate of clarifier zone	cum/hr/ m ²	Not more than 1.2		
	i. Velocity in launder	m/sec.	Not more that 0.4		
	j. Platform with railing		1 M wide all along clariflocculator		
	k. Rake bridge :				
	i. Material		MS IS: 2062 Corrocoated or FRP coated.		
	ii. Other features		Suitably braced to provide rigidity. Gear boxes for bridge drive shall be either oil-free type or suitable arrangement for collecting leak oil shall be provided.		
	l. Sludge blow-off				
	i. Continuous		By gravity through telescopic stand pipe for continuous discharge.		
	ii. Intermittent		Through blow-off valve		
	m. Size of the clarifier	φ M x SWDM	By bidder		
	n. Flocculation Agitator		Vertical Slow speed motor driven thru reduction gear , MS Corrocoated/ FRP coated		
7.0	Chemical House				
	a. Number	No	One		
	b. Type		Two (2) storeyed building		
	c. Ground Floor		Chemical storage for PT Plant for 30 days (min.).		
	d. First Floor		Location of Chemical Tanks EL Approx. 5.0m with dosing pumps.		
	e. Handling Facility		Electrically operated Mono-rail with chain pulley block.		
8.0	Dosing System		Coagulant Tank	Poly Electrolyte tank	Lime Tank
	a. Numbers required		Three(3)	Two (2)	Two (2)
	b. Construction		RCC	RCC	RCC
	c. Internal lining		FRP/ PP Lining		

S. No.	Description	Units	Parameter		
	d. Minimum Capacity (effective)	Cum.	Each tank sized to hold 12 hours requirement		
	e. Solution strength	%	10	0.5	5
	f. Agitator – type		Vertical	Vertical	Horizontal
	MOC		SS	SS	MS
	g. Dissolving basket		In SS 316L Construction with 10 mm Φ holes on 50mm triangular pitch.		
	h. M.O.C. for piping valves, & fittings		CPVC PN 10		
	i. Solution dosing system - Coagulant - Polyelectrolyte		2x2000 lph (min) each diaphragm / plunger type with stroke adjustment metering pumps. 2 x 1000 lph (min)		
	j. Lime dosing system		2 x 1000 lph (min) screw type dosing pumps.		
9.0	Reject Sump		Sludge		
	a. Number	No.	One		
	b. MOC & Type		RCC with lining, Under ground, Outdoor location		
	c. Capacity (Effective)	Cu.m	600 (min.)		
	d. Instruments		Level switch with indication on panel		
	e. Inside Protection		FRP/ PP Lining		
10.0	Sludge Disposal Pumps		Sludge		
	a. Numbers	No.	3 (2 W + 1 S)		
	b. Type		Vertical, non-clog		
	c. Capacity rate	Cum/hr	Minimum 1000		
	d. Head	Mwc	By bidder		
	e. Type of lubrication		Self lubrication		
	f. Material of Construction				
	i. Casing		Duplex SS 2205 UNS 31803		
	ii. Impeller		Duplex SS 2205 UNS 31803		
	iii. Shaft		Duplex SS 2205 UNS 31803		
	iv. Shaft sleeves		Duplex SS 2205 UNS 31803		
	vi. Packing		Braided Impregnated Teflon		
	vii. Flexible coupling		Duplex SS 2205 UNS 31803		
	viii. Bolts & Nuts		SS-316L		
	g. Electric supply		415V, 3 phase, 50 Hz.		
	h. Enclosure & insulation		TEFC, Outdoor type, Class 'B' insulation IPW-55		
	i. Speed of pump motor	Rpm	1450		
11.0	Clarified Water Storage tank				
	a. Number	No.	One (1) (in two sections)		
	b. Effective capacity	m ³	5000		
	c. MOC		RCC		
	d. Type of tank		Above ground, fully covered (in RCC), RCC tank.		
	e. Level Indicator		Electro – mechanical		

S. No.	Description	Units	Parameter
	f. Inside protection		FRP/ Corrocoat lining/ as per Civil Spec

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.

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,	4	
	Storage & preservation manuals		
	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 To	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		R&D work inprogress	
	Duct design.			
	Pressure part			

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

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

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
	Design principle for Up rating/down rating of existing design/ modules for the specific project.			
	Selection of nos., type and arrangement of bearings, load calculation on bearings, bearing oil flow calculation Selection, design and control principle for Turbine governing system Performance calculation Steam path audit Layout principle of various equipment's of TG and its integral system Latest technological advancements			
MANDAYS	45	10	10	
Boiler Feed Pumps	Techno-economic syudies for Selection of BFP Configuration and its drive Criteria for selection of boiler	Familiarization of power plants of various makes of feed pumps Data collection of BFP	Manufacturing process of various components of BFP Assembly of BFP	

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

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
	suction piping wrt NPSH margin Latest technological trends in BFP design			
MANDAYS	20	5	10	
Condenser	Selection of condenser type and its optimization wrt temp rise across condenser, pressure drop in condenser, surface area etc.	Comparative studies of salient features	Manufacturing process of various components of condenser Assembly	
	Techno economic studies for Selection of condenser tube material and other parts depending on water quality Condenser support selection & design Sizing of condenser w.r.t. super critical units Latest technological trends in condenser arrangement and design Condenser vacuum system design	Collection of data for analysis of availability of Condenser O&M history/problems related to condenser	Testing capability at works Product development in process Future plan for technology induction R&D work in progress	

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
MANDAYS	10	5	5	
Feed Regenerative Equipment's	Thermal and mechanical design calculation of heaters Basis of selecting horizontal/vertical heaters Selection of TTD and DCAs for various heaters, and their effect on turbine heat rate Configuration of HP heaters (2x50% v/s100% capacity	Comparative studies of salient features Analysis of data O&M history/problems related to heaters	Manufacturing process of various components of heaters Assembly Testing capability at works Product development in process	
	Sizing criteria for De-aerator/Heaters Selection of tube & tube sheet material of heaters Latest technological trends in heaters design		Future plan for technology induction R&D work in progress	
MANDAYS	15	10	10	
3-dimensional CFD modeling	CFD model development and validation of design data for steam turbine, BFP, CEP, condenser, heaters etc.			

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
MANDAYS	20			
Compressors	Equipment Theory & Maintenance Practice			
MANDAYS	16	-----	4	
Ash Handling System	Equipment Theory & Maintenance Practice			
MANDAYS	16	4	4	
Coal Handling System	Equipment Theory & Maintenance Practice			
MANDAYS	20	5	5	
H ₂ Plant	Equipment Theory & Maintenance Practice			
MANDAYS	10	3	3	
Condensate Polishing Unit	Equipment Theory & Maintenance Practice			
MANDAYS	15	5	5	

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

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

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

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
MANDAYS	6	3		
BOP (DDCMIS)	Hardware organization		Manufacturing process of PLC hardware	
	Operating system features		Integration & testing facilities	
	Data base organization			
	Logic/loop algorithm Development of control logic & loop s/w & MMI application development			
MANDAYS	24	-	6	
BOP Controller System				
1) Hard Ware	Equipment Theory & Maintenance Practice			
MANDAYS	30	10	10	
2) Soft Ware	Equipment Theory & Maintenance Practice			
MANDAYS	30	10	10	
VMS				
1) Hardware	Equipment Theory &			

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

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
	Maintenance Practice			
MANDAYS	16	-	4	
Networking / MIS	Equipment Theory & Maintenance Practice			
MANDAYS	12	-	4	
Electric Power Supply System	Theory & design features		Manufacturing/assembly process	
			Testing methodology	
MANDAYS	5	2		

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

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

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
CRITICAL PIPING & POWER CYCLE PIPING	Design familiarization for critical piping of supercritical Plant Optimization study for sizing including pressure drop calculation and selection of single or double lead together with Owner's engineers Design and stress analysis of lines with Expansion Joints together with Owner's engineers Design and stress analysis of piping systems with two phase flow involving Owner's engineers Transient analysis and optimum sizing of feed suction piping together with Owner's engineers.	Familiarization with feed back (in super critical plant) on failure analysis and vibration analysis of piping. Study of Feed back regarding hanger setting strategies and practice	Cold Setting of spring hanger Cyclic tests carried on spring hangers. Cyclic tests carried on expansion joints Manufacturing process of critical piping components and appreciation of their testing facilities at shop	

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
	Static and dynamic analysis of critical piping including seismic and other occasional load analysis (safety valve blowing condition). A joint activity together with Owner's engineers. Study and collection of data pertaining to special welding requirements (pre and post weld heat treatment and electrode selection criteria etc.) of materials used in high temp piping system. Study and collection of data on special requirements in case of welding dissimilar metals and electrode selection criteria			
MANDAYS	45	10	10	

ANNEXURE-III

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

LEGENDS

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

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

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

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

2. QP/INSPN CATEGORY:

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

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

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

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

ANNEXURE-IV

[illegible]

ANNEXURE-V

		Project :		Stage :		FIELD WELDING SCHEDULE (To be raised by the Bidder) Welding Code:								DOC. NO.:		
		Bidder :												REV. NO.:		
		Bidder No. :												DATE :		
		System :												PAGE : OF		
Sl. No.	DRG No. for Weld Location and Identification mark	Description of parts to welded	Matl. Spec.	Dimensions		Process of welding	Type of Weld	Electrode filler spec.	WPS. No.	Min. pre-heat	Heat treatment		NDT method/ Quantum	REF		Remarks
											Temp.	Holding time		Spec. No.	ACC Norm Ref.	
NOTES:																
SIGNATURE																

ANNEXURE-VI

MFGR.'s LOGO	MANUFACTURER'S NAME AND ADDRESS		MANUFACTURING QUALITY PLAN					PROJECT : PACKAGE : CONTRACT NO. : MAIN-SUPPLIER:					
			ITEM :		QP NO.: REV.NO.: DATE: PAGE: OF....								
SL. NO	COMPONENT & OPERATIONS	CHARACTERISTIC S	CLA SS	TYPE OF CHEC K	QUANT UM OF CHECK	REFERENC E DOCUMENT	ACCEPTAN CE NORMS	FORMAT OF RECORD		AGENCY M C N			REMARKS
1.	2.	3.	4.	5.	6.	7.	8.	9.	D *	**	10.	11.	
				LEGEND: * RECORDS, IDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** M: MANUFACTURER/SUB-SUPPLIER C: SUPPLIER/NOMINATED INSPECTION AGENCY, N: THE OWNER						DOC. NO.: REV..... CAT.....			
MANUFACTURER/ SUB-SUPPLIER		MAIN-SUPPLIER						FOR THE					

SIGNATURE	P: PERFORM VERIFICATION. W: WITNESS AND AS APPROPRIATE, CHP: THE OWNER SHALL IDENTIFIED IN COLUMN "N"	V: OWNER USE	REVIEWED BY	APPROVED BY	APPROVAL SEAL

ANNEXURE-VII

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

SIGNATURE	'A' SHALL BE WITNESSED BY THE OWNER FQA, 'B' SHALL BE WITNESSED BY OWNER'S ERECTION / CONSTRUCTION DEPTT. AND 'C' SHALL BE WITNESSED BY ERECTION SUPPLIER (A & B CHECK SHALL BE OWNER CHP STAGE)	OWNE R USE	REVIEWED BY	APPROVE D BY	APPROV AL SEAL

CHAPTER 10

10.0 MISCELLANEOUS PUMPSETS

10.1 GENERAL INFORMATION

10.1.1 Sump pumps specified hereinafter shall be used to dewater various sump pits in various plant areas like BTG area, Plant Water System, Ash Handling plant etc. where gravity draining is not be envisaged and to ensure general housekeeping

10.1.2 Pumps under this specification have been divided into following three (3) groups according to different duty envisaged and location of sumps/pits.

10.1.2.1 Group - A

The Group - A pumps shall be electric motor driven permanently installed vertical wet pit bottom suction volute type and shall handle drainage water, containing solid particles with sludges, polluted liquid, oils etc. from the area where they are installed. These pumps shall run intermittently by the use of high and low level switches in the sump. Particle size in the water shall not normally exceed 15 mm.

Group-A pumps shall also be provided to all indoor sumps of the plant and outdoor sumps of capacity 5 cu.m and above and underground cable vaults (if any) under the scope of this specification.

10.1.2.2 Group - B

These pumps shall be horizontal centrifugal electric motor/diesel engine driven portable type. Each pump set along with control panel etc. shall be mounted on a trolley for ease of transportation. These pumps shall be suitable for dewatering of pipelines of large diameter, if required and alike jobs and handling of liquids containing hard solid particles, sludge, polluted liquid, significant amount of fuel oil/HSD etc. and particle size shall not normally exceed 20 mm. These types of pumps shall be used in different plant areas.

10.1.2.3 Group - C

The Group - C pumps shall be vertical submersible portable type pump motor sets with suitable arrangement for carrying to any place and for lowering to and raising from various water reservoirs and pits. The pump motor set shall be suitable for handling water containing mud/sludge, solid particles, cotton waste, silica, ash particles, coal particles, polluted liquid etc. The particle size in water shall not exceed 20 mm. These pumps shall be utilised to dewater various deep sumps/pits (e.g. C.W pump house) in case of any eventuality.

10.2 CODES AND STANDARDS

10.2.1 The design, manufacture and performance of the sump pumps and drives specified, hereinafter, shall comply with the requirements of all applicable codes, the latest applicable Indian/British/American/DIN Standards, in particular the following:

10.2.2 IS-1710 : Vertical Turbine Pumps for clear cold and fresh water.

10.2.3 IS-5120 : Technical Requirements – Roto-dynamic special purpose pumps.

10.2.4 IS-5600 : Sewage and drainage pumps.

10.2.5 Hydraulic Institute Standards of USA.

10.2.6 The materials of the various components shall conform to the applicable IS/BS/ASTM/DIN Standards.

10.3 GENERAL PERFORMANCE REQUIREMENT

10.3.1 The pumps shall be designed to have best efficiency at the specified duty point. The pump set shall be suitable for continuous operation at any point within the "Range of Operation" as stipulated by the manufacturer.

10.3.2 Pumps shall have a continuously rising head capacity characteristics from the specified duty point towards shut off point, the maximum head being at shut off.

10.3.3 Permanently installed vertical pumps shall be suitable for parallel operation. The head vs capacity, the bhp. vs capacity characteristics etc. shall match to ensure equal load sharing and trouble free operation throughout the range. Drive Motor shall not be overloaded when pump discharge is more than rated condition.

10.3.5 The static head requirement of portable submersible type sump pump may have a considerably wide range of variation depending upon the depth of pit being dewatered. While the pump shall have adequate capacity at the maximum head, the motor shall be sufficiently rated to cater for any overloading during the pump operation at its minimum possible head, i.e., maximum discharge.

10.3.6 Pump motor set shall run smooth without undue noise and vibration. Acceptable peak to peak vibration limits shall generally be guided by Hydraulic Institute Standards (latest edition).

10.4 SCOPE OF WORK

10.4.1 Pumps under groups A, B and C as listed in the Annexure- I along with drive units, couplings and other accessories mentioned below, as also those needed to make the pump-motor sets complete in all respect, for proper operation and maintenance. All motors in outdoor duty shall be provided with IP-55 enclosure and canopy. In addition to the accessories listed in Annexure-I, each pump set shall also include the following:

10.4.2 For the vertical Group - A sump pump motor sets

Two (2) nos. redundant ultrasonic type level transmitter (2 Nos.) with limiter technique shall be provided for alarming, auto start & auto stop. along with necessary junction box, local control panel, control cables etc. to achieve automatic starting/stopping of the sump pumps, and also ON/OFF indication for sump pump shall be monitored at DDC system. The entire assembly being mounted on the same base frame as mentioned above (item "b"). The control panel shall also be equipped with start/stop push button for starting/stopping individual sump pumps manually. Local control panel and cable shall be as per requirements described else where in the specification.

10.4.3

For each of the trolley mounted horizontal Group-B sump pump motor sets/pump-Diesel Engine sets

- a) One (1) no. 7.5 meters long hose for the pump suction and one (1) no.30 meters long hose for the pump discharge, either ends of each hose being provided with female hose coupling.
- b) One (1) no. 500 mm long straight pipe piece, with both ends flanged, one end matching with the pump suction nozzle.
- c) Two (2) nos. male type hose couplings, one of which is suitable for coupling with the above mentioned 500 mm pipe piece on one side and the 7.5 meters long suction hose on the other side, whereas the other is suitable for coupling with the pump discharge nozzle on one side and the 30 metres long hose on the other side. The pump suction pipe-piece and discharge nozzle shall be of flanged type. As such each coupling end that is to match with the pipe/pump nozzle shall also be flanged and shall be equipped with necessary bolts, nuts & gaskets.
- d) A foot valve (of Bidder's recommended size) with suction strainer, necessary coupling and matching piece/reducer (if necessary) to couple with the 7.5 meter long suction hose end.
- e) A starter panel complete with incoming switch/contacter, fuse, overload relays, start-stop push button, O/L reset push button, cable gland, wiring terminals, red and green indication lamps (LED type), necessary control cables etc., and also 50 metres length of flexible power cable with power plug at one end and arrangement to connect the other end with the starter panel.
- f) The pump motor set with a baseframe along with the starter panel, power cable, suction & discharge hoses etc., as mentioned above, shall be mounted on a suitable trolley with swivelling front wheel and having adequate fixing arrangement for all equipment, for operation without any undue vibration and with facility for being handled by a single operator.

10.4.5

For each of the portable submersible Group-C sump pump motor sets.

- a) Two (2) nos. 30 metres long discharge hose, having female hose coupling at both ends.
- b) One (1) no. 500 mm long pipe piece with both ends flanged, one end connected by necessary bolts, nuts & gaskets with the flanged discharge nozzle of the sump pump.
- c) One (1) no. male type hose coupling, one end of which is suitable to couple with the discharge hose and the other end is flanged, matching with the above mentioned 500 mm long pipe end and connected therewith by necessary bolts, nuts & gaskets.
- d) Suitable attachment for temporary seat of the pump motor set on the floor at sump bottom.

- e) One (1) no. 25 metres long submersible type power cable having a power plug at one end and a hermetically sealed (waterproof) cable gland for connection with the pump drive- motor at the other end.
- f) Suitable lugs and other attachments on the pump motor assembly frame, for hoisting and lowering of the pump motor set from and to the sump.
- g) One starter panel, having a plug socket as receptacle of the above mentioned power plug (item "e"), a 25 metre long incoming power cable with switch/contactors and fuse, start- stop push buttons, red and green LED type indication lamps, over load relays, O/L reset push button, cable gland etc., and also a suitable arrangement for temporarily mounting the starter panel, near the sump, where the portable sump pump-motor set is to work. The incoming 25 metre long power cable shall also be provided with a suitable power plug at one end.

10.4.6 Lubrication of one (1) initial fill and one additional fill after commissioning.

10.4.7 Rust inhibitor paint at Manufacturer's works.

10.5 DESIGN AND CONSTRUCTION

10.5.1 The design, construction testing and other details of the sump pumps and related accessories shall be in line with the stipulations and data in this chapter.

10.5.2 Each sump pump shall be equipped and coupled with a drive motor, with rating so selected as to have at least 15% margin over the maximum power required by the pump, throughout its range of operation. All other requirements of the drive motors shall be as stipulated in the Electrical Specification Vol IV.

The discharge rate of sump pump is uncontrolled. As such pump should be capable to operate even under a condition of as low as 25% of specified total head. Motors of group-B pumps should be designed to cater such eventuality.

10.5.3 All electrical items shall conform to the stipulations of Electrical Specification Vol IV as applicable.

10.5.4 All piping shall be as per IS-1239 of medium or heavy grade (as suited for the maximum operating pressure) and shall be either galvanised or painted with approved rust inhibiting paint. Pipe size shall be as per Appendix-II. Any matching piece/reducer required to match the pipe with pump nozzle, hose, etc. shall be provided.

10.5.5 All valves shall be steel body type as per applicable IS/BS/ANSI standard, with pressure class compatible with the maximum working pressure.

10.5.6 All hoses shall be of steel wire reinforced type. Pump suction hose shall be suitable for working under vacuum. Pump discharge hose shall be suitable to withstand the maximum pressure that it may be subjected to in all working conditions, including hydrostatic testing of the sump pump discharge line.

10.5.7 Pump suction strainer shall have openings large enough just to permit the entry of solids having maximum size as stipulated under clause no. 1.02.00.

- 10.6 Pumps
- 10.6.1 Pumps under Group-A shall be wet pit type, vertical shaft, centrifugal, vertical submerged suction, non-clog volute type complete with enclosed shaft, discharge pipe, head assembly thrust bearing and drive assembly, cover plates etc.
- 10.6.2 Pumps under Group-B shall be of horizontal shaft, single stage, end suction, radially split casing, centrifugal, non-clog design complete with common base plate, drive assembly etc. These pumps shall be trolley mounted portable type.
- 10.6.3 Pumps under Group-C shall be submersible pump-motor type, single stage and non-clog design and shall be portable type.
- 10.7 Casing
- a) Casing shall be so designed to allow free passage of specified maximum size of solid.
 - b) Casing shall be designed to withstand the maximum shut-off pressure developed by the pump.
 - c) The casings shall be cast, free from blowholes, sand holes, other detrimental defects. The casing shall be complete with suction and discharge connections.
 - d) For pumps under Group-A adequate seal arrangement shall be made to keep leakage of liquid from casing to column assembly to minimum and adequate drain shall be provided in column assembly to permit escape of the leakage flow. The casing shall also include the bearing housing of the bottom pump shaft bearing.
 - e) Casing of pumps under Group-B shall be provided with vent connections and drain connections with valves. These pumps shall be manually primed.
- 10.8 Impeller
- a) The impeller shall be open/semi-open non clog type, cast in one piece and specially designed to pass large solids or unscreened liquids. The clearance between stationary and moving parts should be such as to allow sustained performance without exclusive maintenance.
 - b) Impellers of pumps under Group-A shall have provision for adjustment from an accessible location and for pumps under Group-C shall be capable of passing fibrous material like cotton waste, jutes, etc.
- 10.9 Pump Shaft
- a) Shaft size selected shall be such that critical speed is at least 20% away from the operating speed and the runaway speed.
 - b) The shaft shall be ground and polished to final dimension and of ample size to withstand all stresses resulting from rotor weight, hydraulic loads and across the line starting. Shaft shall be provided with renewable sleeves particularly under stuffing boxes and other locations as recommended by pump manufacturers.

- c) The coupling between shafts shall be so designed that they become tight during pump operation.

10.10 Column Pipe (for pumps under Group-A)

The discharge pipe shaft assembly shall be flanged or screwed as per manufacturer's standard and standard length of each piece of column pipe shall be in conformity to the shaft piece lengths from consideration of easy handling.

10.11 Bearings

- a) Adequate nos. of properly designed bearings shall be furnished. Bearings for pumps shall be antifriction type and lubricated by grease. Line shaft bearings of vertical pumps shall also be grease lubricated. All necessary grease gun, grease cup and tubing shall be included.
- b) Thrust bearing of adequate design shall be furnished for taking the entire pump thrust arising from all probable conditions of continuous operation through out its "range of operation" and also the shut-off condition. The life of thrust bearing shall be 20,000 working hour minimum for the load corresponding to the duty point. The bearings shall be lubricated by grease from a location conveniently accessible. Design shall be such that the lubricant cannot contaminate the handling liquid.

10.12 Wearing Ring/Liner Plate

Renewable wearing rings/liner plates shall be provided either on impeller or on the casing or on both impeller and casing.

10.13 Stuffing Box

Stuffing Box of pumps under Group-A shall be of mechanical packing type. For pumps under Group-B and Group-C mechanical seal of reliable design shall be provided.

10.14 Coupling

Pump and motor shall be connected with a suitable flexible coupling. Coupling shall be provided with coupling guard.

10.15 Mounting Plate for Group-A Pumps and Base Plate for pumps under Group-B.

Each pump under Group-A shall be provided with a suitable mounting plate. The mounting plate shall be adequately sized to accommodate the level switches, discharge pipe, grease cups etc. if any. Pumps and motor under Group-B shall be mounted in one base plate. Base plate shall be of rigid construction properly ribbed as needed. Suitable drain with valve and drain funnel shall be furnished by the Bidder.

The necessary supporting plate, mounting frame, base plate etc. as required shall be supplied under this specification, along with anchor bolts, foundation bolts, pipe, sleeves etc. Lifting lug, eyebolts, etc. as required for the proper handling of each pump set shall be furnished.

10.16 Suction Bell

The pumps under Group-A, C shall be complete with adequately dimensioned suction bell to guide and streamline intake fluid.

10.17 Material of Construction

For material of construction of various parts of data specification sheet shall be referred to.

10.18 **INSPECTION AND TESTING**

10.18.1 All pumps shall be tested at the shop for capacity, head, efficiency and brake horse power. These tests are to be done according to the requirements of "Hydraulic Institute Standard".

10.18.2 The pump integral accessories like thrust bearing, pump motor coupling etc. shall be subject to tests as per manufacturer's standard.

10.18.3 Test on motors, control panels, starter panels, cables shall be conducted as per the requirement of Vol.IV of this specification and as per Quality Assurance Plan to be approved by Owner during detail engineering.

10.18.4 After delivery/erection at site, pumps shall be operated to prove satisfactory and trouble free performance.

10.19 **DRAWINGS, DATA, INFORMATION REQUIRED**

10.19.1 Location and dimension of all sumps which requires assisted evacuation, present in the areas covered under the scope of this specification.

10.19.2 List of location of Group-A .

10.19.3 Characteristic curves of pumps showing effective head, pump input power, efficiency, submergence and NPSH, against capacity ranging from shut-off condition to 125% or rated capacity for Group A, B pumps and to 150% of rated capacity for Group C pumps.

10.19.4 Speed vs. torque curve of the pump corresponding to recommended mode of pump starting, super-imposed on speed vs. torque of the motor, corresponding to 80% and 100% rated voltage.

10.19.5 Diagram showing the type of lubrication system etc.

DATA SPECIFICATION SHEET

S. No.	Description	Group A	Group B	Group C
1	Pumps			
1.1	Rated Capacity	Capacity of each pump should be so selected to empty sump pit in 10 to 15 minutes	Twenty (20)	Fifty (50)
1.2	Total Dynamic Head at rated Capacity (MLC)	To be calculated with 10% margin on frictional drop	15	20
1.3	Minimum suction lift	-	6	-
1.4	Nos. required	These pumps shall be provided in all indoor sumps and outdoor sumps of 5 cum & above and underground cable vaults and CW pumphouse. Pumps shall be of 2 x 100% capacity for each sump.	Four (4) (2 electric motor driven and 2 diesel engine)	Four (4)
1.5	Duty	Intermittent		
1.6	Pump design standard	IS 5120/ IS 1710/ HIS		
1.7	Parallel operation	Yes	No	Yes
1.8	Material of Construction			
a)	Base Plate/ Cover Plate	MS – IS 2062	MS – IS 2062	MS – IS 2062
b)	Column Pipe	MS – IS 2062	MS – IS 2062	MS – IS 2062
c)	Casing	2% NiCi	2% NiCi	2% NiCi
d)	Impeller	2% NiCi	2% NiCi	2% NiCi
e)	Pump/ Impeller Shaft	SS 410	SS 410	SS 410
f)	Shaft Sleeve	SS 410	SS 410	SS 410
g)	Shaft Coupling	SS 410	SS 410	SS 410
h)	Shaft Bearing	BUSH GM as per IS 306	BUSH GM as per IS 306	BUSH GM as per IS 306
i)	Gland	CI IS 210 FG 260	CI IS 210 FG 260	CI IS 210 FG 260
j)	Fasteners	SS 304	SS 304	SS 304

Note : In all areas where Group A pumps are installed and will handle Sea Water like CWPB Pit the material of construction of all components of the pumps shall be Duplex Stainless steel.

CHAPTER 13

13.0 LP PIPING, VALVES & SPECIALITIES

13.1 Equipment sizing Criteria

- 13.1.1 All the piping systems and equipment supplied under this package shall be designed to operate without replacement and with normal maintenance for a plant service life of 30 years, and shall withstand the operating parameter fluctuations and cycling which can be normally expected during this period.
- 13.1.2 For all LP piping system covered under this specification, sizing and system design shall be to the requirements of relevant codes and standard indicated elsewhere. In addition to this, requirements of any statutory code as applicable shall also be taken into consideration.
- 13.1.3 Inside diameters of piping shall be calculated for the flow requirements of various systems. The velocities for calculating the inside diameters shall be limited to the following.

a) Water Application

		Water Velocity in m/sec		
	Pipe Size	Below 50 mm	50-150 mm	200 mm & above
a)	Pump suction	-----	1.2-1.5	1.2-1.8
b)	Pump discharge and recirculation	1.2-1.8	1.8-2.4	2.1-2.5
c)	Header	----	1.5-2.4	2.1-2.4

The pipes in CW, ACW & DMCW system shall be designed to maintain a maximum velocity of 2 m/s inside the pipelines at pump discharge.

Pipe line under gravity flow shall be restricted to a flow velocity of 1 m/sec generally Channels under gravity flow shall be sized for a maximum flow velocity of 0.6 m/sec.

WILLIAM & HAZEN formula shall be used for calculating the friction loss in piping systems with the following "C" value.

i)	Carbon steel pipe	100
ii)	CI Pipe/Ductile Iron	100
iii)	Rubber lined steel pipe	120
iv)	Stainless steel pipe	100

For calculating the required pump head for pump selection, at least 10% margin shall be taken over the pipe friction losses and static head shall be calculated from the minimum water level of the tank/sump/reservoir from which the pumps draw water.

b) Compressed Air Application

Compressed air – 15.0 m/sec. (under Average Pressure & Temp. conditions)

- 13.1.4 The pipes shall be sized for the worst (i.e. maximum flow, temp. and pressure values) operating conditions.
- 13.1.5 Based on the inside dia. so established, thickness calculation shall be made as per ANSI B 31.1 OD and thickness of pipes shall than be selected as per ANSI B 36.10/IS-1239 Heavy grade/IS-3589/ASTM-A-53/API-5L/ANSI B 36.19 as the case may be.
- 13.1.6 Corrosion allowance of 1.6 mm will be added to the calculated thickness being considered.
- 13.1.7 Bend thinning allowance/manufacturing allowance etc. shall be as per the requirement of the design code provision.
- 13.1.8 High points in piping system shall be provided with vents alongwith valves as per the system requirement. Low points shall be provided with drains alongwith drain valves as per the system requirement. Drain lines shall be adequately sized so as to clear condensate in the lines. Material for drain and vent lines shall be compatible with that of the parent pipe material.
- 13.1.9 Material of construction for pipes carrying various fluids shall be as specified elsewhere.
- 13.1.10 Compressed air pipe work shall be adequately drained to prevent internal moisture accumulation and moisture traps shall be provided at strategic locations in the piping systems.
- 13.1.11 Depending upon the size and system pressure, joints in compressed air pipe work shall be screwed or flanged. The flange shall be welded with the parent pipe at shop and shall be hot dip galvanized before dispatch to site. Alternatively, the flanges on GI pipes may be screwed-on flanges also.
- 13.1.12 Threaded joints shall be provided with Teflon sealant tapes.
- 13.1.13 Following types of valves shall be used for the system/service indicated.

System	Type of Valves					
	Butterfly	Gate	Globe	Check	Ball	Plug
Water	x	x	x	x	x	
Air		x	x	x	x	
Drains & Vents		x	x	x		
Fuel oil		x	x	x	x	x

In water service, valves above 200 NB size shall be butterfly valves.

- 13.1.14 Recirculation pipes alongwith valves, breakdown orifices etc. shall be provided for important pumping systems as indicated in respective process and instrumentation diagrams (P&IDs). The recirculation pipe shall be sized for minimum 30% design

flow of single pump operation or the recommended flow of the pump manufacturer whichever is higher.

13.1.15 All Piping 450 NB & Above shall be designated as Large dia Piping.

13.2.00 TECHNICAL SPECIFICATION

13.1.00 GENERAL

Specific technical requirements of low-pressure piping, fittings, supports, valves, specialties and tanks etc. have been covered under this Sub-section. It includes details pertaining to design and material of construction for piping, fittings, valves, equipment, etc. cleaning/surface preparation application of primer and painting on over ground piping. It also includes detailed technical requirement of laying underground/buried piping including water proofing/anti corrosive protection. It also covers design, engineering, manufacturing, fabrication, technical details of piping, valves, specialties, piping hangers/supports, tanks etc.

13.2.00 Pipes and fittings

13.2.1 All low pressure piping systems shall be capable of withstanding the maximum pressure in the corresponding lines at the relevant temperatures. However, the minimum thickness as adhered to. The bidder shall furnish the pipe sizing / thickness calculation as per the criteria mentioned above under LP piping equipment sizing criteria of this Technical Specification.

13.2.2 Piping and fittings coming under the purview of IBR shall be designed satisfying the requirements of IBR as a minimum.

13.2.3 Supporting arrangement of piping systems shall be properly designed for systems where hydraulic shocks and pressure surges may arise in the system during operation. Bidder should provide necessary protective arrangement like anchor blocks/anchor bolt etc. for the safeguard of the piping systems under above mentioned conditions. The requirement will be, however, worked out by the contractor and he will submit the detailed drawings for thrust/anchor block to the Employer. External, and internal, attachments to piping shall be designed so as not to cause flattening of pipes and excessive localized bending stresses.

13.2.4 Bends, loops, off sets, expansion or flexible joints shall be used as required in order to prevent overstressing the piping system and to provide adequate flexibility. Flexibility analysis (using software packages such as Caesar-II etc.) shall be carried out for sufficiently long piping (straight run more than 300M).

13.2.5 Wherever Bidder's piping coming under this specification, terminates at an equipments or terminal point not included in this specification, the reaction and the thermal movement imposed by bidder's piping on equipment terminal point shall be within limits to be approved by the Employer.

13.2.6 The hot lines shall be supported with flexible connections to permit axial and lateral movements. Flexibility analysis shall be carried out for pipelines which have considerable straight run as indicated above and necessary loops/expansion joint etc. shall be provided as may be necessary depending on layout.

13.2.7 Piping and fittings shall be manufactured by an approved manufacturer of repute. They should be truly cylindrical of clear internal diameter, of uniform thickness, smooth and strong, free from dents, cracks and holes and other defects.

- 13.2.8 For rubber lined ERW pipes, beads shall be removed.
- 13.2.9 Inspection holes shall be provided at suitable locations for pipes 800 NB and above as required for periodic observations and inspection purposes.
- 13.2.10 At all intersection joints, it is Contractor's responsibility to design and provide suitable reinforcements as per the applicable codes and standards.
- 13.2.11 For large size pipes/duct, at high point and bends/change of direction of flow, air release valves shall be provided as dictated by the system requirement and operation philosophy & tripping conditions of pumping system. Sizing criteria for air release valves shall be generally on the basis of valve size to pipe diameter ratio of 1:8. Requirement shall be decided as per relevant code.

Transient analysis / surge analysis wherever specified and required shall be conducted in order to determine the location, number and size of the Air-Release valve on certain long distance/high volume piping systems such as CW/ ACW/ Raw Water etc.

13.3.00 Material

- 13.3.1 Alternate materials offered by Bidder against those specified shall either be equal to or superior to those specified, the responsibility for establishing equality or superiority of the alternate materials offered rests entirely with the Bidder and any standard code required for establishing the same shall be in English language.
- 13.3.2 No extra credit would be given to offers containing materials superior to those specified. Likewise no extra credit would be given to offers containing pipe thickness more than specified.
- 13.3.4 All materials shall be new and procured directly from the manufacturers. Materials procured from traders or stockiest are not acceptable.
- 13.3.5 All materials shall be certified by proper material test certificates. All material test certificates shall carry proper heat number or other acceptable reference to enable identification of the certificate that certifies the material.
- 13.3.6 Material of construction for pipes carrying various fluids shall be as follows:

1.	Circulating Water (CW) – CW Pumphouse to Condenser & Condenser to Cooling Tower	RCC DUCT WITH INSIDE PROTECTIVE COATING AS INDICATED IN VOLUME VI
2.	Circulating Water (CW) – Pump Discharge, condenser risers including header near condenser and cooling tower riser.	IS 3589 FABRICATED FROM IS 2062 PLATES –INTERNALLY LINED WITH CORROCOAT OR POLYUREA COATING OF 1500 MICRONS DFT /GRP/ FRP
3.	ACW	UPTO 150 NB - ASTM A 312 TP 316 L (ERW)/ DUPLEX SS 200 NB & ABOVE - ERW IS 1978 (OR) API5L (OR) IS 3589 FABRICATED FROM IS 2062- Internally lined with Corrocoat or polyureA Coating inside of 1500 microns DFT
4.	RO Stage I reject, RO Stage II	UPTO 150 NB - ASTM A 312 TP 316

	Reject, Guard pond inlet & discharge, Piping from Reject sump,. Ash water piping using sea water and all other sea water applications.	L (ERW)/ DUPLEX SS 200 NB & ABOVE - ERW IS 1978 (OR) API5L (OR) IS 3589 FABRICATED FROM IS 2062- Internally lined with Corrocoat or polyureA Coating inside of 1500 microns DFT/ GRP/ FRP
5.	Sea Water Intake Pipe, CT Make up, Make up upto clarifier & CT Blowdown Pipe	GRP
6.	RO Stage I Permeate, Filtered Water, service water, AHP Seal Water, HVAC Make up, Air Pre-Heater Wash water, Passivated DM Water and clarifier sludge.	IS-2062 Gr. B/ASTM-A-36/ASTM A-53 type 'E' Gr. B/IS-3589 Gr. 410/IS-1239 Heavy. 150 NB & above pipes shall be spiral welded.
7.	RO Stage II Permeate, Dematerialized water, (condenser Make up water, Boiler fill and Deaerator Fill water) & DMCW overhead tank make-up water	Stainless steel to ASTM A-312, Gr. 304 welded for sizes above 50mm NB Stainless steel to ASTM A312, Gr. 304 sch. 40 Seamless for sizes 50 mm and below
8.	Drinking water	ASTM A-53 type E Gr. B galvanized /IS 1239 heavy galvanized/IS 3589 Gr 410 Galvanized to SI-4736 or equivalent.
9.	Instrument air & plant air.	ASTM A-53 type E Gr. B galvanized /IS 1239 heavy galvanized/IS 3589 Gr 410 Galvanized to SI-4736 or equivalent.
10.	Fuel Oil piping	API5L
11.	HOSES FOR HFO TANKER HEATING (STEAM/ CONDENSATE)	CARBON STEEL – ELECTRO ZINC PLATED
12.	FUEL OIL UNLOADING LINES	IS1239 / IS1978 / API5L Gr.B (ERW) / IS3589 FABRICATED FROM IS 2062 PLATES
13.	FUEL OIL PUMP DISCHARGE LINES	ASTM A 106 GR B
14.	UF Feed/ Chemical Backwash (Upto 150 NB) (Pipes & Fittings)	CPVC ON 10 Sch 40
15.	UF Feed/ Chemical Backwash (> 150 NB)	GRP
16.	Sodium Hypochlorite (pipes & Fittings)	CPVC Sch 80 ASTM
17.	RO High pressuer Discharge (Pipes & Fittings)	Dupless SS
18.	Cleaning Solution Line (Pipes & Fittings)	CPVC ON 10 Sch 40

13.3.7

In water lines, pipes upto 150 mm NB shall conform to ANSI B36.10/ASTM-A-53, Type-E Gr. B/IS:1239 Gr. Heavy and minimum selected thickness shall not be

less than IS: 1239 Grade heavy except for dematerialized water and condensate spill lines.

- 13.3.9 Pipes of above 150 mm NB shall be to AWWA-C200/ANSI B 36.10/ASTM A-53/IS 3589 Gr. 410. Pipe to be fabricated by the bidder shall be rolled and butt welded from plates conforming to ASTM A-53 type 'E' Gr. B/IS 2062 Gr. B/ASTM-A-36. However, larger pipes, i.e. 1000 mm NB and above shall be made from plates conforming to ASTM A 36/IS 2062 Gr. B and shall meet the requirements of AWWA-M-11(for deflection & buckling criteria considering water filled pipe as well as vacuum condition that may prevail during transient/ surge conditions, truck-load, rail-load and weight density for compacted soil or any other load as the case may be).
- 13.3.10 In dematerialized water service, the pipes upto 50 NB shall be of stainless steel ASTM A 312, Gr. 304 sch. 40 Seamless. The size for these pipes shall be to ANSI B 36.19. These shall be socket welded. The material for pipe from 65 mm NB upto and including 400 NB shall be to ASTM A 312, Gr. 304 (welded). In no case the thickness of fittings shall be less than parent pipe thickness.
- 13.3.11 Bidder/Contractor shall note that pipes offered as per a particular code shall conform to that code in all respects i.e. Dimension, tolerances, manufacturing methods, material, heat treatment, testing requirements, etc. unless otherwise mentioned elsewhere in the specification.
- 13.3.12 Instrument air, Plant (service) air lines and Drinking water lines shall be to ASTM A 53 type E grade B/ANSI B 36. 10/IS 3589, Gr. 410/IS: 1239 Heavy (in case thickness calculated is more than gr. Heavy, ANSI B 36.10 Schedule numbers shall be followed) and galvanized to IS 4736 or any equivalent internationally reputed standard. The material of the pipes shall be to ASTM A 53 type 'E' Gr. B/IS: 3589, Gr. 410/IS: 1239 Gr. Heavy. The fittings shall be of either same as parent material or malleable iron to IS-1879 (galvanized).
- 13.3.13 Spiral welded pipes as per API-5L/IS-3589 are also acceptable for pipe of size above 150 NB. However minimum thickness of the pipes shall be as elaborated in above clauses.
- 13.3.14 Condensate lines shall be to ASTM A 106 Gr. B and dimension to ANSI B 36.10 schedule "standard" as minimum to be maintained.
- 13.3.15 If carbon steel plates of thickness more than 12 mm are used for manufacture of pipes, fittings and other appurtenances, then the same shall be control-cooled or normalized as the case may be following the guidelines of the governing code.

13.4.0 Piping Wall Thickness

- 13.4.1 The calculation of wall thickness required for pipelines subject to internal and/or external pressure shall be based on the formulae and recommendations as given in the applicable codes. Adequate allowances shall be made towards thinning due to bending, weakening at branch connections, threading, commercial tolerances on pipe wall thickness, corrosion and erosion, etc., and the same shall be subject to approval by Purchaser. In any case a minimum corrosion allowance of 1.0 mm shall be considered while selecting the thickness.
- 13.4.2 In case of carbon steel materials, the nominal wall thickness of pipeline shall not be less than the minimum acceptable values given below:

NB mm (inch)	15 (1/2)	30 (3/4)	25 (1)	32 (1¼)	40 (1.5)	50 (2)	65 (2.5)	80 (3)	100 (4)	125 (5)
Min. thickness, mm	3.2	3.2	3.6	3.6	3.6	3.6	3.6	4.0	4.5	5.4
NB mm (inch)	150 (6)	200 (8)	250 (10)	300 (12)	350 (14)	400 (16)	450 (18)	500 (20)	600 (24)	
Min. thickness, mm	5.4	6.35	6.35	6.35	7.1	7.1	7.1	8.0	8.0	

> NB 600 mm to NB 900 mm	-	8.0 mm
> NB 900 mm to NB 1200 mm	-	10.0 mm
> NB 1200 mm to 1400 mm	-	12.0 mm
> NB 1400 mm to 1600 mm	-	14.0 mm
> NB 1600 mm to NB 2200 mm	-	16.0 mm
> NB 2200 mm	-	18.0 mm

13.5.00 Piping Layout

- 13.5.1 Piping shall be grouped together where practicable and routed to present a neat appearance.
- 13.5.2 Piping routing shall be such as to provide sufficient clearance for removal and maintenance of equipment, easy access to valves, instruments and other accessories. The piping shall not encroach on the withdrawal space of various equipments.
- 13.5.3 Over head piping shall have a normal minimum vertical clearance of 2.5 meters above walkways and working areas and 8 m above roadways/railways. When several pipelines are laid parallel, flanged joints must be staggered. Welded and flanged joints should as far as possible be located at one third span from supports. If the support is situated right under the welded joints this joint must be reinforced with a strap. Flanged and welded joints must be avoided in the middle of the span. Valves should be located in such a manner so as to ensure their convenient operation from the floor or the nearest platform.
- 13.5.4 Pipelines of NB 50 size and below are regarded as field run piping. It is Bidder's responsibility to plan suitable layouts for these system insitu. Bidder shall prepare drawings indicating the layout of field run pipe work. These drawings shall be approved by Project Manager to the installation of the field run pipe work. Based on these approved layouts the Bidder shall prepare the BOQ of field run-pipe and submit to Employer for approval.
- 13.5.5 All piping shall be routed so as to avoid interference with other pipes and their hangers and supports, electrical cable trays, ventilation ducting, structural members, equipment etc.
- 13.5.6 Adequate clearance shall be ensured with respect to the above to accommodate insulation and pipe movements, if any.
- 13.5.7 Piping shall generally be routed above ground but where specifically indicated / approved by the project Manager the pipes may be arranged in trenches or buried. Pipes at working temperature above the ambient shall however not be buried.

13.5.8 Sufficient up stream and down stream lengths shall be provided for flow measuring devices, control valves and other specialties.

13.5.9 All local instruments shall be located on pipelines as to render them observable from the nearest available platforms.

13.5.10 Openings provided in the wall for pipelines must be closed with bricks and mortar with 10-12 mm clearance between brick work and pipe after taking care of insulation and thermal movement, if any. The clear space must be filled with felt or asbestos or approved filling compound.

13.6.00 Slope/Drains and Vents

13.6.1 Suitable slope shall be provided for all pipelines towards drain points. It is Bidder responsibility to identify the requirements of drains and vents, and supply the necessary pipe work, valves, fittings, hangers and supports etc. As per the system requirement low points in the pipelines shall be provided with suitable draining arrangement and high points shall be provided with vent connections where air or gas pockets may occur. Vent shall not be less than 15 mm size. Drains shall be provided at low points and at pockets in piping such that complete drainage of all systems is possible. Drain shall not be less than 15 mm for line size up to 150 mm, not less than 20 mm up to 300 mm and not less than 25 mm for 350 mm to 600 mm pipes and not less than 50 mm for 600 mm and above pipes.

13.6.2 Air piping shall be sloped so that any part of the system can be drained through the shut-off drain valve or drain plugs.

13.7.0 Pipe Joints

In general all water lines 65 mm NB and above, are to be joined generally by butt welding except the locations where valves/fittings are to be installed with flanged connections and 50 mm and below by socket welding unless mentioned otherwise specifically. All air lines shall be of screwed connection and rubber lined pipes of flanged connections.

13.7.1 Screwed

- (a) Threading of pipes shall be carried out after bending, heat treatment etc. If not possible, threading may be done prior to these operations but proper care should be taken to protect them from damage. Threads shall be to ANSI B 2.1 (taper) NPT/IS:554 unless specified otherwise.
- (b) Galvanized pipe shall generally be joined by screwing into sockets. The exposed threaded portion on the outside of the pipes shall be given a zinc silicate coating. Galvanized pipes shall not be joined by welding. Screwed ends of GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead before jointing. For galvanized pipe sizes above 150 mm NB, screw & socket jointing as per ASTM-A-865 shall be employed for both pipe-to-pipe and pipe-to-fitting jointing. For pipe to fitting connection since no direct threading can be done on the fittings (supplied as per ASTM-A-234 Gr. WPB and ANSI B-16.9) necessary straight pipe lengths acting as match pieces shall be welded to the fitting at both ends and subsequently the free ends of the straight lengths shall be threaded as per ASTM A-865 for jointing with main pipe. Once welding of fittings with match pieces and threading of free ends of match pieces are over, the entire fabricated piece shall be galvanized, or in case match pipes and fittings are already galvanized before the above mentioned fabrication then

suitable application of Zinc-Silicate paste adequately at the welded surface (both in side & out side) after welding with zinc rich electrode, alongwith the nascent threaded metal portion at both free ends given the same application of Zinc Silicate paste. Alternatively flanged jointing may be employed for pipe sizes 100 NB and above. However, the bidder shall ensure the galvanized pipe joints do not fail during hydro test.

- (c) Teflon tapes shall be used to seal out screwed joints and shall be applied to the male threads only. Threaded parts shall be wiped clean of oil or grease with appropriate solvent if necessary and allowing proper time for drying before applying the sealant. Pipe ends shall be reamed and all chips shall be removed. Screwed flanges shall be attached by screwing the pipe through the flange and the pipe and flange shall be refaced accurately.
- (d) For pipe sizes from 350 mm NB to 550 mm NB (including 350 NB & 550 NB) the GI pipes shall be of flanged connection. However, the pipes after welding of flanges shall be completely galvanized. Any site welding done on galvanized pipes shall be done with zinc-rich special electrodes and the welded surfaces whether inside or outside shall be coated with zinc-silicate pasts. Seal welding of flanges with zinc-rich electrode will be permitted only when any flange is leak-prone during hydro testing.
- (e) For pipe sizes 600 mm NB and above, the GI pipes shall be of welded connection (with zinc-rich special electrodes) followed by application of zinc silicate coating at welded surfaces both inside and outside the pipe, except for the last blank/blind flange, or, equipment connection where application of zinc-silicate paste after welding cannot be done due to inaccessibility of the inside welded surface and where galvanic protection has been impaired due to welding of pipe-to-pipe joint. Thus the last erection joint shall be flanged joint.

13.7.2 Welded

- (a) For making up welded joints (butt weld or socket weld) the welding shall be performed by manual shielded metal arc process in accordance with the requirements specified elsewhere in the spec. Any welder employed for carrying butt welding shall be qualified as per ASME section IX for the type of joints he is going to weld. Jointing by butt weld, or socket weld shall depend upon the respective piping material specifications.

13.7.3 Flanged

- (a) Flanged connections for pipes are to be kept to the minimum and used only for connections to vessel, equipments, flanged valves and other fittings like strainer/traps/orifices etc. for ease of connection and maintenance etc. Rubber lined pipes shall be flange joined only.
- (b) All flanged valves intended for installation on steel piping system, shall have their flanges drilled to ANSI B 16.5 (or equivalent) and according to the pressure class stated in their respective piping material specification.
- (c) Drilling on flanges of flanged valves must correspond to the drilling of flanges on the piping system on which the valves are installed.

13.8.00 Bends/elbows/mitre bends/Tees/Reducers & other fittings

- 13.8.1 Unless otherwise specified elbows shall be of long radius type.
- 13.8.2 For pipe sizes up to 65 Nb, long radius forged elbows or seamless pipe bends shall be used. Pipe bends, if used, shall be cold bent to a radius measured to the centre line of pipe of 3 to 5 times the pipe diameter.
- 13.8.3 For steel pipes 80 Nb and above, seamless long radius forged elbows shall be used. For pipe size 250 Nb and above mitre bends may be used for all pipes except rubber lined pipes. The bend radius shall be $1\frac{1}{2}$ times the nominal pipe diameter. 90 deg. Bends (mitre) shall be in 4 pieces (3 cuts) and 45 deg. mitre bends shall be in 3 pieces $22\frac{1}{2}$ deg. Fabrication of mitre bends shall be as detailed in BS 2633/BS534.
- 13.8.4 Mitre bends are not acceptable in case of rubber lined mild steel pipes.
- 13.8.5 For pipe fittings such as reducers and tees, the material shall be to ASTM-A-234 gr. WPB up to 300 NB. For pipe reducers and tees above 300 NB, the fittings may be fabricated conforming to parent pipe material. Provision of compensation pads shall be kept as per ANSI B 31.1. The fittings shall conform to the dimensional standard of ANSI B-16.9.
- However, for pipes up to 150 NB, pipe fittings may be supplied with material and dimension conforming to IS 1239 in case parent pipes also conform to IS 1239.
- For pipes, above 1200 NB, reducer and tees shall be to dimensional standard of AWWA-C-208.
- 13.8.6 Stainless steel fittings shall conform to either ASTM-A-182, Gr. 304 (316 for Sea water application, if any) or ASTM-A-403, Gr. WP 304 (316 for Sea Water application, if any) Class-S, for sizes up to and including 50 mm NB, i.e. the fitting shall be of seamless construction.
- However, for stainless steel fittings above 50mm NB, the same shall conform to ASTM-A-403, Gr. WP 304 (316 for Sea water application, if any), Class W i.e. the fittings shall be of welded construction strictly in accordance with ASTM-A-403.
- 13.8.7 In no case, the thickness of fittings shall be less than the thickness of parent pipe, irrespective of material of construction.
- 13.9.00 Flanges**
- 13.9.1 Flanges shall be slip on type. Welding of flanges in tension is not permitted.
- 13.9.2 All flanges and flanged drilling shall be to ANSI B 16.5/BS EN-1092 of relevant pressure/temperature class. Flanges shall be fabricated from steel plates conforming to ASTM A 105/IS 2062 Gr. B. However stainless steel flanges shall be fabricated from SS plates to ASTM-A-240, Gr. 304 (316 for Sea water application, if any) or equivalent. For all Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water (Sea water) etc flanges & bolts & nuts shall be SS 316 L construction.
- 13.10.00 Specific technical requirement of laying buried pipe with anti corrosive treatment**

The pipe in general shall be laid with the top of the pipe minimum 1.0 (one) meter below finished general ground level.

13.10.1 Trenching

- (a) The trench shall be cut true to the line and level and shall follow the gradient of the pipeline. The width of the trench shall be sufficient to give free working space on each side of the pipe. Trenches shall conform to IS 5822.
- (b) Free access shall be provided for the welding of the circumferential joints by increasing the width and depth of the trench at these points. There should be no obstruction to the welder from any side so that good welded joint is obtained.
- (c) The free working space shall conform to IS: 5822. The trench shall be excavated so as to provide minimum cover of 1000 mm between the top of the pipe and finished grade.
- (d) Prior to lowering and laying pipe in any trench, the bidder shall backfill and compact the bottom of the trench or excavation in accordance with IS: 5822 to provide an acceptable bed for placing the pipe.
- (e) Coating and Wrapping shall be done as under.

13.10.2 Preparation and cleaning of piping

- (a) The pipeline shall be thoroughly cleaned of all rust, grease, dirt, weld scales and weld burrs etc. moisture or other foreign matter by power cleaning method such as sand blasting, power tool cleaning, etc. Grease or heavy oil shall be removed by washing with a volatile solvent such as gasoline. Kerosene will not be permitted for cleaning. This cleaning operation shall be immediately followed by priming with the mechanical priming machine.
- (b) Certain inaccessible portions of the pipeline (which otherwise not possible to be cleaned by power cleaning methods) may be scrubbed manually with a stiff wire brush and scrapped where necessary with specific permission of the Project Manager.
- (c) The cleaning and priming operation shall be carried out at site. The entire pipe length shall be cleaned but the ends of the pipes shall be left without coating for a distance of 230 mm for joints, which shall be coating manually at site after laying, welding and testing the pipe.

13.10.4 Trench bed preparation and back filling

Prior to lowering and laying pipe in any excavated trench, the bottom of the trench may require to be back filled and compacted (or as the case may be) to provide an acceptable bed for placing the pipe. Bed preparation in general shall be as per IS: 5822.

13.10.5 Laying of galvanized steel (GI) pipes

All the joints shall be screwed with socket or flanged. Screwed ends of GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead before

jointing Threaded portion on either side of the socket joints shall be applied with Zinc silicate paste.

All the provisions for trenching' bed preparation' laying the pipe application of primer' coating' wrapping with tapes and back filling etc. as indicated for "laying of buried piping" and "anti corrosive protection for buried piping" are applicable for buried galvanized steel (GI) pipes also.

13.11.00 Cleaning and Flushing

13.11.1 All piping shall be cleaned by the Bidder before and after erection to remove grease, dirt, dust, scale and welding slag.

13.11.2 Before erection all pipe work, assemblies, sub-assemblies, fittings, and components, etc. shall be thoroughly cleaned internally and externally by blast cleaning or by power driven wire brushes and followed by air-blowing. The brushes shall be of the same or similar material as the metal being cleaned. Cleaning of Galvanized pipes shall be done in such a manner that the coating on MS pipe is not affected.

13.11.3 After erection, all water lines shall be 1.2-1.5 times the operating velocities in the pipelines.

13.11.4 All compressed air pipe work shall be cleaned by blowing compressed air.

13.12.00 Painting of Pipes

13.12.1 Buried Piping

Internal surfaces

- (i) Surface cleaning by sand blasting.
- (ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.
- (iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 150 microns.

Tests to be carried out after application : Bond/ Adhesion test, Holiday test

External surfaces

- (i) Surface cleaning by Sand Blasting.
- (ii) Coal tar primer compatible with coal tar enamel grade. The number of coats shall be two with a DFT of 35 microns each.
- (iii) Coal tar enamel shall be applied. A single spiral inner wrap of glass fibre tissues shall be applied overlapping at least 25 mm ensuring impregnation of glass fibre tissues in the first coat. The second coat of enamel and second outer wrap of glass fibre felt, Type – I to IS: 7193-1974 will be applied in the same way confirming to Table – 10 of IS – 10221 – 1982.

The total thickness of the coating will not be less than 4.0 mm

- (iv) Alternatively Wrapping with coal tar based anticorrosion tape conforming to IS 15337: 2003 is also acceptable in lieu of s.no. (iii) above. Wrapping thickness shall be 4.0 mm.

Tests to be carried out after application : Bond/ Adhesion test, Holiday test

13.12.2 Overground Piping

Internal surfaces

- (i) Surface cleaning by sand blasting.
- (ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.
- (iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 150 microns.

External surfaces

- (i) Surface cleaning by Sand Blasting.
- (ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.
- (iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

13.12.3 Other requirements

- (a) Paint manufacturers instructions shall be followed in method of application, handling, drying time etc.
- (b) The color of the finish paint shall be as per approved color-coding.
- (c) If finish paint was applied in shop, one coat of finish paint shall be applied at site.
- (d) The dry film thickness of paint shall not be less than 0.15 mm.

13.12.4 Color code for identification

The pipes shall be color painted/banded for identification as per the approved color-coding scheme and shall be generally as per IS-9404.

13.13.00 Specification for hangers and supports

13.13.1 All supports and parts shall conform to the requirement of power piping code ANSI B 31.1 or approved equivalent.

13.13.2 While designing supports for rubber lined pipes special consideration should be given. Any kind of welding on these pipes is not allowed after rubber lining.

- 13.13.3 Hanger for piping 65 mm Nb and larger and all spring support assemblies regardless of size shall be completely engineered in conformance with the provisions of power piping code ANSI B 31.1.
- 13.13.4 Hangers, saddles, supports etc. shall be fabricated from plates/pipes sections conforming to ASTM A 53/IS: 2062/IS:226/ or equivalent. They shall be designed to provide the required supporting effects and allow pipeline movements as necessary. The structural steel work shall be as per IS: 800/BS:4360. Insulation protection saddles shall be used at support point of all insulated piping.
- 13.13.5 The support shall be so interspaced as to minimize sagging of the pipes and to keep them within permissible limits where pipes are full with the conveying media.
- 13.13.6 The maximum spans of the supports of straight length shall not exceed the recommended values indicated in ANSI B 31.1.
- 13.13.7 All pipe supports shall be designed to provide an absolute minimum head room of 2.5 m from floor in passages/walkways.
- 13.13.8 At all sliding surfaces of supports suitable arrangement is to be provided to minimize sliding friction.
- 13.13.9 All components of hangers/support shall be provided with two coats of primer (red oxide paint) at shop before dispatch to site. After erection they shall be given finish coat of Long Oil Synthetic enamel to IS: 2932 of total DFT 100 to 140 microns. CLH & VLH will be primed with Epoxy Zinc rich primer of 50 micron followed by finish painting of Aliphatic Acrylic Polyurethane or equivalent of DFT 65 microns.
- 13.14.00 Design/Construction/Material Particulars of Gate/Globe/Check Valves/Globe Stop Valve/Butterfly Valve**
- 13.14.1 GENERAL**
- (a) All valves shall be suitable for the service conditions i.e. flow, temperature and pressure, at which they are required to operate.
 - (b) The valves as well as all accessories shall be designed for easy disassembly and maintenance.
 - (c) Valves to be installed outside shall be required to have the stem properly protected against atmospheric corrosion.
 - (d) All rising stem valves shall be provided with back seat to permit repacking (of glands) with valves in operation. All valves shall preferably be of outside screw and yoke type.
 - (e) All valves shall be closed by rotating the hand wheel in the clockwise direction when looking at the face of the hand wheel. In case where the hand wheel is not directly attached to the valve spindle suitable gearing shall be introduced.
 - (f) All valves shall have indicators or direction clearly marked on the hand-wheel so that the valves opening/closing can be readily determined.
 - (g) Special attention shall be given to operating mechanism for large size valves with a view to obtaining quick and easy operation ensuring that a

- minimum of maintenance is required. For valves of size 350 mm and above either bevel or spur gearing shall be provided to facilitate manual operation.
- (h) The valves coming in vacuum lines shall be of extended gland type and / or water sealed.
 - (i) The actuator-operated valves shall be designed on the basis of the following:
 - (1) The internal parts shall be suitable to support the pressure caused by the actuators.
 - (2) The valve-actuator unit shall be suitably stiff so as not to cause vibrations, misalignments, etc.
 - (3) All actuator-operated valves shall be provided with hand operated gearing mechanism also.
 - (4) All actuators operated valves shall open/close fully within time required by the process.
 - (j) Valves coming under the purview of IBR shall meet IBR requirements.
 - (k) Gate/sluice valves shall be used for isolation of flow. Gate valves shall be provided with the following accessories in addition to other standard items:
 - (1) Hand wheel
 - (2) Position indicator (for above 50 mm NB valve size)
 - (3) Draining arrangement wherever required.
 - (l) Globe valves shall be used for regulation purposes. They shall be provided with hand wheel, position indicator, draining arrangement (wherever required) and arrow indicating flow direction.
 - (m) Check valves shall be used for non-return service. They shall be swing check type or double door (Dual plate) check type with a permanent arrow inscription on the valve body indicating the fluid flow direction. In long distance pipes lines with possibility of surge-occurrence, dual plate check valves are preferable for its spring controlled opening/closing of flaps/doors against flow reversals. However, dual plate check valves shall not be used for sizes more than 600 mm NB.
 - (n) All gate and globe valves shall be provided with back seating arrangement to enable on line changing of gland packing.
 - (o) All gate and globe valves shall be rising stem type and shall have limit switches for full OPEN and full CLOSED indication wherever required. This will include motor-operated valves also wherever required. In such cases the limit switches shall form an integral part of the valve. Stop-gap arrangement in this respect is not acceptable.
 - (p) All valves shall be provided with embossed name plate giving details such as tag number, type, size etc.

- (q) Wherever required valves shall be provided with chain operator, extension spindles and floor stands or any other arrangement approved by employer so that they can be operated with ease from the nearest operating floor. Wherever necessary for safety purpose locking device shall be provided. Further, necessary small platforms for facilitating easy valve operation shall be provided by the contractor wherever necessary in consultation with project manager within the bid price at no extra cost to employer.
- (r) All valves except those with rising stems shall be provided with continuous mechanical position indicator; rising stem valves shall have only visual indication through plastic/metallic stem cover for sizes above 50 mm nominal bore.
- (s) For CI gate, globe and check valves wherever thickness of body/bonnet is not mentioned in the valves standards, thickness mentioned in IS-1538 for fitting shall be applicable.

13.14.2 VALVE BODY MATERIAL

Valve body material for various services shall be as follows:

Valve body material for water application like DM Cooling Water (Passivated DM Water) (DMCW), RO Stage I Permeate, AHP Seal Water, APH/ ESP Wash, Service Water, Potable Water, HVAC Make UP shall be cast iron for sizes 65 NB and above; gun-metal/ Forged Carbon Steel for sizes 50 NB and below.

Valve body material for sea water application like Circulating Water. Auxiliary Cooling water, Blowdown, CT make up, sea water Intake, Guard pond inlet & Discharge, Ash Water using sea water, RO Stage II reject, RO Stage I reject, Reject Sump discharge and all other sea water applications shall be SS 316 L for all sizes.

For compressed air application, valve body material shall be cast carbon steel or forged carbon steel for sizes 65 mm NB & above and Gun metal for sizes 50 NB and below.

DM water: SS body and disc alongwith SS internals.

Condensate: Cast Carbon Steel/Forged Carbon Steel.

- 13.14.2.1 The design, material, construction, manufacture, inspection, testing and performance of valves shall comply with all currently applicable statutes, regulations and safety codes in the locality where the valves will be installed. The valves shall conform to the latest editions of applicable codes and standards as mentioned elsewhere. Nothing in this specification shall be construed to relieve the Bidder of his responsibility. Valves in general shall conform to the requirements of the following standards.

Standards and Codes

AWWA-C-504	Rubber seated butterfly valves
BS-5155/EN-593	Cast iron and steel body butterfly valves for general purpose.
IS-778	Gun-metal gate, globe and check valves for general purpose.

BS-5154	Copper alloy globe/globe stop and check and gate valves for general purpose.
IS-780	Sluice valves for water works purpose (50-300 mm size)
IS-2906	Sluice valves for water works purpose (350-1200 mm size)
IS-5150	Cast iron wedge and double disc gate for general purpose.
BS-5152	Specification for cast iron globe valves
BS-5153	Cast iron check valves for general purpose.
IS-5312	Swing check type reflux (non-return) valves
ANSI B 16.34	Standard for valves
API-594	Standard for Dual-check valves
API-600	Steel gate valves
ANSI-B-16.10	Valves face to face and other relevant dimension
API-598	Valves inspection test

13.14.2.2 End Connections

The end connections, shall comply with the following:

Socket welding (SW) – ANSI B 16.11

Butt Welding (BW) – ANSI B 16.25

Threaded (SC) – ANSI B 2.1

Flanged (FL) – ANSI B 16.5 & AWWA-C-207 (steel flanges), ANSI B 16.1 (Cast Iron flanges)

- 13.14.2.3 All cast iron body valves (gate, globe and non-return) shall have flanged end connections; (screwed ends for Ductile D.2NI body valves are not acceptable).
- 13.14.2.4 All steel and stainless steel body valves of sizes 65 mm and above shall have flanged or butt welding ends. Valves of sizes below 65mm shall have flanged or socket welded ends. Compatibility of welding between valve body material and connecting pipe material is a pre-requisite in case of butt-welded joints.
- 13.14.2.5 All gun metal body valves shall have screwed ends.
- 13.14.2.6 All flanged end valves/specialties shall be furnished alongwith matching counter flanges, fasteners, gaskets etc. as required to complete the joints

13.15.00 Check Valves

13.15.1 Check valves shall comply with the following characteristics:

- (a) For bore greater than 2" the valves must be swing check type or dual plate check type suitable for installation in all positions (vertical and horizontal);
- (b) For bore smaller than or equal to 2" the valves must be of the piston type to be installed, in horizontal position.
- (c) In the case of swing check valves, the body seat shall be inclined at such an angle from the vertical as will facilitate closing and prevent chatter.

13.15.2 Drilling on flanges of flanged valves must correspond to the drilling on flanges of the piping system on which the valves are to be installed.

13.15.3 All flanged valves intended for installation in steel piping systems shall have their flanges drilled to ANSI B 16.5 (or equivalent) and according to the pressure class.

13.15.4 Counter flanges to be installed on air pipes shall be screwed-on type irrespective of size.

13.16.00 Globe Valves

13.16.1 The globe valves shall have the following characteristics;

Straight conveyed flow

Right angle

Preferably, the valves shall be of the vertical stem type.

13.16.2 Globe valves shall preferably have radiused or spherical seating and discs shall be free to revolve on the spindle.

13.16.3 The pressure shall preferably be under the disc of the valve. However, globe valves, with pressure over the disc shall also be accepted provided (i) no possibility exists that flow from above the disc can remove either the disc from stem or component from disc (ii) manual globe valves can easily be operated by hand. If the fluid load on the top of the disc is higher than 40-60 KN, bypass valve shall be provided which permits the downstream system to be pressurized before the globe valve is opened.

13.16.4 For the regulating valves, valves with regulating plug & parabolic outline disc type is preferred.

13.16.5 All motorized globe valves with regulating plug for which indication of percentage (%) opening are required in the control room shall be provided with necessary position transmitter.

13.17.00 Gate valves

All gate valves shall be of the full-way type, and when in the full open position the bore of the valve shall not be constricted by any part of the gate.

Gate valves shall be of the solid/elastic or articulated wedge disc and rising stem type.

13.18.00 Air Release Valve

- (a) The air release valves shall be of automatic double air valve with two orifices and two floats. The float shall not close the valve at higher air velocities. The orifice contact joint with the float shall be leak tight joint.
- (b) The valve shall efficiently discharge the displaced air automatically from ducts/pipes while filling them and admit air automatically into the ducts/pipes while they are being emptied. The valve shall also automatically release trapped air from ducts/pipes during operation at the normal working pressure.
- (c) Body material of automatic air release valves shall comply generally with BS 1452 Gr. 14/IS:210 Gr. FG 260 and spindle shall conform to high tensile brass.
- (d) Air release valves shall not have any integral isolation device within them. Each Air release valve shall be mounted, preceded by a separate isolation gate/butterfly valve.

13.19.00 Butterfly Valves

13.19.1 Design/Construction

- (a) The valves shall be designed for the design pressure/temperature of the system on which it is installed and in accordance with AWWA-C-504, EN-593 or any other approved equivalent standard latest edition. Fabricated steel (IS: 2062 GR. B) butterfly valves instead of cast iron body valves are also acceptable for size above 300 mm nb diameter. In such a case, however, the bidder will have to necessarily submit thickness calculations, in order to establish the integrity of the fabricated valve body under the system operating pressure condition.
 - (1) The valves shall be suitable for installation in any position (horizontal/vertical etc.) and shall be generally of double-flanged construction. However for sizes 600 NB and below the valves of Wafer construction are also acceptable.
 - (2) The seals, both on the body (sleeve) and on the disc shall be of the material specified. Necessary shaft seal shall be provided and adequately designed to ensure no leakage across the seal. This seal shall be designed so that they will allow replacement without removal of the valve shaft. The sealing ring on the disk shall be continuous type and easily replaceable.
 - (3) For all types of valves, the design with shaft eccentric to the disc is preferred. The shaft shall be solid type and shall pivot on bushings. Bushings/sleeve type bearings shall be contained in the hub of valve body. The bearing shall be self-lubricated type with low coefficient of friction and should not have any harmful effect on water and on valve components.
 - (4) The design of the shaft shall be such that it will safely sustain maximum differential pressure across the closed valve. The shaft

and any key (taper pin etc.) for transmitting the torque between shaft and disc shall be capable of withstanding the maximum torque required to operate the valve. However, the shaft diameter shall not be less than the minimum shaft diameter specified in relevant code. Necessary Torque Calculation and the torque class selected on the basis of the same shall be furnished to the Employer for information.

- (5) The disc shall rotate from the full open to the tight shut position. The disc shall be contoured to ensure the least possible resistance to flow and shall be suitable for throttling operation. While the disc is in the throttled position, valve shall not create any noise or vibration.

- (6) The operating mechanism shall be mounted directly on or supported from the valve body.

- (7) All valves shall be complete with:

Position indicator (located in a visible place)

Arrow indicating the flow direction;

Adjustable mechanical stop limiting devices to prevent over

Travel of valve disc in open/close position.

All valves shall be "tight shut off"

- (8) Hand operated valves shall have the following

Local hand controls

The hand controls shall close the valve with clockwise rotation.

The hand controls shall be dimensioned to guarantee an easy maneuver under most severe conditions.

The hand controls shall be provided with locking systems suitable to avoid the disc assuming a non-desirable position during the operation.

Hand wheel shall be made of malleable iron with arms and rims of adequate strength. The hand wheel of diameters 300 mm or less shall be provided with handles for ease of operation. The pulling force required on the hand wheel rim shall not exceed 25 Kgf when operating the valve under full flow and operating pressure.

Valves-350 Nb and above shall have pressure equalizing bypass valves, wherever system parameters warrant the same.

Valves-350 Nb and above shall also be provided with gear operator arrangement suitable for manual operation. Manual operation of valve shall be through worm and gear arrangement having totally enclosed gearing with hand wheel diameter and gear ratio designed to meet the required operating torque. It shall be designed to hold the valve disc in intermediate position between full open and full closed position without creeping or fluttering.

Adjustable stops shall be provided to prevent over travel in either direction.

Limit and torque switches (if applicable) shall be enclosed in water tight enclosures alongwith suitable space heaters for motor actuated valves, which may be either for On-Off operation or inching operation with position transmitter.

13.19.2 Material of Construction (Butterfly Valves)

Materials and other design details shall be as indicated below:

(a) Cast Iron Butterfly valves

Body & Disc	ASTM A48, Gr. 40 with 2% Ni/ IS: 210. Gr. FG-260, with 2% Ni and epoxy coated
Shaft	BS 970 431 S: 291/EN 57, or AISI-410 or AWWA-permitted shaft material equivalent to EN-57/AISI-410 or better.
Seat ring	18-8 Stainless steel
Seal	Nitrile Rubber
Companion Flanges	IS 2062
External hardware	SS 316
Internal hardware	SS 316

(b) Duplex Stainless Steel Butterfly valves (All Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water (Sea water) etc.)

Body & Disc	SS 316 L
Shaft	SS 316 L.
Seat ring	SS 316 L
Seal	Nitrile Rubber
Companion Flanges	SS 316 L
External hardware	SS 316 L
Internal hardware	SS 316 L

(c) Stainless Steel Butterfly Valves

Body & Disc	ASTM A 351, Gr. CF8M/ASTM-A-182-Gr. 304

Shaft	ASTM A 182, Gr. 316/ASTM-A-479 Gr. 316/Equivalent
Disc & Seat Rings	EPT/BUNA-N/Neoprene
Companion Flanges	SS 304
External hardware	SS 316
Internal hardware	SS 316

(d) Carbon Steel Butterfly Valves

Body & Disc	ASTM A 216, Gr. WCB
Shaft	ASTM A 182, Gr. 304/ASTM-A-479 Gr. 304/Equivalent
Disc & Seat Rings	EPT/BUNA-N/Neoprene
Companion Flanges	IS 2062
External hardware	SS 316
Internal hardware	SS 316

13.19.3 Proof of Design Test (Type Test) for Butterfly Valves

Proof of Design (POD) test certificates shall be furnished by the bidder for all applicable size-ranges and classes of Butterfly valves supplied by him, in the absence of which actual POD test shall be conducted by the bidder in the presence of Employer's representative.

All valves that are designed and manufactured as per AWWA-C-504 shall be governed by the relevant clauses of POD test in AWWA-C-504. For Butterfly valves designed and manufactured to EN-593 or equivalent, the POD test methods and procedures shall generally follow the guidelines of AWWA-C-504 in all respect except that Body & seat hydro test and disc-strength test shall be conducted at the pressures specified in EN-593 or the applicable code. Actuators shall also meet requirements of POD test of AWWA-C-504.

13.20.00 MATERIAL OF CONSTRUCTION (GATE/GLOBE/CHECK VALVE)

(a) The materials shall generally comply with the following:

(1) Cast Steel Valves	
Body & bonnet	ASTM A 216 Gr. WCB/ ASTM A 105
Disc for non-return Valves	ASTM A 216 Gr. WCB/ ASTM A 105
Trim.	ASTM A 182 Gr. F6 or Equivalent
Companion Flanges	IS 2062
External hardware	SS 316

	Internal hardware	SS 316
(2)	Stainless Steel Valves	
	Body & Bonnet	ASTM A 351 Gr. CF 8M/ ASTM A 182 Gr. 304
	Disc	-do-
	Trim.	ASTM 182 Gr. F. 316 /ASTM-A-479 Gr. 316 or Integral with body
	Companion Flanges	SS 304
	External hardware	SS 316
	Internal hardware	SS 316
(3)	Cast Iron Valves	
	Body & bonnet 260	BS 1452 Gr. 14/IS-210 Gr. FG
	Seating surfaces and rings	13% chromium steel/13% Chrome overlay
	Disc for non-return valves	BS 1452 Gr. 14/IS-210 Gr FG 260
	Hinge pin for non-return valves	AISI 316
	Stem for gate globe valves	13% chromium steel or Equivalent
	Back Seat	13% chromium steel / 13% Chrome overlay
	Companion Flanges	IS 2062
	External hardware	SS 316
	Internal hardware	SS 316
(4)	Gun Metal Valves	
	Body and bonnet	IS 318 Gr. 2/Equivalent Standard
	Trim	-do-
	Companion Flanges	IS 2062
	External hardware	SS 316
	Internal hardware	SS 316
(5)	Duplex Stainless Steel (All Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water etc)	

Body & bonnet	SS 316 L
Disc for non-return	SS 316 L
Stem	SS 316L
Trim.	SS 316 L
Companion Flanges	SS 316 L
External hardware	SS 316 L
Internal hardware	SS 316 L

- (b) Cast iron body valves shall have high alloy steel stem and seat.
- (c) Material for counter flanges shall be the same as for the piping except for sea water application.

13.21.00 Float Operated Valves

- (a) Valve shall automatically control the rate of filling and will shut off when a predetermined level is reached and close to prevent over flow on pre-set maximum water level. Valve shall also open and close in direct proportion to rise or fall of water level.

(b) DESIGN AND CONSTRUCTION FEATURES

The following design and construction feature of the valve shall be the minimum acceptable.

- (c) Valves shall be right-angled or globe pattern.
- (d) Valves shall be balance piston type with float ball.
- (e) Leather liner shall not be provided.
- (f) The body and cover material shall be cast iron conforming to ASTM-A 126 Grade 'B' or Is: 210 Grade 200 or equivalent, and float shall be of copper with epoxy painting of two (2) coats. For all sea water applications the complete valve shall be SS 316 L construction.
- (g) Valves shall be suitable for flow velocities of 2 to 2.5m/sec.
- (h) The valves shall have flanged connections.

13.22.00 PAINTING OF VALVES:

Two (2) coats of primer followed by three (3) coats of epoxy of approved color code/shade (usually same as that of connected piping) shall be applied to all exposed surfaces except stainless steel surface, Galvanized steel surface and gun metal surface at shop as required to prevent corrosion, before dispatch. The use of grease/oil other than light grade mineral oil, for corrosion protection is prohibited. The total DFT of painting shall be 150 micron (minimum). If during transport, unloading/unpacking or erection at site any part of the painted surface gets

damaged, the same shall be made good by the contractor by repainting with compatible painting primer and enamel to the satisfaction of the project manager.

13.23.00 RUBBER EXPANSION JOINTS

- 13.23.1 All parts of expansion joints shall be suitably designed for all stresses that may occur during continuous operation and for any additional stresses that may occur during installation and also during transient condition.
- 13.23.2 The expansion joints shall be single bellow rubber expansion joints. The arches of the expansion joints shall be filled with soft rubber.
- 13.23.3 The tube (i.e. inner cover) and the cover (outer) shall be made of natural or synthetic rubber of adequate hardness. The shore hardness shall not be less than 60 deg. A for outer and 50 deg. A for inner cover.
- 13.23.4 The carcass between the tube and the cover shall be made of high quality cotton duck, preferably, square woven to provide equal strength in both directions of the weave. The fabric plies shall be impregnated with age resistant rubber or synthetic compound and laminated into a unit.
- 13.23.5 Reinforcement, consisting of solid metal rings embedded in carcass shall be provided.
- 13.23.6 Expansion joints shall be complete with stretcher bolt assembly. The expansion joints shall be suitable to absorb piping movements and accommodate mismatch between pipelines.
- 13.23.7 The expansion joints shall be of heavy duty construction made of high grade abrasion-resistant natural or synthetic rubber compound. The basic fabric for the 'duck' shall be either a superior quality braided cotton or synthetic fibre having maximum flexibility and non-set characteristic.
- 13.23.8 The expansion joints shall be adequately reinforced, with solid steel rings, to meet the service conditions under which they are to operate.
- 13.23.9 All expansion joints shall be provided with stainless steel retaining rings for DM water application and IS 2062 Gr. B galvanized steel retaining rings for ordinary water for use on the inner face of the rubber flanges, to prevent any possibility of damage to the rubber when the bolts are tightened. These rings shall be split and beveled type for easy installation and replacement and shall be drilled to match the drilling on the end rubber flanges and shall be in two or more pieces.
- 13.23.10 The expansion joints shall have integral fabric reinforced full-face rubber flanges. The bolt on one flange shall have no eccentricity in relation to the corresponding bolt hole on the flange on the other face. The end rubber flanges shall be drilled to suit the companion pipe flanges.
- 13.23.11 All exposed surfaces of the expansion joint shall be given a 3 mm thick coating of neoprene. This surface shall be reasonably uniform and free from any blisters, porosity and other surface defects.
- 13.23.12 Each control unit shall consist of two (2) numbers of triangular stretcher bolt plates, a stretcher bolt with washers, nuts, and lock nuts. Each plate shall be drilled with three holes, two for fixing the plate on to the companion steel flange and the third for fixing the stretcher bolt.

13.23.13 Each joint shall have a permanently attached brass or stainless steel metal tag indicating the tag numbers and other salient design features.

13.23.14 Bidder to note that any metallic part which comes in contact with DM / Corrosive water shall be of stainless steel material.

13.23.15 For all Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water etc the bolts & nuts, stretcher plates and companion flanges shall be SS 316 L.

13.24.00 STRAINERS

13.24.1 Simplex type

The strainers shall be basket type and of simplex construction. The strainer shall be provided with plugged drain/blow off and vent connections. The free area of the strainer element shall be at least four (4) times the internal area of the connecting pipe lines. The strainer element shall be 20 mesh. Pressure drop across the strainers in new condition fitted with a removable plug. The material of construction of various parts shall be as follows:

(a)	Body	IS: 318, Gr. 2 up to 50 mm Nb, and IS: 210 Gr. FG 260 above 50 mm Nb. (For DM water/ -Body: AISI 316 or equivalent) SS 316 L (all Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water etc)
(b)	Strainer Element	Stainless steel (AISI 316) SS 316 L (all Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water etc)
(c)	End connection	Screwed upto 50 mm Nb, and flanged above 50 mm Nb

13.24.2 Duplex type

- (a) The strainers shall be basket type and of duplex construction. The strainer shall be provided with plugged drain/blow off and vent connections. The free area of the strainer element shall be at least four (4) times the internal area of the connecting pipe. The mesh of strainer element shall be commensurate with the actual service required. Pressure drop across the strainer in new condition shall not exceed 4.0 MWC at full flow.
- (b) Wire mesh (if applicable) of the strainers shall be suitably reinforced. The material of construction of various parts shall be as follows.

Body	IS: 318, Gr. 2 Up to 50 mm Nb, and IS:210, Gr. FG 260 of ASTM-A-515 Gr. 75/IS-2062 Gr. B and internally epoxy-painted above 50 NB.



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IIB

REV 00

**SECTION – IIB
GENERAL TECHNICAL REQUIREMENT (ELECTRICAL)**



2 x 660 MW ENNORE SEZ STPP

**BASIC TECHNICAL FEATURES
FOR HT / LT MOTORS
(FOR BHEL-PEM SCOPE PACKAGES)**

Doc. No.	PE-DC-412-565-E003
Rev. No.	
Dated	
Page	

1.0 This document covers the basic technical features of high tension (HT) and low tension (LT) squirrel cage induction AC motors employed for driving auxiliaries of BHEL-PEM scope packages in **2 x 660 MW ENNORE SEZ STPP**.

2.0 CODES AND STANDARDS

The motors shall generally conform to IS 325/IEC-60034. LT motors above 10 kW with continuous duty (S1) shall be energy efficient IE2 conforming to IS-12615: 2011.

3.0 DESIGN REQUIREMENTS

3.1 General Requirements

The design ambient temperature shall be 50 deg C.

3.2 Supply system and rated voltage of motors

KW rating	Supply system	Rated voltage of motor
Above 1500 kW	11 KV	11 KV
Above 160 kW up to & including 1500 kW	3.3 KV	3.3 KV
From 200W up to & including 160 kW	415 V	415 V
Below 200W	240V	240V

3.2.1 Supply voltage & variations shall be as follows:-

Voltage variation (AC Supply) (+/-) 10%
Frequency variation (+) 3% to (-) 5%
Combined V & F variation 10% (sum of absolute values)

3.2.2 Motors shall be capable of running continuously at rated output for each of the conditions specified.

3.3 Motor Rating

Motor ratings shall be adequate to meet the requirements of the drive equipment. Motors shall be continuously rated at the design ambient temperature of 50 degree C and relative humidity of 85%. Maximum continuous motor ratings shall have at least a 10% margin above the maximum load demand of the driven equipment under entire operating range including voltage & frequency variation.

3.4 Starting Requirements

3.4.1 Motor shall start smoothly and rapidly. Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% of the motor's full load torque.



2 x 660 MW ENNORE SEZ STPP
BASIC TECHNICAL FEATURES
FOR HT / LT MOTORS
(FOR BHEL-PEM SCOPE PACKAGES)

Doc. No.	PE-DC-412-565-E003
Rev. No.	
Dated	
Page	

- 3.4.2 Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.

Minimum Starting Voltage requirement for all motors (except mill motors):

1. 85 % of rated voltage for motors up to 1000 kW
2. 80 % of rated voltage for above 1000 kW and up to 4000 kW
3. 75 % of rated voltage for above 4000 kW

- 3.4.3 The locked rotor current of the HV (11 kV) motors (except MDBFP motors) shall not exceed 650% of full load current inclusive of tolerance as per IS: 325 and for MV (3.3 kV) motors locked rotor current shall not exceed 700% of full load current inclusive of tolerance as per IS: 325. For LT motors (except energy efficient motors) locked rotor current shall not exceed 700% of full load current inclusive of tolerance as per IS: 325. For LT energy efficient motors above 10kW with S1 duty, locked rotor current shall be as per IS: 12615-2011.

- 3.4.4 The following frequency of starts shall apply to HV (11 kV), MV (3.3 kV) & LT motors

- i) Two nos. consecutive cold starts in quick succession with third start after 5 minutes in cold condition.
- ii) Two nos. consecutive hot starts in the interval of 15 minutes in hot condition.

- 3.4.5 Locked motor withstand time of motors under hot condition at highest voltage limit shall be as follows:

- a) For motors with starting time up to 20 sec.
 - at least 2.5 sec. more than starting time.
- b) For motor with starting time above 20 secs but not exceeding 45 secs.
 - at least 5.0 sec. more than starting time.
- c) For motors with starting time above 45 secs.
 - at least 10% more than starting time.

The starting time of the motor referred above is at minimum permissible voltage. For motors and in cases where the above requirements are not complied with, speed switches of approved make & type shall be provided to bypass the locked rotor protection for a pre-selected time during starting of motors. The speed switches shall have one NO & one NC contacts having maximum interrupting capacity of 5 Amps at 240V AC and 0.25 amps at 220 V DC.

3.5 Running Requirements

- 3.5.1 Motors shall run satisfactorily at a supply voltage of 80% of rated voltage for 5 minutes with full load without injurious heating to the motor.
- 3.5.2 Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty motors.

3.6 Stress during bus Transfer:



2 x 660 MW ENNORE SEZ STPP
BASIC TECHNICAL FEATURES
FOR HT / LT MOTORS
(FOR BHEL-PEM SCOPE PACKAGES)

Doc. No.	PE-DC-412-565-E003
Rev. No.	
Dated	
Page	

3.6.1 Motors shall withstand the voltage and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.

3.6.2 Motor windings shall be adequately braced to satisfactorily withstand the mech. Stresses during above condition.

3.6.3 Motors shall be capable of withstanding heavy in-rush transient current caused by bus transfer without damage.

3.6.4 Motor and driven eqpt. Shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.

3.7 Noise level

The maximum noise level for motors shall be in line with IS 12065.

3.8 Vibration

The maximum vibration for motors shall be in line with IS: 12075.

3.9 Crane duty motors will be of squirrel cage induction motor and shall suit the duty class S4, cyclic duration factor 40% and 300 starts. Crane duty motors shall be provided with VVFD for speed control.

1

4.0 CONSTRUCTIONAL FEATURES

4.1 Degree of Protection

4.1.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor motors shall conform to degree of protection IP: 55 as per IS: 4691 and shall be of weather-proof construction. Canopy shall be provided for outdoor motors. CW motors (in case of screen prot. Drip proof) shall conform to degree of protection IP: 23 as per IS: 4691. The degree of protection for terminal boxes shall be IP 55 for outdoor area & IP 54 for indoor area as per IS 4691.

4.1.2 The stator laminations shall made from suitable silicon steel/magnetic steel sheet varnished on both sides and pressed to form a rigid core.

4.1.3 The rotor shall be of rigid cage construction with die cast aluminium / copper alloy / copper bars firmly wedged in bar slots and brazed to the end rings. The rotor cage shall be designed to operate satisfactorily under respective starting and load duty cycle.

4.2 Enclosure and Cooling

4.2.1 Motors shall generally have totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) enclosures or Closed Air circuit Air (CACA), the method of cooling conforming to IC-0141 or IC-0151 or IC-0161 of IS: 6362 up to 3000 kW motor. CW Motors may be screen protected drip proof (SPDP).

4.2.2 Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.



2 x 660 MW ENNORE SEZ STPP

**BASIC TECHNICAL FEATURES
FOR HT / LT MOTORS
(FOR BHEL-PEM SCOPE PACKAGES)**

Doc. No.	PE-DC-412-565-E003
Rev. No.	
Dated	
Page	

4.2.3 Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.

4.3 Class of Insulation

HV/MV/LT motors shall have class F insulation. The temperature rise of all motors shall be limited to the limits applicable to Class 'B' insulation. In case of continuous operation at extreme voltage limits, 10deg C rise above the temperature limits specified in IS: 325 shall be permissible.

4.4 Bearings

4.4.1 Horizontally mounted motors shall have grease lubricated ball/roller or sleeve bearings. For HV/MV motors, the bearings shall be regreasable type and for LV motors, these bearings can be either sealed life lubricated type or regreasable type as per manufacturer's standard.

4.4.2 The vertical motors shall have a combined thrust and guide bearing on top and guide bearing at bottom. If the ball or roller bearings can take vertical thrust, thrust and guide bearing need not be provided.

4.4.3 After taking all motor driven equipment loads and thrust (if any) into account, the bearings shall be suitable for min. 20,000 working hours. Re-greasable bearings shall be provided with grease nipples and relief holes for on-line re-greasing and shall be suitable for 8000 working hours without changing of the grease.

4.4.4 The bearings of solidly coupled motors shall be of the same type as those of the driven equipment.

4.4.5 For motors below 15 kW shall be provided with sealed ZZ bearing.

4.4.6 Motors rated above 1000kW shall be provided with insulated end shield on non-driving end to prevent flow of shaft current.

4.5 Terminals and Terminal Boxes

4.5.1 Motors of rating 90 kW and up to 160kW will be controlled by air circuit breaker with numerical protection. For all motors of rating up to 90kW shall be provided with MCCBs. The terminal box of motors for HV (11 kV), MV (3.3 kV) & LT motors shall be designed for the maximum fault current for a duration of at least 0.25 secs. **11kV & 3.3kV motors terminals shall be able to withstand 44kA for 0.25 seconds.**

1

4.5.2 Unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.

4.5.3 For HV/MV motors, the main terminal box shall be of phase-segregated type with clamping arrangement for the terminals.

4.5.4 Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A,C,B or V, W & U respectively.

4.5.5 Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.



2 x 660 MW ENNORE SEZ STPP

**BASIC TECHNICAL FEATURES
FOR HT / LT MOTORS
(FOR BHEL-PEM SCOPE PACKAGES)**

Doc. No.	PE-DC-412-565-E003
Rev. No.	
Dated	
Page	

- 4.5.6 Motor terminals and terminal leads shall be fully insulated with no bar live parts.
- 4.5.7 Separate terminal boxes shall be provided for space heaters and temp. Indicators. If this is not possible in case of LT motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non-magnetic material for single core cables) with double compression tinned brass glands shall be provided in terminal boxes.
- 4.5.8 Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 180 and 90 degree for HT and LT motors respectively.
- 4.5.9 Cable glands and cable lugs as per selected cable sizes shall be provided in line with cable erection philosophy. For single core cable termination, gland plates shall be of non-magnetic material.
- 4.6 Grounding

Two separate earthing terminals suitable for connecting G.I. strip grounding conductor shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.

4.7 General

- 4.7.1 Motors provided for similar drives shall be interchangeable.
- 4.7.2 An arrow block shall be screwed on the body of the motors on the non-driving end to indicate the direction of rotation of the motors.
- 4.7.3 Motors for Fuel oil unloading and drain oil pumps located in hazardous areas shall be with flame-proof enclosures in accordance with IS 2148 / IEC 60079.

a) Fuel oil area: Group - IIB.

b) Hydrogen generation plant area: Group - IIC

- 4.8 Neutral terminal box of motors rated 1000kW and above shall provision of mounting Neutral CTs of PS class identical to the CTs to be provided at switchgear end. Further the neutral terminals of HV motors rated below 1000kW shall be accessible.

1

5.0 ACCESSORIES

5.1 SPACE HEATERS

All motors rated 30KW and above shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz.

The leads from space heaters of each motor shall be brought out to a separate terminal Box. Space heaters shall be mounted inside the motor in accessible places so that their removal and replacement is simple.

5.2 RESISTANCE TEMPERATURE DETECTORS (RTDs)

- 5.2.1 HV/MV motors stator windings shall be provided with 12 nos. Simplex 3 wire Platinum RTDs with 100 ohms resistance at 0 deg C for remote monitoring of winding temperature. The leads from RTDs of each motor shall be brought out to a separate terminal Box.



2 x 660 MW ENNORE SEZ STPP

**BASIC TECHNICAL FEATURES
FOR HT / LT MOTORS
(FOR BHEL-PEM SCOPE PACKAGES)**

Doc. No.	PE-DC-412-565-E003
Rev. No.	
Dated	
Page	

5.2.2 For HV/MV motors, each bearing shall be provided with 1 no. Duplex 3 wire Platinum RTDs with 100 ohms resistance at 0 deg C for remote monitoring of bearing temperature. The leads from these RTDs shall be brought out to a separate terminal Box or the terminal box same as for winding RTDs.

5.3 DIAL TYPE TEMP. INDICATORS

5.3.1 For HV/MV motors, each bearing shall be provided with dial type thermometer with adjustable alarm contact and resistance type temperature detector. The indicators shall have 2 nos. NO contacts rated for 5A, 240 V AC and 0.5 A, 220 V DC for alarm/trip purpose.

5.4 Vibration monitoring pads

5.4.1 Provision shall be made in all HV/MV motors for mounting vibration detectors.

6.0 NAME PLATE

Motors shall have stainless steel name plate with all particulars as per IS: 325. In addition bearing identification number and type of lubricant is to be indicated.

7.0 PAINTING

Motor including fan shall be painted with corrosion proof paints of colour shade Siemens grey (RAL 7032).

8.0 TESTING

8.1 Type Tests

For HT & LT Motors, type test reports for type tests as per IS: 325/ IS: 12615 conducted on equipment similar to those proposed to be supplied and carried out within last five years shall be submitted. However, if such reports are not available, one motor of each type shall be subjected to type tests for free of cost.

8.2 Routine Tests

All motors shall be subjected to routine tests as per IS: 325/ IS: 12615 in the presence of customer or customer representative.

306 भारतीय विद्युत निगम 	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO.
		VOLUME NO. :
		SECTION :
		REV NO. : 00
		SHEET :

1.0

INTENT OF SPECIFIATION

The specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer’s work, and packing of Low voltage (LV) squirrel cage induction motors along with all accessories for driving auxiliaries in thermal power station.

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors.

2.0

CODES AND STANDARDS

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:

IS:325	Three phase Induction motors
IS : 900	Code of practice for installation and maintenance of induction motors
IS: 996	Single phase small AC and universal motors
IS: 4722	Rotating Electrical machines
IS: 4691	Degree of Protection provided by enclosures for rotating electrical machines
IS: 4728	Terminal marking and direction of rotation rotating electrical machines
IS: 1231	Dimensions of three phase foot mounted induction motors
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 13555	Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment
IS: 2148	Flame proof enclosures for electrical appliance
IS: 5571	Guide for selection of electrical equipment for hazardous areas
IS: 12824	Type of duty and classes of rating assigned
IS: 12802	Temperature rise measurement for rotating electrical machnines
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 12075	Mechanical vibration of rotating electrical machines

In case of imported motors, motors as per IEC-34 shall also be acceptable.

3.0

DESIGN REQUIREMENTS

3.1

Motors and accessories shall be designed to operate satisfactorily under conditions specified in data sheet-A and Project Information, including voltage & frequency variation of supply system as defined in Data sheet-A

3.2

Motors shall be continuously rated at the design ambient temperature specified in Data Sheet-A and other site conditions specified under Project Information
Motor ratings shall have at least a 15% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified above.

3.3

Starting Requirements

3.3.1

Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

3.3.2

Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.

	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO.
		VOLUME NO. :
		SECTION :
		REV NO. : 00
		SHEET :
The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.		
3.3.3 The following frequency of starts shall apply i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature. ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour) iii) Motors for coal conveyor and coal crusher application shall be suitable for three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be suitable for minimum 20,000 starts during the life time of the motor		
3.4 Running Requirements		
3.4.1 Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.		
3.4.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage upto 70% of the rated voltage for duration of 2 secs.		
3.5 Stress During bus Transfer		
3.5.1 Motors shall withstand the voltage, heavy inrush transient current, mechanical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.		
3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.		
3.6 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.		
3.7 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.		
4.0 CONSTRUCTIONAL FEATURES		
4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691 and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy		
4.2 Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362.		
Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled		
4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.		

	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO.
		VOLUME NO. :
		SECTION :
		REV NO. : 00
		SHEET :
4.4.	Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.	
4.5	Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.	
4.6	In case Class 'F' insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class 'B' insulation. In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.	
4.7	Terminals and Terminal Boxes	
4.7.1	Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A. Unless otherwise stated in Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet "A".	
4.7.2	unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.	
4.7.3	Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or U W & V respectively.	
4.7.4	Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.	
4.7.5	Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.	
4.7.6	Degree of protection for terminal boxes shall be IP 55 as per IS 4691.	
4.7.7	Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.	
4.7.8.	Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.	
4.7.9	Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.	
4.8	Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.	
4.9	General	

	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO.
		VOLUME NO. :
		SECTION :
		REV NO. : 00
		SHEET :
4.9.1 Motors provided for similar drives shall be interchangeable. 4.9.2 Suitable foundation bolts are to be supplied alongwith the motors. 4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above. 4.9.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956. 4.9.5 All motors rated above 30 kW shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz. 4.9.6 Name plate with all particulars as per IS: 325 shall be provided 4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions. 5.0 INSPECTION AND TESTING 5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied. 5.2 LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser. 5.3 All motors shall be subjected to routine tests as per IS: 325 and as per BHEL standard quality plan. 5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A. 6.0 DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT a) OGA drawing showing the position of terminal boxes, earthing connections etc. b) Arrangement drawing of terminal boxes. c) Characteristic curves: (To be given for motor above 55 kW unless otherwise specified in Data Sheet). i) Current vs. time at rated voltage and minimum starting voltage. ii) Speed vs. time at rated voltage and minimum starting voltage. iii) Torque vs. speed at rated voltage and minimum voltage. For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling. iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.		

SS 316 L (all Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water etc)

Strainer element Stainless steel (AISI 316)/ SS 316 L (all Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water etc)

End connection Screwed up to 50 mm NB, and Flanged above 50 NB. Gasket shall be of full face type

- (c) The strainer will have a permanent stainless steel tag fixed on the strainer body indicating the strainer tag number and service and other salient data.
- (d) The size of the strainer and the flow direction will be indicated on the strainer body casting.
- (e) Thickness of the strainer element should be designed to withstand the pressure developed within the strainer due to 100% clogged condition exerting shut-off pressure on the element.

13.24.3

Three shop coats of paint preceded by two coats of primer shall be applied to all exposed surfaces as required to prevent corrosion. All parts shall be adequately protected for rust prevention. The use of grease or oil other than light grade mineral oils for corrosion protection is prohibited.

SPECIFIC ELECTRICAL REQUIREMENT

SL.NO.	PARAMETERS	UNIT	ENNORE
	MOTOR		
1	DESIGN AMBIENT TEMP	DEG. C	50
2	VOLTAGE SUPPLY AND VARIATION	VOLT	415V, + 10%
3	FREQUENCY WITH VARIATION	Hz	50 (+) 3% to (-) 5%
4	COMBINED VOLTAGE & FREQUENCY VARIATION		10%
5	MAX ACCEPTABLE RATING OF MOTOR AT 415 V	KW	160 kW
6	SYSTEM FAULT LEVEL AND ITS DUARTION	KA	50 KA, 1 Sec
7	SUTABILITY OF TERMINAL BOX FOR FAULT LEVEL AND DURATION		50 KA, 0.25 sec
8	CLASS OF INSULATION & TEMP RISE LIMITED TO		Class-F and temp rise limited to Class-B
9	MIN. STARTING VOLTAGE		85%
10	MOTOR RATING FOR SINGLE PHASE SUPPLY		Upto 200W
11	MAXIMUM LOCKED ROTOR CURRENT	% OF FLC	For LT motors (except energy efficient motors) locked rotor current shall not exceed 700% of full load current inclusive of tolerance as per IS: 325. For LT energy efficient motors above 10kW with S1 duty, locked rotor current shall be as per IS: 12615-2011.
12	ACCEPTABLE NOISE LEVEL	DB	85dB at 1.0m in line with IS 12065
13	TYPE OF STARTER PROVIDED IN MCC		DOL
14	DOP OF ENCLOSURE		Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor motors shall conform to degree of protection IP: 55 as per IS: 4691 and shall be of weather-proof construction. The degree of protection for terminal boxes shall be IP 55 for outdoor area & IP 54 for indoor area as per IS 4691.
15	SPACE HEATER REQUIREMENT		30KW & ABOVE
16	PAINT SHADE		Shall be confirmed during detailed engineering.
17	SPECIAL REQUIREMENT		For HT & LT Motors, type test reports for type tests as per IS: 325/ IS: 12615 conducted on equipment similar to those proposed to be supplied and carried out within last five years shall be submitted. However, if such reports are not available, one motor of each type shall be subjected to type tests for free of cost. All motors shall be subjected to routine tests as per IS: 325 / IS: 12615. LT motors above 10kW Shall be energy efficient as per IS: 12615-2011. The motors shall generally conform to IS: 325 / IEC-60034.

	TITLE MOTOR DATA SHEET - C	SPECIFICATION NO.
		VOLUME II B
		SECTION D
		REV NO. 00 DATE
		SHEET 1 OF 2

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

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

	TITLE MOTOR DATA SHEET - C	SPECIFICATION NO.
		VOLUME II B
		SECTION D
		REV NO. 00 DATE
		SHEET 2 OF 2

S. No.	Description	Data to be filled by successful bidder
	c) At starting	
C.	Constructional Features	
1	Method of connection of motor driven equipment	
2	Applicable Standard	
3	DOP of Enclosure	
4	Method of cooling	
5	Class of insulation	
6	Main terminal box	
	a) Type	
	b) Power Cable details (Conductor, size, armour/unarmour)	
	c) Cable Gland & lugs details (Size, type & material)	
	d) Permissible Fault level (kArms & duration in sec)	
7	Space heater details (Voltage & watts)	
8	Flame proof motor details (if applicable)	
	a) Enclosure	
	b) suitability for hazardous area	
	i Zone	O / I / II
	ii Group	IIA / IIB / IIC
9	No. of Stator winding	
10	Winding connection	
11	Kind of rotor winding	
12	Kind of bearings	
13	Direction of rotation when viewed from NDE	
14	Paint Shade & type	
15	Net weight of motor	
16	Outline mounting drawing No (To be enclosed as annexure)	
D.	Characteristic curves/ drawings (To be enclosed for motors of rating $\geq 55\text{KW}$)	
	a) Torque speed characteristic	
	b) Thermal withstand characteristic	
	c) Current vs time	
	d) Speed vs time	

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

Sl.No.	UNITCABLENO	FROM	TO	PURPOSE	REMARKS	CABLESIZE	PATHCABLENO	LOCATION	TENTATIVE LENGTH



TITLE

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IIB

REV 00

**SECTION – IIC
GENERAL TECHNICAL REQUIREMENT (CONTROL AND
INSTRUMENTATION)**

“*” For these systems Remote I/O panels with push buttons, indication lamps and annunciation shall be provided for subsystems where manned local operation is required.

GENERAL

1. The specification hereunder provides a general guideline for Control & Instrumentations to be provided for the Plant auxiliary systems and Off Site Plants. Bidder shall provide functionally independent & geographically distributed PLC (Programmable Logic Control) based control & Instrumentation system with all control equipment, instruments, accessories, cables and erection hardware for safe, efficient and reliable operation of the plant.
2. Each of the Plant Auxiliaries & off site systems shall be provided with annunciation system. It shall be an integral part of the control system. All the field contact for this purpose shall be acquired through control system. The annunciation sequence/logic shall conform to ISA sequence ISA-2A. The window lamps for the system shall be driven through output modules of the control system.



2 x 660 MW ENnore SEZ Supercritical Thermal Power
Project at Ash Dyke of NCTPS
Spec. No. CE/C/P&E/EE/E/OT.No.03/2013-14
Vol. V :567



3. Remote Terminal Units (RTUs) have been envisaged for data acquisition function. Bidder shall provide necessary RTUs comprising of Input / Output modules, Processor etc., signal cable for interface with PLC panel, communication cables, and erection hardware's and other software & hardware for complete functioning of the off - site plants.
4. The instrumentation to be provided for each of the plant auxiliary & Off Site Plant systems shall be as per the technical specification document / drawings wherever provided for the respective systems as a minimum requirement for bidding purpose. However, for completeness of each of the plant auxiliary & Off Site system and its associated equipment, Bidder shall also provide all the necessary instruments to the process requirement even if it is not specifically indicated in the given technical Specification document / drawings.
5. The instrumentation, operation and control philosophy proposed is specific to the plant design. Any improvement over the proposed typical Control & Instrumentation scheme shall be accepted so long as it does not deviate from the basic intent and general philosophy enumerated herein and elsewhere in this specification.
6. Plant auxiliaries / Off Site Plants shall be operated from their respective local control panels or Operating work stations located in the local area control rooms. Some of the auxiliaries will have operational facility from central control room as well as from local panels. All the PLC's of Ash Handling, DM-RO plant, Service water pump house, Compressor Plant, Condensate polishing unit, Fire Water Pump house etc., shall have digital data communication connectivity with DDCMIS already detailed/discussed in chapter 4. The control system for each of the Plant auxiliaries, Off Site Plant and their Man machine interface requirement and DDC MIS interfaces in the central control room shall be as follows:
 - i. Considering the high ambient noise and electromagnetic interference prevailing in power plant, it is recommended that all links between off-site controls and plant DDC MIS shall be based on Dual Optical Fiber Communication (OFC) medium. Necessary ports / converters shall be provided at both ends.
 - ii. PLC and RTU shall be designed for operating in a non air-conditioned harsh environment also. Communication media shall be optical fiber cable with MODBUS / OPC protocol between DDCMIS and PLC as per requirements. Optical cable, PLC end Modem/Converter and DDCMIS end Modem/Converter shall be supplied by bidder at both end. Optical cables shall be routed through GI conduit pipes. Communication protocol between the Modems shall be RS485/Modbus and the maximum communication time for receipt of signal at DDCMIS end should not exceed 2 seconds. The Communication links shall be as per chapter 4.



2 x 660 MW ENnore SEZ Supercritical Thermal Power
 Project at Ash Dyke of NCTPS
 Spec. No. CE/C/P&E/EE/E/OT.No.03/2013-14
 Vol. V :568



DESEIN

Volume- V: Instrumentation & Control Works

- iii. In addition Hard wired signal interfacing shall also be provided for any signal required for interlock, control & protection. Similarly cable for hard ware signal transfer between DDCMIS and PLC/relay based control system shall be supplied, laid terminated by the bidder including preparation of cable schedule. Quantum of hard wired signals for linking each PLC based system and DDCMIS shall be decided during detailed engineering,.
- 7. Bidder will provide necessary separate industrial grade parallel redundant UPS power supply with 60 minutes battery backup for each PLC, Operating station & printer etc. Bidder shall provide necessary separate industrial grade parallel redundant 24 volts DC charger with 60 minutes battery backup for each PLC without Operating station . Bidder shall have to provide necessary cabling for redundant power supply to UPS / charger.
- 8. Whenever control system is PLC based, annunciation system shall be driven by PLC via Digital output. Mimic LED shall also be driven from PLC digital output. For other relay based control systems, solid-state annunciation system shall be provided. Mimic acrylic sheet thickness shall be min 6-7 mm.
- 9. For each PLC system, without OEWS (Operating Engineering Work Station), Laptop along with software shall be provided for engineering (Laptop shall be separate for each PLC with out OWES).
- 10. PLC system without OEWS (Operating & Engineering Work Station) shall have panel mounted push buttons, lamps, H.W. annunciation, indicators, Ammeters and MIMIC etc for operation & control purpose except specifically requirements of control desk mentioned for any package listed above.
- 11. All the PLC control system shall be of same make, model & same family and shall be supplied directly from manufacturer/vendors. PLC system supplied /engineered by system houses shall not be acceptable. It is preferred to have same family of Plant DDCMIS .
- 12. All remote I/O cards shall be with IP-65 protection class and should withstand upto 70 deg.C temperature.
- 13. All cables terminated in the terminal block, power distribution scheme instruments shall be ferruled. Ferruling shall be double cross ferruling (i.e.) source and destination addresses shall be marked on both sides of the tube ferruling.
- 14. Any Package not listed above shall be PLC (redundant hot standby controllers) controlled with one no. OWS, one no. OEWS (Operating & Engineering Work Station) and one no. A4 B/W LJP.



2 x 660 MW ENnore SEZ Supercritical Thermal Power
 Project at Ash Dyke of NCTPS
 Spec. No. CE/C/P&E/EE/E/OT.No.03/2013-14
 Vol. V :569



DESEIN

Volume- V: Instrumentation & Control Works

15. Bidder shall provide local panel for local start/ stop monitoring of auxiliaries and equipment as per requirement .The requirement shall be decided during detailed engineering. All local panel shall be NEMA 4X with canopy.
16. Bidder shall provide am meters, voltmeters, P B indicating lamp, mimic, electrical scheme, indicators, chartless recorders and HW annunciators on the desk/ panels as requirement and shall be decided in detailed engineering.
17. PLC supplier shall prepare graphic for the complete plant with proper tag nos. for drives, binary inputs, analogue inputs, status of drives etc for the soft link for DDCMIS as per format of DDCMIS.
18. Each PLC/Microprocessor based system/electrical system shall be time synchronized with master clock system. Redundant Time synchronisation signals shall be provided for each control system, wherever redundant controllers/processors are provided.
19. Each subsystem PLC shall be provided with HW interfacing with main system PLC for signals used for command, interlocks, protections and other important process parameters.
20. Control, operation & monitoring of electrical distribution system, namely PCC, Bus coupler, Incomer, breakers etc. for respective plant BOP package shall be controlled & operated from its respective PLC operating station/ backup control desk as well as from respective switchgear unit. Control system for the same shall be implemented in the respective PLC envisaged in the local control room. Bidder shall consider all transducers for monitoring of voltage, current, Kwh, power factor at respective PLC operating station and backup control desk. All signals shall be hardwired only.
21. The technical particulars & requirements of PLC, OWS, Printers, LVS and all other related hardwares/software shall be as per Vol. V, Chapter 4.
22. The technical particulars & requirements of UPS & 24 V DC systems shall be as per Vol. V, Chapter 7.

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



2 x 660 MW ENnore SEZ Supercritical Thermal Power
 Project at Ash Dyke of NCTPS
 Spec. No. CE/C/P&E/EE/E/OT.No.03/2013-14
 Vol. V :570



4.0 **SEA WATER TREATMENT PLANT**

4.1 The sea water intake pumps shall supply sea water to the sea water treatment plant dedicated for the proposed 2x660 MW plant and located in the proposed plant site through adequately sized pipeline, control station and cascade aerator.

Refer composite water scheme enclosed in Vol VII for this system. However the water quantities indicated are only tentative. The exact quantities will have to be worked out by the contractor.

4.2 Sea water analysis is enclosed in this chapter.

4.3 **Pretreatment & Filtration Plant**

- a) Flow control station upstream of cascade aerator consisting of a throttling type motorized butterfly valve with isolation valves and bypass valve.
- b) One (1) Cascade type aerator to oxidize ferrous to ferric and to remove dissolved carbon dioxide
- c) One (1) settling chamber with retention time of min. 1 minute. Drainage to be connected with sludge sump.
- d) One (1) flow measuring element (Parshall flume) and 2 nos. flow transmitter, one at the inlet channel to flash mixer and the other at the outlet channel of clarifier.
- e) One (1) flash mixer with retention time of min. 1 minute and slow speed agitator or baffles, isolation gates etc. Drainage to be connected with the sludge sump.
- f) Two (2) clariflocculators (over ground), complete with rake mechanism, flocculator mechanism along with drive and drive motors, telescopic type continuous sludge discharge arrangement, intermittent timer operated by-pass sludge disposal system, flushing arrangement etc.
- g) Coagulant (Alum) Dosing system consisting of 2 nos. dosing tank and 2 x 100% capacity dosing pumps complete with associated piping and valves.
- h) Coagulant aid (Polyelectrolyte) Dosing system consisting of 2 nos. dosing tank and 2 x 100% capacity dosing pumps complete with associated piping and valves.
- i) Lime dosing system consisting of 2 nos. dosing tanks and 2 x 100% capacity dosing pumps complete with associated piping and valves.
- i) Clarified water storage tank (above ground) of RCC construction and effective capacity 5000 m³, with two compartments and a common sump and a pumphouse. This tank shall be covered.
- j) The Clarified water pumphouse shall house 3 x 50 % Filter feed Pumps.
- k) One (1) - Chemical house (two storeyed) for housing various chemical solution tanks and chemicals (30 days chemical storage space) with toilet block.



The various chemical handling and dosing equipment in the plant shall be designed for the following dosing rates:

i)	Coagulant (FeCl_3)	:	40 ppm (max.)
ii)	Lime	:	10 ppm (max.)
iii)	Polyelectrolyte	:	1 ppm (max.)
iv)	Chlorine for Pre- Treatment	:	5 ppm (max.)

A minimum of 300 mm freeboard shall be provided for all the units and chemical solution tanks etc.

All pipes shall be routed through pipe racks only.

- l) One (1) complete sludge handling system consisting of reject sump of 2000 cum. effective capacity, three(3) nos. vertical sludge pumps (2Working+1Stand-by) , each of 1000 cum/hr capacity , sludge flushing arrangement etc.
- m) One(1) no. platform dial type weighing scale of 0-500 kg capacity and an electric hoist of suitable capacity in the chemical house.
- n) All RCC channels/ ducts and hume pipes as required for sea water PT plant.
- o) All pipe, or RCC channels/ ducts and hume pipes required for sludge disposal drain/ filter backwash water shall be led to sludge/ reject sump.
- p) Necessary flushing arrangement for the sludge pipes and filter back wash water disposal pipes.
- q) Two nos. (1W+1S) twin section dual media filters with inlet channels, flow controller, filter media, internals complete with associated piping and valves.
- r) Seven nos (6W+1S) Ultra filter modules complete with filter media, internals complete with associated piping and valves. Backwash provision of the UF shall consist of UF backwash pumps 2(1W+1S), dosing skids with dedicated pumps 2(1W+1S). Filter backwash from the filter outlet shall also be led to guard pond.
- s) One (1) no. RCC UF Permeate Water Storage tank of effective capacity 2000 cum in two compartments. Tank shall be covered.
- t) Seven (6W +1S) Cartridge filters.
- u) 3 x 50% Cartridge Filter Feed Pumps.
- v) 2 x 100% UF Backwash Pumps
- w) Other civil works as specified.
- x) Isolating gates and shutters as detailed below:
 - i. Isolation gates with hand wheel at inlet to clariflocculator
 - ii. Isolation gates with hand wheel at outlet of clariflocculator



C. DATA SHEET

FOR

MOTORISED

VALVE ACTUATOR

	Data Sheet FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.: PE-ID-412-145-I902	
			VOLUME II B	
			SECTION D	
			REV. NO. 01	DATE: 04.07.15
			SHEET 1 OF 3	
Data Sheet A & B				
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
GENERAL *	* PROJECT	2x 660 MW ENNORE STP		
	OFFER REFERENCE			
	* TAG NO. SERVICE			
	* DUTY	☐ ON / OFF	☐ INCHING	
	* LINE SIZE (inlet/outlet): MATERIAL			
	* VALVE TYPE	☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ BUTTERFLY		
	* OPENING / CLOSING TIME			
	* WORKING PRESSURE			
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF 0-55 DEG C AND RELATIVE HUMIDITY OF 0-95%		
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY		
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY		
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY		
CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, WEATHER PROOF, IP:68		
	MECHANICAL POSITION INDICATOR	TO BE PROVIDED FOR 0-100% TRAVEL		
	BEARINGS	DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.		
	GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION	METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.		
	SIZING	OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 85% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. FOR INCHING SERVICE - 150 STARTS/HR MINIMUM & FOR REGULATING SERVICE - 600 STARTS/HR MINIMUM.		
HANDWHEEL	* REQUIRED	☒ YES ☐ NO		
	* ORIENTATION	☐ TOP MOUNTED ☐ SIDE MOUNTED		
	*TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.			
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY		
	MOTOR MAKE / MODEL / TYPE / RATING (KW)	BIDDER TO SPECIFY		
	@ MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE RATED CURRENT- INCLUSIVE OF I.S. TOLERANCE		
	ACTUATOR APPLICABLE WIRING DIAGRAM	☐ ENCLOSED (BIDDER TO CONFIRM) A: ☐ DRG. NO. 3-V-MISC-24227 R00 B: ☐ DRG. NO. 3-V-MISC-24550 R00 C: ☐ DRG. NO. 3-V-MISC-24283 R00 D: ☐ DRG. NO. 4-V-MISC-90271 R11 E: ☐ For Thyristor based Integral starter, Bidder/Vendor to furnish wiring diagram		
	COLOUR SHADE	☐ BLUE (RAL 5012) ☐ DURING DETAIL ENGG.		
	PAINT TYPE (## Refer Notes)	☐ ENAMEL ☒ EPOXY ☐		
	SHAFT RPM	BIDDER TO SPECIFY		
	OLR SET VALUE	BIDDER TO SPECIFY		
	@ STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY		
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY		
	@ PWR SUPP TO MTR / STARTER	415V, 3PH, AC		
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ☐ 110 V		

324

	Data Sheet FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.: PE-ID-412-145-I902		
			VOLUME II B		
			SECTION D		
			REV. NO. 01	DATE: 04.07.15	
			SHEET 3 OF	3	
Data Sheet A & B					
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)		
POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty & other specific applications)	☒ REQUIRED ☐ NOT REQUIRED			
	MFR & MODEL NO.	BIDDER TO SPECIFY			
	TYPE	☐ ELECTRONIC (2 WIRE) R/I CONVERTER ☒ ELECTRONIC (2 WIRE) CONTACTLESS			
	SUPPLY	☒ 24V DC ☐			
	OUTPUT	☒ 4-20mA			
	ACCURACY	$\pm 1\%$ FS			
SPACE HEATER	@SPACE HEATER	REQUIRED			
	@ POWER SUPPLY (NON INTEGRAL)	230V AC, 1 PH., 50 Hz			
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY			
	@ RATING				
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED			
	ENCL CLASS ACTUATOR/MOTOR T.B.	@ ☒ IP 68 @ ☐			
	@ EARTHING TERMINAL	REQUIRED			
	PLUG & SOCKET (9 PIN) (FOR COMM, LS/TS FEED BACK, PoT)	☐ REQUIRED ☒ NOT REQUIRED ☐ 2 NOS. ☐			
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:			
	@ SPACE HEATER CABLE GLAND	SIZE:			
	OTHER CONTROL CABLE GLANDS	QUANTITY & SIZE : Cable gland suitable for 8Px0.5 sq mm & 2P x 0.5 sq mm Cable.			
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY		_____ Kg.	
NOTES: 1. SCOPE: DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY. 2. CODES & STANDARDS: DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATIONAL STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH: IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691 AND IS-4722 3. ACTUATOR SHALL HAVE HARDWIRED CONTACTS FOR FOLLOWING SIGNALS (a) ACTUATOR IN LOCAL MODE (b) ACTUATOR IN REMOTE MODE. 4. BIDDER TO ENSURE AVAILABILITY OF SPARE 1NO + 1NC LIMIT SWITCH & TORQUE SWITCH. 1 5. SS TAG NAME PLATE SHALL BE PROVIDED. 6. TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C. 1 7. CABLE GLANDS OF DOUBLE COMPRESSION TYPE, NI PLATED BRASS MATERIAL SHALL BE PROVIDED. 8. THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION. THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE. 9. THE MOTOR SHALL OPERATE SATISFACTORILY UNDER THE +/- 10% SUPPLY VOLTAGE VARIATION AT RATED FREQUENCY, -5% TO +3% VARIATION IN FREQUENCY AT RATED SUPPLY VOLTAGE, SIMULTANEOUS VARIATION IN VOLTAGE & FREQUENCY THE SUM OF ABSOLUTE PERCENTAGE NOT EXCEEDING 10%. 10. THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING. 1 11. LOCAL DIGITAL POSITION INDICATOR SHALL BE PROVIDED WITH EACH ACTUATOR. \$\$ TORQUE SWITCH & LIMIT SWITCH SHALL ACT INDEPENDENT OF EACH OTHER. TANDEM OPERATION IS NOT ACCEPTABLE. ## EPOXY PAINT IS RECOMMENDED FOR COASTAL AREAS.					
NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @= TO BE FILLED BY ES					

D.SPECIFICATION

FOR

MEASURING INSTRUMENTS

CHAPTER-3**FIELD AND MEASURING INSTRUMENTS****3.00.00 FIELD & MEASURING INSTRUMENTS (PRIMARY & SECONDARY INSTRUMENTS)****3.01.00 GENERAL REQUIREMENTS**

3.01.01 Instruments, control devices and other equipment accessories covered under this specification shall be furnished in accordance with I&C specification sheets and drawings enclosed herewith and the requirements of all applicable clauses of this specification.

3.01.02 The instrumentation and control equipment shall conform to all applicable codes and standards including those referred in Cl. no. 1.08.00 in this Volume. All equipment and systems shall also fully comply with the design criteria stated in chapter-2 of this part.

3.01.03 The instrumentation/control equipment and accessories shall be from the latest proven design for which the performance and high availability have been demonstrated by a considerable record of successful operation in power station service for similar applications. The bidder shall furnish sufficient evidence to fully satisfy the Owner in this regard.

3.01.04 For plug in type instruments, The plug & sockets shall be polarized to prevent wrong connections and have facility for secure coupling in plug-in position to prevent loose connections. Signal/Electrical connection shall be screwed connection with double compression type Nickel-plated brass cable glands for Explosion proof area, Flame proof area and high vibration prone area.

3.01.05 Every instrument requiring power supply shall be provided with a pair of easily replaceable glass cartridge fuse of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.

3.01.06 All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved. The enclosures of all electronic instruments shall conform to IP-65 unless otherwise specified (Explosion proof for NEC article 500, class 1, Division 1 area & flame proof) and an anti corrosive paint shall be applied to the field mounted enclosures / instruments. All the field instruments shall also be provided with SS tag nameplate and double compression type Nickel-plated brass cable gland. Gaskets, Fasteners, Counter and mating flange shall also be included wherever required with the field instruments.

3.02.00 Following minimum requirement of field instruments shall be fulfilled by Bidder (In addition, Redundancy criteria for field instruments shall be as specified elsewhere in specification): -

- i. Level switches / pressure switches / flow switches/any other process switches etc. for OLCS / Alarms / Interlocks / Protection. Pressure switches at inlet, outlet



- of individual pumps and discharge header of pumps for protection and auto start / stop & alarms.
- ii. Level switches for sump/tank level high/normal/ low/very low interlocks.
 - iii. Level Transmitters (Type as per Owner approval) for open sump/tank/bunker/vessel/heaters.
 - iv. Stand pipes on both side of tank for all level instruments (LT, LS & LG).
 - v. Flow elements with flow transmitter & Flow meter for flow measurement of process medium like Steam, Water, Air, Flue Gas, Fuel oil, open channel liquid, solid fuel, ash flow, DM water, Raw water, Instrument and Service air etc. as decided by owner.
 - vi. Pressure gauges and temp. Gauges at inlet and outlet of each heat exchanger and cooler.
 - vii. DPG, DPT & DPS across the filters/strainers.
 - viii. Tapping points/test points shall be provided.
 - ix. All primary Instruments, hardwares & JB's etc used for measurement for HFO, LDO & Turbine Lube Oil system shall be flame proof (IEC-79.1, Part I). All primary Instruments, hardwares & JB's etc used for measurement for Hydrogen shall be intrinsically safe and explosion proof as per NEC article 500, class 1, Division 1 area I.
 - x. All Thermocouples & RTDs shall be Duplex.
 - xi. All Field Instruments used in acid or alkaline atmosphere shall be with standard Anti corrosion coating i.e. the combination of Polyurethane and epoxy resin baked coating (ANSI/ISA-71.04).
 - xii. All primary instruments installed at "Minus level or Floor" shall be with protection class of IP 68.
 - xiii. Transmitters (all type) for monitoring & controls purpose.
 - xiv. Pull cord, belt sway, zero speed switches, emergency stop PB for conveyers, other limit switches, cable gland etc. of CHP which produce spark shall be provided with dust and flame proof enclosure conforming to IS-2148.
 - xv. Lockable Deinterlock switches shall be provided for CHP as per requirement.
 - xvi. Bidder shall provide electronics weighing in motion system as per IS-11547, hermetically sealed load cell of precision strain gauge type, 100% over load protection of cell and 250% overload protection for the construction; one calibrator attachment with two weighers.



- xvii All field mounted push button, selector switch etc. shall be as per IEC or NEMA 4X protection.
- xviii All limit switch shall be conform to IEC-60947-5-1.
- xix At APH, **temperature measuring device of different lengths forming grid** shall be provided to have average temperature for variable flow of flue gas, secondary air and primary air. These temperatures may be connected to nearest remote I/O panel.
- xx. On both left and right sides of furnace, separate lines shall be laid and provided with **furnace pressure transmitters having wider range** than the furnace pressure transmitter.
- xxi. Temp. Transmitters are envisaged with RTD & Thermocouples for monitoring services/application only. However any RTD & Thermocouples are used for control, interlock & protection application, same shall be directly wired to DDCMIS/DCS/PLC using instrumentation & Extension cables respectively.
- xxii. As for the water flow/ steam flow measurements, **necessary flow elements/transmitters are chosen in the process line and supplied such that their algebraic summation shall be mass balanced for calculating the system efficiency.**
- xxiii. Contacts less, electronic 2-wire position transmitters shall be provided for all inching type motorised valve and dampers.
- xxiv. For CW sump level, Raw water reservoir level, Turbine oil tank, coal bunkers, Ash Silo, LDO/HFO tank, DM water tanks, CS tank, Acid and alkali applications, only non contact type level transmitters like Acoustic, Ultrasonic, Radar based shall be provided by bidders as specified in NIT and as approved by owner.
- xxv. Considering the type of application, wireless technology to bring signals to DDCMIS may be adopted by interfacing with OPC gateway to avoid cabling for smart level transmitters specified above at sr. no. xxiv. However Wireless technology as adopted by Bidder shall be reliable and field proven in power plants and same shall be approved by Owner.
- xxvi. For Turbine oil, HFO/LDO applications & H₂ Gas application, zener protection on power supplies shall be included.
- xxvii. Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application. For HFO, LFO Applications, SS capillary with thin wafer element with ANSI RF flanged ends are to be provided. For hazardous area, explosions proof enclosure as described in NEC article 500 shall be provided.

FIELD INSTRUMENTS SHALL BE SUPPLIED & OFFERED AS PER DATA SHEETS SPECIFIED BELOW:



2 x 660 MW ENnore SEZ Supercritical Thermal Power
Project at Ash Dyke of NCTPS
Spec. No. CE/C/P&E/EE/E/OT.No.03/2013-14

Vol. V /Sheet - 40



3.03.00 TRANSMITTERS, SWITCHES, GAUGES AND PANEL MOUNTED INSTRUMENTS**3.03.01 Pressure, Differential Pressure, DP type Level and Flow Transmitters (PT, DPT, LT & FT)**

Smart Transmitters of the electronic type shall be furnished.

All Transmitter shall be installed in closed LIE in the boiler area. Similarly transmitter for TG shall also be in LIE except the transmitters located in covered area on TG floor and these shall be mounted in LIR.

Transmitters shall be equipped with mounting brackets suitable for a mounting in transmitter enclosures.

In general, Transmitters are envisaged to be grouped at several places as to be decided during detailed engg. stage. For this purpose, suitable enclosures complete with all tubing, fittings, purge meters, loop cable trays etc. shall be provided.

Type/Construction	:	Sealed capacitance/ Inductance/ Silicon resonance type
Material		
- Body	:	Die cast Aluminum with epoxy coating for air & flue gas SS316 for other services
- Diaphragm	:	316 SS
- Measurement element	:	Teflon seal
- Valves	:	Carbon steel for non-corrosive Applications SS316 for corrosive applications.
Output signal	:	4 to 20 m Amp. DC (Two wires) HART Compatible
Local Indicator	:	LCD indicator (5 digit) with scale of Engg. unit
Overall Accuracy	:	$\pm 0.04\%$ or better of Span for BTG package $\pm 0.065\%$ or better of Span for BO P packages $\pm 0.2\%$ or better of span for remote seal type transmitter.
Turn down ratio	:	100:1 in general
Stability	:	$\pm 0.15\%$ of URL for 5 years.
Response time	:	150 msec.
Power supply	:	24V DC nominal
Drive capability	:	600 Ohms nominal
Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
Span and Zero	:	Locally adjustable, non-interacting



Zero suppression /
elevation : At least 100% of Span

Connection

- Process : 1. Half (1/2) inch NPT (F)
Quarter (1/4) inch NPT
with/without oval flanges

- Electrical : Suitable for Plug in type connection (Both side of transmitter), unused entry with blind plug.

Accessories

- For Absolute Pressure Transmitters: Two (2) valve SS316 manifold

- For Gauge & Vacuum pressure transmitter : Three (3) valve SS316 manifold

- For DP, level & flow transmitter : Five (5) valve SS316 manifold

- For oil and corrosive liquids : Separator diaphragm seals

- For all transmitters : Mounting bracket

Manifold should not be mounted on the transmitter, Manifold shall be non integral and standalone type. Snubbers/Pulsation dampners shall be used where the process media is unstable for measurement such as the discharge of a pump. Over range protection shall be used where necessary. The coil syphons & condensate pots shall be used for steam services. Transmitters shall be provided with suitable drain & vent points.

3.03.01.01 Transmitters & other HART based instruments shall be supplied along with 3 Nos. of universal type hand held/portable pressure calibrators. Temperature transmitters shall be supplied along with 3 Nos. of hand held/portable mV source generators.

3.03.02 PRESSURE SWITCHES (PS) & DIFFERENTIAL PRESSURE SWITCHES (DPS)

Applicable Standards : IS3624 - 1966/ISA-RP-8.1 except as modified in spec.

Type/Construction : Bourdon/Sealed Diaphragm Piston
Actuated preferable. Indicators with contacts are not acceptable.

Materials

- Bellows : 316 SS

- Bourdon tube : 316 SS

- Movement : 316 SS

- Enclouser : Die-cast aluminum with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere.

- Protective Diaphragm : Teflon



Accuracy	:	$\pm$ One (1) percent or better
Repeatability	:	$\pm$ 0.5(half) percent or better
Setting & Differential	:	Adjustable
Contact		
- Number	:	DPDT /2 SPDT
- Type	:	Auto reset with internal Adjustable snap action micro switch
- Rating	:	5 Amp, 240V AC / 0.2 Amp, 220V DC
Connection - instrument	:	Half (1/2) inch NPT Male Process
Electrical	:	Suitable for Plug in type connection. All the switches are internally connected and brought to the surface with Amphenol male/female connection. Cabling need not terminated inside the switch. Cable ends are to be soldered in connector and to be inserted for easy maintenance.
- Over range protection	:	One Fifty (150) percent of full scale
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)
Accessories		
- 3 / 5 valve manifold	:	As applicable for all switches
- Self cleaning type pulsation dampners/Snubber (Material SS316)	:	Pump and compressor discharge lines
- Syphon	:	For all steam lines
- Protective separating diaphragm	:	For fuel oil & corrosive liquid lines.
Mounting	:	Local (in LIE/LIR for BTG package).

3.03.03 PRESSURE & DIFFERENTIAL PRESSURE GAUGES (PG & DPG)

Applicable standard	:	IS:3602-1966, IS/3624, ASME B 40.1
Type/Construction	:	
-760 mm to 1.0Kg/cm2	:	Bellows/Diaphragm
-Above1.0Kg/cm2	:	Bourdon Tube
- Suction side of pumps	:	Compound gauge
Materials		
- Bourdon tube	:	316 SS
- Bellows	:	316 SS
- Movement	:	316 SS
- Case	:	SS 316/ Die-cast aluminum with stoved enamel black finish. Epoxy coating



		shall be provided for corrosive atmosphere.
- Protective Diaphragm	:	Teflon
Dial size	:	150mm with shatter proof glass
Scale Details	:	Graduations in black lines on white dial, on white dial, 270 Deg. pointer deflection scale provided with glass cover. Smallest scale division shall be one (1) percent of full scale value or smaller. Pointer stop for all gauges.
Accuracy	:	$\pm$ One (1) percent or better
Connection - Instrument Process	:	1/2 inch NPT Male Bottom
Mounting	:	Local
	:	1/2 inch NPT Male (Back entry) mounted on local gauge board.
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)

Accessories

- 3 way needle valve/manifolds	:	For all gauges
- Self cleaning type	:	Pump and compressor discharge lines
Pulsation dampener/snubber (S316)	:	
- Syphon	:	For all steam lines
- Protective separating	:	For fuel oil and corrosive liquid lines

Other particulars

- External Zero adjustment	:	For all gauges
- Safety device	:	
Ranges 5 to 20 Kg/cm ²	:	Rubber blow out disc with open front construction.
Ranges above 20 Kg/cm ²	:	Neoprene safety diaphragm at the back with solid front construction.
- Over range protection	:	One Fifty (150) percent of full scale

Other Requirments

	:	Movement mechanism shall be glycerin filled for oil services & vibration prone area.
	:	For Fuel oil & corrosive liquid lines diaphragm type sensors required. Armored capillary of 10 M for Fuel oil & Corrosive liquid service.



- : Contact type pressure gauges are not acceptable for interlock & protection.
- : For condensate storage tank the pressure gauge in terms of 0-10000 mm wc or suitable range having **dial size of 300mm or bigger size** shall be provided.

3.03.04 **TEMPERATURE TRANSMITTERS**

Type	:	SMART type configurable from control room through HART protocol (HMS System).
Display type	:	Indicating type (5 digit LCD Display),
Accuracy	:	$\pm 0.10\%$,
Ambient temperature error	:	0.1% per 10°C change
Output	:	4-20 mA DC (2 wire system) HART compatible signals for analogue monitoring inputs to the distributed control system (DDCMIS), DCS & PLC.
Protection class	:	NEMA 4/IP66 or equivalent degree of protection for enclosure/ (Explosion/Flame proof for NEC Class-1, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
Material of accessories	:	SS316.
Stability	:	$\pm 0.1\%$ or ± 0.1 deg C of reading (whichever is great) for 2 years in case of RTD inputs and for 1 year in case of Thermocouples inputs.
Operating Voltage	:	16 – 48 V DC
Calibration	:	as per NIST monograph 125 for T/C & European Curve Alpha = 0.00385 for RTD .
Ref. Junction compensation	:	Provided
Span/zero adjustment	:	Locally adjustable, Non interacting
Auto calibration	:	Provided
Burn out protection upscale	:	Provided
Input - output isolation	:	Provided
Circuit ungrounded	:	Provided

Any RTD & Thermocouples shall be directly wired to DDCMIS/DCS/PLC for metal temperature application, bearing & winding temp application only.

The Temperature transmitter shall accept Universal dual inputs of all types of thermocouples & RTD, 0-5V input signals etc.



Temp. Transmitter shall be extremely stable against Ambient temp variation, The accuracy figure shall be inclusive of effect due to ambient temperature variation.

Considering the application & distance involved for monitoring parameters **wireless technology** shall be adopted by interfacing with DDCMIS through OPC connectivity. However Wireless technology as adopted by Bidder shall be reliable and field proven in power plants and same shall be approved by Owner.

3.03.05 RESISTANCE TEMPERATURE SENSORS WITH THERMOWELLS

Applicable Standard	:	ASME PTC 19.3 - Latest Revision DIN EN 60751:1996, BS EN/IEC60751:2008
Element	:	Platinum, R0=100 ohm 4-wire Duplex for Process Temp. Measurement Platinum, R0=100 ohm 3-wire Duplex for Bearing & Winding Temp. Measurement
Sheath Material/ Insulation	:	316SS/Compacted Magnesium Oxide
Sheath O D	:	8 MM
- Gauge	:	18 AWG
Terminals	:	Spring loaded high temperature ceramic base with silver plated brass for high vibrating locations.
Calibration	:	As per DIN Standard – 43760, Class A
Head	:	Hex Head, Die Cast Aluminum (Screwed) with galvanized SS chain
Response Time	:	6-10 Sec bare & 30 Sec. With protective sheath/thermowell
Accuracy	:	± 0.35 degree C or Class-A whichever is better.
Electrical connection	:	Gold plated Plug in type. Double entry – one unused entry with blind plug
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)

THERMOWELL

Applicable Standard	:	ASME PTC 19.3 TW - 2010
- Construction	:	Tapered drilled from Bar stock (Straight for Air & Gas systems)
- Material	:	- 316 SS/F11/F22/F91 - water and steam Services depending upon process parameters. - Inconel for air & flue gas services For furnace zone, impervious ceramic protecting tube of suitable material along



Temp., Fuel oil temp. measurement
as per IBR rules and regulations

3.03.10 TEST THERMOWELLS (TW)

Applicable Standard	:	ASME PTC 19.3 TW - 2010
Type/Construction	:	Machined from Bar Stock
Material	:	316 SS/F11/F22/F91
Connection	:	
- Pipe	:	M33 x 2
- Test Instrument	:	To suit test instruments
Accessories	:	Plug with chain
IBR Certification	:	For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations Bidder shall provide calculation for thermowell as per ASME – PTC- 19.3 TW - 2010.

Test wells shall be provided on main steam, reheat steam, extraction steam, feed water, condensate, spray water lines and other piping as required to meet ASME test requirements.

3.03.11 DIRECT MOUNTED LEVEL TRANSMITTERS (LT)

Displacer type level transmitter shall not be used in the process anywhere in the plant.

3.03.12 Ultrasonic Level Transmitter (for Water sump/Tank level, Raw water reservoir level, Cooling water fore bay level measurements)

Principle of Operation	:	Detection of reflected ultrasonic pulse
Measuring Ranges	:	Up to 30 meters (typical)
Signal Processing	:	Microprocessor Controlled Signal Processing
Operating Freq.	:	10 KHz to 50 KHz (typical)
Display	:	Head mounted alpha-numeric back lit LCD/LED
Calibration & Configuration	:	Accessible from front of panel & HART calibrator.
Diagnosis	:	On-line
Status	:	For power, Hi / Lo / V. Hi / V. Lo- level indication, fault etc.
Construction	:	Plug-on board
Power supply	:	240 V AC 50 Hz / 24V DC
Signal Output	:	4-20 mA DC with HART (isolated) - 600 Ohm load.
Hysteresis	:	Fully adjustable preferred
Output contacts	:	2SPDT Potential free changeover contacts @ 8A 230V AC.
Accuracy & Repeatability	:	$\pm 0.25\%$ of span or better
Resolution	:	$\pm 0.1\%$ of span
Temperature Compensation:	:	To be provided with Transducer.



Operating temp.	:	Transmitter-50 deg C and Sensor – 80 deg C
MOC Sensor	:	Body- PVDF and Face – Polyurethane
Humidity	:	1% to 95% non condensing.
Enclosure	:	IP-67 Epoxy painted die cast Aluminum or SS316L housing.
Cable Connection	:	3/4" ET
Mounting	:	2" – 4" NPT or flanged
Accessories	:	Cable gland, prefab cable, mounting accessories like EPDM seal, SS316 flanged etc.
		Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications which will be decided during detailed engineering.

3.03.13 CAPACITANCE TYPE LEVEL TRANSMITTER

The total system shall consist of capacitance probe, pre-amplifier and transmitter

Type	:	Capacitance type
Probe	:	a) Rod or suspended electrode. b) Rope type probes may be used only where required probe length is greater than 3 meters
Probe Mounting	:	Stainless steel 1-1/2 ANSI RF Flange / 3/4" NPT (M)
Material of construction	:	316 SS
Insulation	:	PTFE Part/Full as per service.
Transmitter	:	The transmitter shall receive output of the preamplifier and convert it into 4-20 mA DC output signal.
Accuracy	:	± 1% of Full scale
Repeatability	:	± 0.5 % of Full scale
Load	:	Min 600 Ohms
Enclosure	:	Powder/Epoxy coated Die cast aluminum. with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
Ambient temperature	:	0-60 °C.
Mounting	:	Wall / Surface
Supply voltage	:	240V AC, 50Hz / 24V DC
Response time	:	100 m sec or better
Cable connection	:	3/4" ET
Accessories	:	Counter flange, Cable gland, prefab cable if any
Preferable features	:	Alarm output contacts with adjustable set point facility

3.03.14 GUIDED WAVE RADAR/RADAR LEVEL TRANSMITTER

Type	:	Guided wave Radar (Contact type)/Radar (Non contact type) as finalized by owner.
Application	:	For Turbine Lube oil tank, HFO & LDO tank level,



Output Signal	:	Pulse
Material of Construction	:	AISI 316
Sensor Seal	:	PTFE / higher based on temperature
Flow range	:	As required.
Linearity	:	0.25% or better.
Repeatability	:	0.02% or better.
Ambient temperature	:	50 deg C
Mounting	:	On-Line mounting with flanges of stainless steel.
Enclosure	:	IP 65
Accessories	:	Nuts, bolts, gaskets etc.
Transmitter		
Electronics	:	Solid State
Power Supply	:	240V AC, 50Hz. UPS
Input	:	Input from Sensor
Display	:	4 1/2 digit LCD
Output	:	Isolated 4-20mA DC HART
Measuring Accuracy	:	0.5% of full scale range
Totalized Value	:	Required
Housing	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
Nameplate	:	Tag number, service engraved in stainless steel tag plate
Accessories	:	Clamping strip, bracket, prefab cable etc. Special tool kit for calibration/ configuration .

3.03.23 Flow Transmitter (Ultrasonic)

Type	:	ULTRA SONIC, 2-wired
Sensing element	:	Non-contact
Output	:	4-20mA with HART Protocol
Accuracy	:	$\pm 0.1\%$ FS
Supply	:	24 V DC
Enclosure class	:	IP-65
Transmitter		
Mounting	:	On Nozzle
Mounting position	:	Top mounted
Housing	:	Plastic
Display	:	Head mounted LCD Display and remote LCD display
Process connection	:	NPT/Flanged
Electrical connection :	:	NPT
Turn Down ratio	:	1:100
Measuring range	:	Adjustable (as per process requirement)
Totaliser	:	Required
Accessories	:	As per process requirement Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications which will be decided during



detailed engineering.

3.03.24 Positive Displacement Flow Transmitter

Positive displacement flow transmitters shall be offered. An electronic totalizer shall be provided for each flowmeter and the location of the totalizers shall be acceptable to the Owner. Air eliminators shall also be provided to ensure maximum accuracy.

Type	:	Hall Effect Sensor
Body Material	:	AISI 316L/Die Cast Aluminium.
Wetted part Material (Like Piston, Bearing, gear etc)	:	AISI 316L/Die Cast Aluminium.
O ring material	:	PTFE / higher based on temperature
Flow range	:	As required.
Accuracy	:	$\pm 0.5\%$ or better of reading
Repeatability	:	$\pm 0.03\%$ or better.
Ambient temperature	:	50 deg C
Mounting	:	On-Line mounting with flanges of stainless steel.
Electronics	:	Solid State
Power Supply	:	230V AC, 50Hz. UPS
Display	:	4 1/2 digit LCD for Flow rate & totalized value.
Output	:	Isolated 4-20mA DC
Turn Down ratio	:	1:30
Totalized Value	:	Required
Housing	:	IP-65/ (Explosion proof for NEC Class-1, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
Nameplate	:	Tag number, service engraved in stainless steel tag plate
Accessories	:	a) Clamping strip, bracket, prefab cable, battery etc.



- Nuts, bolts, gaskets, mesh etc.
b) Special tool kit for calibration/configuration.

3.03.25 Electromagnetic Flow meter

Electromagnetic flow meters shall have separate transmitter having accuracy $\pm 0.2\%$ with zero stability feature, suitable for process medium with ≤ 5 micron Siemens conductivity, flanges material SS-316, electrode & measuring tube material SS-316, liner material Teflon and enclosure IP-66, local digital display configurable as totaliser, 4-20 mA output signal HART compatible with zero and span field adjustable. Application – DM Water and for other application as decided by owner.

3.03.26 FLOW GAUGES (FG)

- Type/Construction : a) On-line type Rotameter for 50 Nb and below lines
b) Bypass type Rotameter for above 50 Nb lines.

Material**- For On-line type**

- Metering Tube : Borosilicate glass
Float : 316 SS
Packing : Teflon
End fittings : 304 SS

-For Bypass type

- Metering Tube : Borosilicate glass
Float : 316 SS
Packing : Teflon
End Fittings : 304 SS
Orifice Plate : 316 SS
Carrier ring : 304 SS
Flanges & Mating flanges : Same as pipe material, 200 lbs ANSI - RF
- Impulse pipe : Same as pipe material
- Fittings : 2000 ANSI, SW ends to match with pipe material.
- Dial Size/Scale length : 250 mm
Scale Details : Direct reading type engraved on detachable Aluminum scale
- Accuracy : $\pm$ Two (2) percent
Reproducibility : Half (1/2) percent
Rangeability : 1:10
Connection : SCRD NPT



Accessories	:	a) Isolating valves (for Bypass type only)
		b) Bolts, Nuts and Gaskets as required
Tests	:	Shall be tested at two hundred (200) percent of the maximum process pressure

3.03.27 SIGHT FLOW GLASS INDICATORS

Type/Construction	:	Flapper type.
Materials	:	
Body	:	Carbon steel/SS316 as per process requirement
Glass	:	Toughened Borosilicate
Gaskets	:	Neoprene
Bolts & nuts	:	SS
Flappers / Rotating Wheel	:	316 SS
Flappers / Rotating Wheel holder	:	304 SS
Process Connection	:	SW (Socket Welded)
Accessories	:	Scale, Bolts, Nuts, Cover plates and Gaskets as required
Tests	:	Tested at two hundred (200) percent of the maximum process pressure.

3.03.28 SOLID FLOWMETER

Type	:	Online Impact type Microprocessor Based
Measuring Principle	:	The system measurement is basically pertains to the measurement of horizontal deflection using LVDT, created by the impact of solid flow upon an online sensing plate. The horizontal deflection being proportional to the impact forces, LVDT convert this horizontal movement into electrical signal. The inbuilt integrator convert this signal into time based flow rate indication & provide totalized flow also.
Sensing plate	:	316 SS
Sensing head	:	Sensing mechanism shall be mounted outside the process flow line.
Enclosure	:	316 SS
Enclosure protection	:	IP 67 class
Accuracy	:	+/-1%
Repeatability	:	+/- 0.2%
Drift	:	Both zero & span $\pm$ 2% / month
Output	:	4-20mA DC isolated, load 600 ohm (min)
Digital communication	:	yes, (HART) facility
Power supply	:	240 V AC, 50Hz. UPS
Ambient condition	:	Temperature -60 ^o C, RH-95% Environment – Highly Dusty



Accessories : Shall be complete with all the accessories including digital display for flow rate, integral vents, baffles for air separation, etc. which ever required for satisfactory operation.

Note:-

1. The above on line flow meter shall not create any obstruction on flow.
2. User's list shall be submitted to support on proven satisfactory performance for similar process application.

3.03.29

Instrument Air System

The instrument Air Supply System for various pneumatic Control & Instrumentation devices like pneumatic actuators, power cylinders, I/P converters, pneumatically operated valves etc. shall be complete in all respect with necessary Air Filter Regulators, valves, piping/tubing etc.. Each pneumatic instrument shall have an individual air shut off valve. The pressure-regulating valve shall be equipped with an internal filter, a 50 mm pressure gauge and a built in filter-housing blow down valve.

Filter shall be of minimum 5-micron size & sintered bronze material.

On collection of water in the drains of instrument air lines, mechanical automatic drains and periodically solenoid operated drains (with electronic timer - 15m, 30m, 60m and 2 Hours & Timing adjustable) are to be provided.

For mechanical type & Electrical type, the locations to be provided in the instrument air lines of boiler area, Chimney area, turbine area etc., shall be decided during detailed Engineering.

Bulk header nearby the crowded applications shall be provided and from this bulk header individual air lines with necessary isolation valves are laid to the application.

These bulk header are to be provided with **mechanical / electronic based automatic Drains**.

Individual moisture separator for O₂ analyzer or vital application shall be provided nearby the instrument so as to enhance the cell life or the performance of vital final control elements.

3.03.30

Air Filter Regulator (AFR)

Constant bleed type AFR with an accuracy of ± 1.0 % inlet pressure range of 5-8 kg/ cm² and suitable spring ranges (AFR) for use with positioners in control valves, control damper, E /P converters and shut off valves for phosphor bronze filter element; Filtering particles above five microns. Weather and water proof enclosure. Material of accessories will be SS316.

Air filter regulators shall be provided in the :

- (a) Air supply line to valve positioners / power cylinders
- (b) Air supply line to electric to pneumatic converters.



- (c) Air supply line to pneumatic interlocked block valves.
- (d) For each instrument rack, field instruments enclosure for purging.

3.03.31 Electro-Pneumatic Convertors (E/P)

Two wire type E/P convertors with an accuracy of $\pm 0.25\%$ accepting 4-20 mA dc signals from control system and converting to 0.2 to 1 kg/cm² air pressure to operate valve positioner of all final control elements; Housed in cast aluminum casing (with polyurethane paint); NEMA 4 or equivalent degree of protection for enclosure. Material of accessories will be S.S. E/P convertors shall have fail freeze (stay put) feature also. Process connection shall be 1/4" NPT (F) and Electrical connection shall be 1/2" NPT (F). Zero/span adjustment facility shall be provided. The E to P converters shall **retain the pneumatic signal (last value) even in failure of control signal** and shall have **self volume boosters**. Necessary air lock devices and pressure switches for air pressure low alarming shall be provided.

3.03.32 Solenoid Valves

Solenoid valves shall be provided with control valves / pneumatic control valves hooked up with process interlock requirements and where direct tripping is involved. The number of ways for solenoid valve shall be provided as indicated below:

- (a) Two (2) way solenoid valves shall be provided, where process line of less than 50 mm with low pressure and temperature application.
- (b) Three (3) way solenoid valve shall be provided commonly, where the pressure is admitted or exhausted from a diaphragm valve or single acting cylinder, e.g., Pneumatic operated spray water block valve.
- (c) Four (4) way solenoid valve shall be provided for operating double acting cylinders, e.g., Pneumatically operated on-off type dampers.
- (d) For operation of the fuel oil corner nozzle valves, fuel oil trip valves etc., **double coil solenoid valve** (latch coil & relatch coil) shall be adopted.
Single coil usage requires always power and loss of power leads to closure of above valves resulting the unit trip or loss of generation.
- (e) Solenoid Valve coils shall be Class-H high-temperature or Class-F construction as applicable and shall be designed for continuous duty. Three-way solenoid valves shall be designed for universal operation so that the supply air may be connected to any port. Solenoid enclosures shall be NEMA-4/ (Explosion proof for NEC Class-1, Division 1 area)/ flame proof (IEC-79.1, Part I) As applicable). Body material of solenoid valve shall be Die Cast Aluminum or SS316.
- (f) All solenoid shall be with varistor, LED indication, surge suppress diode and circuits.

3.03.33 Power Cylinders (Pneumatic)

Mounting Type	:	a) Fixed position mounting (End mounting).
	:	b) Trunnion mounting
Control Signal	:	0.2 to 1 Kg/Sq. cm. from I/P converter for modulating purposes. 24V/48VDC operated solenoid valve operating on pneumatic line.



		The Pilot solenoid will have separate coils for open closing purpose.
Supply Air	:	0-7 Kg / Cm ² .
Selection	:	Based upon thrust / torque, stroke length, angular movement, full-scale travel time, repeatability, space factor etc. Provision for air-to-open and air-to-close operation.
Casing	:	IP-65.
Accessories (as required)	:	a) Air lock relay b) Hand wheel. c) Air filter regulator with gauge. d) Volume Booster. e) Limit Switches. f) Positioner with Input, Output and supply pressure gauges. g) Pilot Solenoid Valve (Double Coil type) h) Position Transmitter (4-20 mA DC linear output, LVDT or non contact type).
Fail-safe operation	:	Stay put, open or close position on pneumatic / electrical power supply failure as per process safety criteria.
Repeatability	:	Better than 0.5% of full travel.
Hysteresis	:	Less than 1% of full travel.



3.03.42

Junction Boxes

v.	Type	:	Flame proof/weather proof
vi.	Enclosure	:	IP-65/Explosion/Flame Proof as per area classification.
vii.	Material	:	FRP with protective Coating
viii.	Cable entry	:	Bottom or Side
ix.	Cable glands	:	Double compression type – Nickel plated brass with PVC hoods.
x.	Mounting	:	Indoor/Outdoor
xi.	No. of terminals	:	As required with standardization with 20% spare of each size & type.
xii.	Terminals	:	Phoenix/Wago (screw less cage clamp type spring loaded)
xiii.	Grounding	:	Two terminals for body and shield ground
xiv.	Door	:	Hinged, lockable type.
xi.	Suitable mounting clamps and other accessories shall be in scope of bidder.		
xii	The brackets, bolts, nuts, screws, glands, lugs required for erection shall be of brass, included in bidder scope of supply. High voltage & insulation resistance test shall also be conducted.		
Xiii	M6 Ni plated Brass earthing stud shall be provided (external 2 nos. internal 1 no.)		
xiv	Gasket (Normal)- Neoprene thickness 6.0 mm		

3.03.43

Interposing Relays (IPR)

Electromagnetic type IPRs with modular design, plug-in type connections, suitable for channel/DIN rail mounting in cabinets; coil rating 24V D.C; 2 set of silver plated change over contacts rated for 0.5A 220 V DC/8 A 240 V AC. Free wheeling diode across relay copper coil and self reset type status LED indicator flag (electronic) shall be provided. Manual forcing/override facility is required. The test voltage for relay shall not be less than 4 KV with operating temperature from –20 deg. C to 60 deg. C. The relay shall have the necessary approvals like V0 inflammability class in accordance with UL94", IEC60664/IEC60664A/DIN VDE 0110. Facility to stimulate IPR manually shall be provided. The VA burden of relays shall be suitable to match the capacity of output modules. Interposing relay & sockets for mounting the interposing relay shall be of same make only.

3.03.44

RECORDERS (CHARTLESS)

Type	:	Micro-processor based, Digital TFT display type
- No. of Channels	:	Forty Eight (48) point).



		6 Nos. of recorders shall be supplied with BTG packages and the parameters shall be decided during detailed Engineering. Quantities of recorders for BOP packages shall be decided during detailed Engineering. (Simultaneous parameter display preferred)
Input Signal	:	Fully configurable multi range (Programmable) universal (input)
Recording method	:	Continuous with different colour, for each channel
Display colour	:	Selectable from 30 Colours
Bar graph facility	:	To be provided
Digital indication	:	To be provided
Accuracy	:	+/- 0.1 % for reading for DC V Input And 0.1 Deg for TC/RTD input
Programmability	:	Front key board
Data Storage	:	hard disk/ Flash Memory
Data Retrieval	:	Compact 4 GB flash Memory card and USB port with 8 GB USB drive.
Scan rate	:	≤ 20 m second for individual channel. Selection of scan time for individual channel is required.
Power Supply	:	240 VAC 1 Phase UPS
Ambient Temperature	:	0-50 Degrees
Mounting	:	Front panel mounted weather & Dust proof IP 65
Application software	:	Yes, To be provided
Internal Memory	:	400 MB or more
Screen	:	≥ 10.5" colour LCD TFT
Resolution	:	≥ 640 X 480 Pixels
Type of Display	:	i) Trends ii) Bar Graph iii) Digital display/ values
Event Sampling	:	1/2/5/10/30/60/120 sec.
Zoom & Scroll Facility	:	Required
OWS and printer connectivity port	:	Required
	:	Necessary software shall be supplied for uploading the data.
Communication	:	Additional MODBUS/PROFIBUS ports connectivity between recorder and third party systems.

3.03.45 DIGITAL INDICATOR

Type	:	Programmable electronic digital indicator with floating point decimal.
Input	:	4-20 mA DC/1-5V DC/RTD/T/C.
Number of inputs	:	One
Range	:	As per requirement/adjustable by end user



		through key pad available on the indicator.
Number of digits	:	Four plus sign
Digit height	:	20 mm or larger
Display	:	Fluorescent red
Input over range/open sensor (T/C)	:	All digits to flash
Input hold time	:	0.7 seconds max.
Accuracy	:	$\pm 0.25\%$ of span
Power supply	:	240V AC, 50Hz
Mounting	:	Flush panel, compatible for mounting on mosaic grid panel
Size	:	96x48 mm
Other Particular	:	Indicator receiving thermocouple signal shall have automatic cold junction compensation.
	:	Retransmission Output 4 -20 mA isolated required.
	:	24 V DC inbuilt power supply
	:	Alarm contact with 2 N/O/NC contact (rating 5A/230 V AC)

3.03.46 RECEIVER INDICATORS (SINGLE/DUAL CHANNEL)

Type	:	Analogue indicator
Input Signal	:	Universal input (T/C, RTD, 4-20 mA, Voltage)
Scale	:	Range fully configurable and programmable
Measurement Accuracy	:	$\pm 0.2\%$ of span ± 1 count
Resolution	:	0.5% Span
Dead band	:	$\pm 0.2\%$ of span
Repeatability	:	0.2% of span
Full scale response time	:	Less than two(2)seconds
Power Supply	:	240V AC, 50 Hz
Connection	:	Plug in type
Accessories	:	Mounting Bracket for Bins
Other Particulars	:	Indicator receiving thermocouple signal shall have automatic cold junction compensation.
	:	Retransmission Output 4 -20 mA isolated required.

3.03.47 Temperature Scanner

Type	:	Microprocessor based Electronic Digital Scanner.
No. of channels	:	16/24 (as per the application)
Input	:	RTD /Thermocouple/4-20mA
Accuracy	:	± 0.1 of FS ± 1 count
Number of digits	:	4 digit (7 segment display with Engg. Units)
Digit height	:	12 mm or larger
Display color	:	Fluorescent red/green
Display mode for	:	



Input over range/open sensor	:	All digits to flash
Mounting	:	Panel mounting
Zero and Span	:	Adjustable by digital calibration
Serial communication communication	:	Isolated RS232/485 for modbus-RTU
Memory Capacity	:	5MB Flash
Alarm output	:	Required
Contact rating	:	2A at 220 V AC
Power supply	:	240 V AC/24 V DC
Properties	:	i. Any channel shall be configured for Data Logging
		ii. Channel to Channel online Isolation shall be provided
		iii. Real Time RTC Interface for Printer shall be provided
Operation Modes	:	Auto/manual mode, Run mode, Verify mode, Calibration Mode, Program mode.

3.03.48 AMMETERS (AMM)

Input	:	4-20 mA DC
Mounting	:	Flush panel, compatible for mounting on mosaic grid panel
Face Dimensions	:	96 x 96 mm
Scale/Type	:	Moving coil, circular, FSD 240 deg. With six times suppression scale
Zero adjustment	:	Screw on meter face
Accuracy	:	± 1 percent (class 1)
Indication	:	Pointer with scale
Magnetic Shield	:	Shielded Case
Quantities	:	For all HT Motors & LT motor with rating ≥ 30 KW and other critical application motors/drives.

3.03.49 VOLTMETER:

Input	:	4 - 20 mA DC
Mounting	:	Flush Panel, compatible for mounting on mosaic grid panel
Face Dimension	:	96x96 mm
Range	:	As per requirement
Accuracy	:	$\pm < 0.5$ %
Indication	:	Digital type 4 1/2 digit
Magnetic Shield	:	Shielded Case
Connection	:	Plug in type
Quantities	:	For 230 V AC input power supply, UPS power supply, 24 V DC interrogation voltage & 220 V DC.

3.03.50 FREQUENCY METER/MW METER (DIGITAL)

2 x 660 MW ENNORE SEZ Supercritical Thermal Power
Project at Ash Dyke of NCTPS
Spec. No. CE/C/P&E/EE/E/OT.No.03/2013-14



Type	:	Electronic digital 7- segment with fluorescent display
Input	:	4 - 20 mA DC
Mounting	:	Flush Panel compatible for mounting On mosaic grid panel
Number of digits	:	4 1/2 digit
Face Dimension	:	192X192 mm
Digit size	:	Approximately 40 mm
Range	:	As per requirements
Accuracy	:	± 0.2 Hz
Display	:	Red LED display.
Connection	:	Plug in type
Magnetic Shield	:	Shielded Case

3.03.51 AC CURRENT TRANSDUCERS

Input	:	0 - 1 A CT current
Output	:	Dual 4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.52 DC CURRENT TRANSDUCERS

Input	:	0 - 75 mV
Output	:	Dual 4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.53 AC VOLTAGE TRANSDUCERS

Input	:	0 - 110 V PT, Volts
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.54 DC VOLT TRANSDUCERS

Input	:	System Voltage
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.55 TRANSDUCERS FOR POWER

Input	:	CT and PT (1A) (110V)
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.56 TRANSDUCERS FOR FREQUENCY

Input	:	110 V PT Volts
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.57 TRANSDUCERS FOR POWER FACTOR

Input	:	PT (110V)
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.58 TRANSDUCERS FOR MVAR

Input	:	CT & PT (110V/1A)
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.59 DIFFERENTIAL FREQUENCY TRANSDUCERS (FOR SYNCHRONIZATION)

Input	:	110 V PT
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.60 DIFFERENTIAL VOLT TRANSDUCERS (FOR SYNCHRONIZATION)

Input	:	System voltage
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.61 PUSH BUTTONS (PB)/ ILPBs FOR ON/OFF, OPEN/CLOSE, START/STOP

Type	:	Momentary/Miniaturised Suitable for mosaic grid 24x48 Mm with 2 PB and 3 coloured LED.

Contact Configuration	:	2 NO + 2 NC
Contact Material	:	Hard Silver Alloy
Contact Rating	:	500V / 10 A
Insulation Voltage terminals and earth	:	2 KV for 1 minute between

Lamp Rating :-

a) Voltage	:	240 V AC
b) Watt	:	2 Watt (approx.)

Colour



5.11.00 Technical Specifications of Conductivity Analyser

a)	Applicable standard	ASME PTC 19.11-1970 except as modified in this specification.
b)	Type:	
	i) Cell	Flow through type/ removable type (withdraw able with sealing valve)
	ii) Monitors	Electronic (Microprocessor based) indicating type with multi range facility
c)	Material :	
	i) Cell	Epoxy resin/SS316
	ii) Electrode	Platinised/SS316
	iii) Monitors body	Carbon steel/Aluminum/Polycarbonate
d)	Monitor output	
	i)	4-20 mA D.C. with HART protocol spare out put
	ii)	4-20mA DC with HART protocol for DDCMIS Output load : 500Ω
e)	Power supply	240V, AC, 50 Hz from UPS
f)	Accuracy	± 1% of full scale span
g)	Stability	± 1% of full scale per month non-cumulative
h)	Repeatability	± 0.3% of span



- i) Annunciation contacts from monitors
 - i) Number 2SPDT
 - ii) Type Snap action micro switch
 - iii) Rating 5 amp, 240 V, 0.2 Amp, 220V DC
- j) Connection:
 - i) Cell
 - On line/pipe mounted
(ON LINE in sample table)
1/4 (Quarter) inch NPT (F) SCRD for
on-line type and Three quarter (3/4) inch NPT (M)
SCRD for pipe mounted.
flush panel mounting
 - ii) Monitors
- k) Electrical Half (1/2) inch NPT (F) SCRD
- l) Accessories
 - i) Automatic temperature compensation in the range 0-100°C
 - ii) Ammonia (NH₃) removal equipment.
 - iii) Sample coolers
 - iv) Flow and pressure regulators
 - v) SS316 impulse tubing and fittings
 - vi) Isolation & drain valves as required
 - vii) Other accessories as required
 - viii) Adequate length of cables for connecting coils to monitors
 - ix) Sample rate set valves
 - x) Alarm settings and Alarm indications on monitor.
- m) Other particulars Cell shall be suitable for maximum pressure of 7 kg/cm² and maximum temp. of 100°C
- n) Response time ≤ 3 seconds

5.11.01 CONDUCTIVITY COMPARATOR

Applicable Standard	:	ASME PTC 19-11-1970 except as modified this specification
Type of cells	:	Flow through type / removable type with draw able with sealing valve)
Transmitter	:	Electronic (Micro processor based) indicating type with multi range facility pipe mounted.
Material of Cell body	:	SS316
Material of cell Electrode	:	Platinised/SS316
Output	:	4 to 20mA DC isolated with HART output



Power Supply	:	240V AC, 50 Hz. From UPS
Accuracy	:	+/-1% of full scale span.
Stability	:	±1% of full scale per month non-cumulative
Repeatability	:	+/-1% of span
Protection class	:	IP - 65
Process connection	:	¼ inch NPT (F) / SCRD for on line type. ¾ inch NPT (M) SCRD for pipe mounted
Electrical connection	:	½ inch NPT (F) SCRD
Accessories	:	Automatic temp. Compensation in the range of 0-100 Deg.C

5.12.00**Technical Specification of pH Cell and Transmitters**

a)	Applicable Standard	pH electrodes shall conform to IS: 6804-1972 except as modified in this specification
b)	Type:	
	i) Cell	Measuring and Reference Electrode Combination with Flow through type (SS316/Polypropylene flow chambers) for power plant's steam & water application. Sensor shall not be affected by flow variation. Sensor shall be designed for power plant applications.
	ii) Monitors	Electronic (microprocessor based) indicating type with adjustable range facility.
c)	Material:	
	i) Measuring & reference	Toughened sensitive
	ii) Electrode	pH glass
	iii) Monitor body	Carbon steel/Aluminum/Polycarbonate
d)	Monitor output	
	i)	4-20 mAmp D.C. with HART protocol spare out put
	ii)	4-20mA DC with HART protocol for DDCMIS Output load : 500Ω
e)	Power supply	240V AC, 50 Hz from UPS
f)	Accuracy/repeatability	+ 0.03 pH/+0.02PH
g)	Resolution	+ 0.01 pH or 1 mV. 1C
h)	Stability	0.02 pH per week
i)	Annunciation contacts from monitors:	



	i)	Number	2 SPDT 'Hi' and 'Lo'
	ii)	Type	Snap action micro switch
	iii)	Rating	5 amp, 240V AC, 0.2 Amp, 220V DC
j)	Connection:		
	i)	Process	One-quarter (1/4)inch NPT(F) SCRD ON-LINE
	ii)	Electrical	Half (1/2) inch NPT(F) SCRD
k)	Mounting:		
	i)	Cell	Pipe Mounted
	ii)	Monitors	Flush panel mounting
l)	Accessories		
	i)	Automatic temperature compensation with fast response integral temperature sensors in the range 0-100°C	
	ii)	Co-axial cable as required	
	iii)	Sample coolers	
	iv)	low and pressure regulators	
	v)	Standard pH solutions	
	vi)	SS316 impulse tubing and fittings	
	vii)	Isolation & drain valves as required	
	viii)	Electrode holders	
	ix)	Other accessories as required	
	x)	Sample rate set valves	
	xi)	Alarm settings and indications on monitor.	
	xii)	RFI/EMI shielded, weather and corrosion proof casing	

5.13.00 Technical Specification of Dissolved Oxygen Analyser

a)	Applicable Standards	ASTM PTC 19.11-1970 except as modified in this specification	
b)	Type	Microprocessor based Electro-chemical	
c)	Material	Die-cast aluminum/SS/Polycarbonate	
d)	Output	i) 4-20 mAmp DC spare output ii) 4-20 mAmp, DC Isolated output for DCS.	
e)	Supply	240V AC, 50 Hz from UPS	
f)	Accuracy	± 5 % of reading	
g)	Response:		
	i)	Sensitivity	$\pm$ Two (2) per cent overall
	ii)	Time (sensor)	Less than 30 seconds for 90% step change.
h)	Connection:		



i)	Process	One quarter (1/4) inch NPT(F) SCRD
ii)	Electrical	Half (1/2) inch NPT (F) SCR D
i)	Accessories	i) Sample cooler assembly with shut off valve at cooling water inlet, with thermometer and reducing valve at sample outlet. ii) Flow stabilizer iii) Automatic temperature compensation iv) Other accessories as required v) Calibration device.
j)	Ranges	As per sample stream detail table
k)	Mounting	Flush
l)	Annunciation contacts:	
i)	Number	2 SPDT
ii)	Type	Snap action microswitch
iii)	Rating	5 Amp 240V AC, 0.2 amp 220V DC

5.14.00 Technical Specification of Silica Analyzer (SI OX)

a)	Applicable standard	ASME PTC 19.11-197 except as modified in this specification
b)	Type	Multi Channel (max of each Three channel) Colorimetric Analyzer (with auto reagent shut off feature in case of sample loss or power loss) built in phosphate inhibition feature. Micro processor based.
c)	Material:	
i)	Case	Die cast aluminum
d)	Cycle/Response Time	Twelve (12) minutes Maximum
e)	Analyser output	i) 4 to 20 m Amp DC for spare output ii) 4 to 20 m Amp DC Isolated output for DCS/PLC
f)	Power supply	240V AC, 50 Hz from UPS
g)	Accuracy	$\pm 1\%$ of span
h)	Repeatability	$\pm 2\%$ of full scale
i)	Sensitivity	0.2 micrograms/liter
j)	Connection:	
i)	Process	Quarter (1/4) inch NPT(F) SCR D
ii)	Electrical	Half (1/2) inch NPT (F) SCR D
k)	Ranges	As per sample stream detail table



l)	Mounting	Flush
m)	Annunciation contacts:	
	i) Number	2 SPDT
	ii) Type	Snap action micro switch
	iii) Rating	5 amp 240V AC 0.2 Amp 220V DC
n)	Accessories	
	i)	Automatic temperature compensation between 5 to 50 deg C
	ii)	Automatic zeroing provision
	iii)	SS316 tubing & vessels
	iv)	All chemical reagents for 12 months operation of the analyzer
	v)	Sample rate set values
	vi)	Comprehensive diagnostic and alarm features.
	vii)	Auto sampling facility with necessary valves & solenoids in the sample lines shall be provided.

5.15.00 Technical Specification of Hydrazine Analyzer

i)	Type	Microprocessor based Electrochemical
ii)	Case material	Die-cast aluminum/SS/Polycarbonate
iii)	Analyzer output	
	i)	4-20 mA DC for spare output
	ii)	4-20 mA DC isolated output for DDCMIS
iv)	Power supply	240V AC, 50 Hz from UPS
v)	Accuracy	±2% of full scale
vi)	Response Time	<4 minutes.
vii)	Sensitivity	1.0 microgram/liter
viii)	Annunciation contacts:	
	- Number	2 SPDT
	- Type	Snap action micro switch
	- Rating	5A 240V AC, 0.2 A, 220V DC
	- Mounting	Flush mounting
ix)	Accessories	
	i)	Flow regulator
	ii)	Flow gauges
	iii)	Other accessories as required
	iv)	Sample rate set valves
	v)	Chemical reagents as applicable for 12 months consumption

5.16.00 Technical Specification of Sodium Ion Analyzer

i)	Type	Microprocessor based Continuous flow through sample type with sodium responsive



		electrode and reference electrode having pH adjustment facility (Max 3 streams)
ii)	Case material	Die-cast aluminum/SS/Polycarbonate
iii)	Analyzer power supply	240V AC, 50 Hz from UPS
iv)	Analyzer output	i) 4-20 mA DC for spare output ii) 4-20 mA DC isolated output for DDCMIS
v)	Accuracy	Better than $\pm 5\%$ of full scale
vi)	Response Time	6 minutes. max
vii)	Sensitivity	0.1 ppb
viii)	Annunciation contacts:	
	- Number	2 SPDT
	- Type	Snap action microswitch
	- Rating	5A 240V AC, 0.2A, 220V DC
	- Mounting	Flush
ix)	Terminal points	All components piped & wired to terminal points
x)	Accessories	i) Flow regulator ii) Flow gauges iii) Sample rate set valves iv) Other accessories as required to make the system complete v) Chemical reagents as applicable for 12 months consumption

5.17.00 Technical Specification of Phosphate Analyzer

i)	Type	Microprocessor based Continuous flow through sample type with colorimetric detection system (Max 3 streams)
ii)	Case material	Die-cast aluminum/SS/Polycarbonate
iii)	Analyzer power supply	240V AC, 50 Hz from UPS
iv)	Analyzer output	i) 4-20 mA DC for spare output ii) 4-20 mA DC isolated output for DDCMIS
v)	Accuracy	Better than $\pm 4\%$ of full scale
vi)	Sensitivity	Better than 1 ppm
vii)	Annunciation contacts:	
	- Number	2 SPDT
	- Type	Snap action micro switch
	- Rating	5A 240V AC, 0.2A, 220V DC
	- Mounting	Flush
viii)	Terminal points	All components piped & wired to terminal points
ix)	Accessories	i) Flow regulator



- ii) Flow gauges
- iii) Sample rate set valves
- iv) Other accessories as required to make the system complete
- v) Chemical reagents as applicable for 12 months consumption

5.18.00 Technical Specification of Chloride Analyzer

- i) Type Microprocessor based Continuous flow through sample type.
- ii) Analyzer power supply 240V AC, 50 Hz, Single Phase from UPS
- iii) Analyzer output
 - i) 4-20 mA, DC spare output
 - ii) 4-20 mA, DC isolated output for DDCMIS
- iv) Accuracy Better than ± 10 % of full scale
- v) Sensitivity Better than 1 ppm
- vi) Range As per Requirements.
- vii) Annunciation contacts:
 - Number As per schedule, 2 SPDT
 - Type Snap action micro switch
 - Rating 5A, 240V AC, 0.2A, 220V DC
 - Mounting Flush
- viii) Terminal points All components piped & wired to terminal points
- ix) Accessories
 - i) Flow regulator
 - ii) Flow gauges
 - iii) Sample rate set valves
 - iv) Other accessories as required to make the system complete

5.19.00 Technical Specification of Chlorine Analyzer

- i) Type Microprocessor based Continuous flow through sample type with automatic temperature compensation.
- ii) Analyzer power supply 240V AC, 50 Hz, Single Phase from UPS
- iii) Analyzer output
 - i) 4-20 mA, DC spare output
 - ii) 4-20 mA, DC isolated output for DDCMIS
- iv) Accuracy 0.005 mg/ltr. or 1% of range.
- v) Sensitivity 0.001 mg/ltr. (1 ppb)
- vi) Range As per schedule.
- vii) Annunciation contacts:
 - Number As per schedule, 2 SPDT



	-	Type	Snap action micro switch
	-	Rating	5A, 240V AC, 0.2A, 220V DC
	-	Mounting	Flush
viii)		Terminal points	All components piped & wired to terminal points
ix)		Accessories	i) Flow regulator ii) Flow gauges iii) Sample rate set valves iv) Other accessories as required to make the system complete

5.20.00 Technical Specification of Residual Chlorine Analyser**SENSOR**

Method	:	Amperometric
Electrodes	:	Gold Cathode/Silver Anode
Cell Material	:	PVC
Electrolyte	:	Potassium Bromide

TRANSMITTER

Type	:	Microprocessor Based with self diagnostic features
Transmitter Output	:	4 – 20 mA
Enclosure Protection	:	IP65
Enclosure Material	:	Polyester coated Al.
Electrical Connection	:	½" NPT (F)
Mounting	:	FIELD
Display Type	:	LCD
Display Details	:	4 digit backlit LCD matrix
Diagnostics	:	Required
Meter Range	:	0-1 mg/l
Resolution	:	0.01 ppm
Area Classification	:	SAFE
Electromagnetic Compatibility	:	BUILT – IN
Temp. Compensator	:	AUTO – BUILT – IN
Temp. Compensating element	:	PT100

5.21.00 Technical Specification of Turbidity Analyser**SENSOR**

Reference type	:	On Line
Operating principle	:	Alternating Light Source
Cleaning	:	Self Cleaning
Electrode holder – type	:	Flow Through
Body Material	:	CPVC
Process Connection	:	½" NPT (F)





STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR ANALYTICAL INSTRUMENTS

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	VISUAL						
	MAKE, MODEL No.						
	POWER SUPPLY						
	TYPE						
2	DIMENSIONS CHECK			P	V	V	
3	FUNCTIONAL CHECK			P	V	V	
4	LEAKAGE TEST			P	V	V	
5	HV / IR TEST			P	V	V	
6	LINEARITY			P	V	V	
7	RESPONSE TIME			P	V	V	
8	ENCLOSURE CLASS			P	V	V	
9	ACCESSORIES, AS APPLICABLE			P	V	V	
10	ACCURACY / CALIBRATION			P	V	V	
11	ALARM CONTACT TEST			P	V	V	
12	ANALOG OUTPUT CHECK			P	V	V	
13	BURN-IN TEST OF ELECTRONIC PARTS	1/LOT		P	V	V	
14	IN-BUILT INDICATOR, ZERO, SPAN, RANGE SCALE SELECTION ETC	SEE NOTE-1 BELOW		P	V	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL,
P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR ANNUNCIATORS

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE/ MODEL						
	DIMENSIONS OF HARDWARE						
	MODULARITY						
	SEQUENCE						
	FACIA DETAILS						
2	FUNCTIONAL TEST	100%		P	W	V	
3	IMMUNE TO STEP VARIATIONS IN THE POWER SUPPLY	SEE NOTE-1 BELOW		P	W	V	
4	DEGREE OF PROTECTION FOR ENCLOSURE	TYPE TEST		P	W	V	
5	I/R CHECK	SEE NOTE-1 BELOW		P	W	V	
6	RESPONSE			P	W	V	

Legend :

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Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TRANSMITTER

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECKS FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	VISUAL.						
	MODEL/TAG No						
2	PROCESS CONNECTION			P	W	V	
3	ACCURACY			P	W	V	
4	REPEATABILITY			P	W	V	
5	HYSTERESIS			P	W	V	
6	EFFECT OF TEMP VARIATION ON ACCURACY			P	W	V	
7	SPAN / ZERO ADJUSTMENT	ONE / TYPE		P	W	V	
8	EFFECT OF SUPPLY VOLTAGE VARIATION			P	W	V	
9	EFFECT OF LOADING (500 OHM METERS)			P	W	V	
10	HIGH PRESSURE TEST	SEE NOTE-1 BELOW		P	W	V	
11	BURN-IN TEST	ONE / TYPE		P	W	V	
12	DEGREE OF PROTECTION			P	W	V	
13	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	

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Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- When material corelation are not available manufacturer's compliance to be provided.
- Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR SOLENOID VALVES

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	MAKE						
	MODEL No.						
2	MATERIAL (BODY. PLUNGER/TRIM)			P	W	V	
3	PORT SIZE			P	W	V	
4	CABLE CONNECTION SIZE			P	W	V	
5	ENCLOSURE CLASS			P	W	V	TYPE TEST CERTIFICATE TO BE FURNISHED BY VENDOR
6	No. OF COILS & INSULATION CLASS			P	W	V	TEST CERTIFICATE TO BE FURNISHED FOR INSULATION CLASS BY VENDOR
7	POWER SUPPLY CHECK			P	W	V	
8	IR / HV TEST			P	W	V	
9	FUCTIONAL TEST			P	W	V	

Legend :

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Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR PRESSURE & DP GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks	
				M	C	B		
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V		
	SENSOR TYPE							
	DIAL SIZE							
	MODEL NO/TAG NO							
	RANGE/SCALE							
	SWITCH CONTACT RATING & NOS.							
	END CONNECTION							
2	CALIBRATION				P	W	V	
	ACCURACY							
	REPEATABILITY							
	SET POINT ADJUSTMENT							
3	OVER PRESSURE & LEAK TEST			P	W	V		
4	OPERATION OF PRESSURE. RELIEF DEVICE	ONE		P	W	V		
5	REVIEW OF TC FOR	FOR LOT		V	V	V		
	MATERIALS OF SENSOR							
	MOVEMENT							
	PROCESS CONNECTION							
	HOUSING							
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST	V	V	V			
7	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW	V	V	V			

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- When material correlation is not available, MFR's compliance to be provided
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR PRESSURE SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	1.1 MODEL NO/TAG NO						
	1.2 RANGE						
	1.3 END CONN						
	1.4 NO. OF CONTACT						
2	CALIBRATION			P	V	V	
	2.1 REPEATABILITY						
	2.2 SET POINT ADJUSTMENT						
	2.3 DIFFERENTIAL						
3	OVER PR & LEAK TEST				P	V	V
4	ELECT. INSULATION/HV TEST	ONE		P	V	V	
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT		V	V	V	
	5.1 SENSOR						
	5.2 MOVEMENT						
	5.3 PROCESS CONNECTION						
	5.4 HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	REVIEW OF TC OF MICROSWITCH	FOR LOT		V	V	V	

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Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to carry out ROUTINE TEST on 100 %.
- Contractor to provide compliance certificate for tests/checks verified by contractor and the same alongwith test certificates to be verified by BHEL



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR LEVEL GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR TYPE	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS / DRWGS	P	W	V	
	MODEL/ TAG NO.						
	DAIL SIZE						
	RANGE/SCALE						
	END CONNECTION						
2	DIMENSIONS, PROCESS CONNECTION	ONE / LOT		P	W	V	
3	ACCURACY			P	W	V	
4	MATERIAL TC FOR			P	V	V	
	BODY ISO.						
	VALVE						
	GAUGE GLASS						
5	HYD. TEST	SEE NOTE-1 BELOW		P	W	V	
6	ACCESSORIES AS APPLICABLE			P	W	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL,
P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.

E.SPECIFICATION FOR PLC

Bidder's equipment which are vulnerable to electrical noise shall be hardened to eliminate possible problems.

The Bidder shall be fully responsible for detailed recommendations on the type, size, shielding, input balancing, ripple amplitude and frequency, isolation and grounding for field inputs and for the equipment furnished by the Bidder to achieve an installation with minimum noise from all sources.

The Bidder shall carefully review the Electrical Field Construction and cabling specifications given in Section-9 of this volume. If the performance of the equipment furnished by the Bidder is likely to be adversely affected in any manner because of these cabling and electrical field construction practices, the Bidder shall bring this to the attention of the Owner along with his proposal.

Any additional equipment, services required for effectively eliminating the noise problems shall be identified by the Bidder and shall be included in his lump sum proposal.

The Bidder shall be fully responsible for satisfactory elimination of any noise problems that evidence themselves following the installation of the equipment. All expenses incurred in the elimination of noise problems shall be borne by the Bidder.

2.14.00 SURGE-PROTECTION DESIGN CRITERIA FOR SOLID STATE/MICRO PROCESSOR BASED EQUIPMENTS/DCS/DDCMIS/PLC/UPS etc.

- i. All solid-state equipment shall be able to withstand the noise and surges inherent in a powerhouse. The equipment shall be designed to successfully withstand without damage to components and/or wiring, application of surge withstand capability (SWC) wave whose shape and characteristics are defined in ANSI publication C37.90a - 1974 entitled "Guide for surge withstand capability (SWC) Tests".
- ii. All solid state equipments, power supply to electronic cards, power supply to controllers, PLC panels, DDCMIS panels, SMPS power supply, UPS, battery chargers etc shall have external surge protection device with Pluggability and life indication as per IEC 61643-1:1998-02 and E DIN VDE 0675 part 6:1996-03/A2: 1996-10, to withstand max. 40 kA, 8/20 u Sec of Surge. The connection of the devices should be made as per TT configuration wherever applicable.
- iii. Signal lines shall have surge protection devices with pluggability and testability as per IEC 61643-21:2000-09 and E VDE 0845 part 3-1:1999-07, to withstand max. 20 kA, 8/20 u Sec of surges.
- iv. For data lines, communication lines, Ethernet/Can networks/LAN, Coaxial lines modular surge protection device should be used as per IEC 61643- 21:2000-09 to withstand a min of 2.5 kA, 8/20 u Sec of surges. The surge protection device should be used with the corresponding connector as being used for the lines i.e. RJ45, D-Sub, BNC, N-Type etc.

"The Bus systems (like Profibus/ Modbus etc) or the Serial Port Systems (like RS-232/ RS-485 etc) shall be protected with suitable surge protection devices, confirming to the latest IEC-61643-21 guidelines. The surge handling capacity of



device shall at least be 10 K A, 8/20 μ Sec between core-core and 20 K A, 8/20 μ Sec between core-ground. The device shall be pluggable & on-site testable".

- v. All electronic cards/modules shall also be protected from failure against accidental/inadvertent application of high voltage upto 500V DC (common mode) even though these modules may be designed to operate at lower voltage levels such as 24V/48V.
- vi. In the case of DC powered system/subsystem/instrument, the design shall ensure protection against reverse polarity.
- iv. The Bidder shall provide details of production tests being carried out to fully satisfy the Owner that the proposed equipment meets the above requirements and to assure that the products furnished shall be of the desired grade.

2.15.00 General Tools and Tackles, Special Calibration Instruments:

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

2.16.00 PG TEST POINTS

2.16.01 Pressure, temperature and flow test points shall be provided in line with latest performance test code requirements.

2.16.02 In addition, pressure and temperature test points shall be provided for the following services:

- (a) At the discharge of all pumps and fans
- (b) At the inlet and outlet of the heat exchangers for the fluid media involved
- (c) Adequate number at the Combustor at different zones
- (d) At the inlet and outlet of each control valve

2.16.03 Pressure test points shall be complete with root valves and shall terminate with a nipple.

2.16.04 Temperature test points shall be provided with thermowell with a cap and chain.



4.02.00 Control System Basic Features/Design Requirements**4.02.01 Design Requirements**

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

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

2. All like instrumentation, control hardware, control and protective system should be of same make and model no. in order to achieve the goal of consistent control philosophy and to minimize the diversity of I&C equipment & spares.
3. Control system shall comply with following general failure criteria :
 - a. No single fault can cause the complete failure of the control system.
 - b. No single fault can cause the boiler or turbine/generator protection system to malfunction or become inoperative.



- c. The grouping of control functions into system blocks shall be arranged such that failure of any one block will only partly degrade the control of the overall system. Such degradation shall always be manageable by operator intervention.
 - d. The control system shall be structured to reflect the redundancy provisions of the plant so that no single fault within the control system can cause the failure of the duty equipment or make the standby equipment unavailable. Start command or stop command/trip command towards safety of process or process equipment shall be hardwired parallel from the **two different DO cards**.
 - e. As a result of a control system fault, a plant item or control function shall always respond to its controls at the actuator level (i.e., remote manual control). That item or control function shall be required to be isolated from automatic control system.
 - f. No single random fault in the entire automation and control system will cause a load loss, forced outage or unit trip.
 - g. No two simultaneous faults shall lead to or potentially cause damage to plant
 - h. Safety related instrumentation and control shall be designed with a fail-safe mode.
 - i. No single fault shall jeopardise the functioning of the entire system.
 - j. The control and automation system and the field instruments and actuators as well as its support systems, power supplies and data networks shall be immune to the electromagnetic interference and shall conform to the internationally accepted standards.
 - k. To meet the operational and safety requirements, the control system hardware and software shall conform to a modular, hierarchical architecture.
 - l. When more than one device utilizes the same measurement or control signal, the transmitter and other components shall be fully equipped to provide all signal requirements without overloading and with proper isolation. Transmitters required to serve multiple receivers shall be arranged so that disconnecting, shorting or grounding of one receiver device shall not have any perceptible influence on any other consumer point of the same signal nor shall change the transmitter calibration.
4. Distributed control equipment shall employ modern distributed microprocessor based technology, as required to comply with the project specification and the DDCMIS system should not be more than 5 year old. A truly integrated DCS is envisaged with all the self sustaining subsystems communicating with each other over the bus network and thus ensuring that the system has a truly global data base.
5. The active control system including the plant protection system is the heart of the DCS system and therefore must stringent safety, availability and reliability



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

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

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

7. To meet the above failure criteria at sr. no. 3, the I&C system shall incorporate self-checking facilities so that internal faults can be detected within the system itself prior to any resulting disturbance to the process. In addition, the protection and safety systems shall incorporate channel redundancy or diversity of measurement as well as self-checking and adequate test facilities. For some important systems, "on line" test shall be employed with no effect to the proper functioning of the protection system.
8. In order to make sure that the DDCMIS is an extremely user friendly system a centralized engineering subsystem is envisaged. An integrated subsystem has to be provided which takes over the complete task of planning, I/O allocation, generation of function schemes and wiring documentation (in design stage) and finally the automatic linking and loading of the planned functions in the target hardware.

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

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



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

10. Individual control elements shall be equipped with permissive to prevent the inappropriate operation of the item and “active interlocks” to trip the item in case of dangerous operation conditions.
11. Each of the multifunction controller together with its I/O and drive level control modules is to be understood as a self sustaining automation island, which executes the functional located to it independently and is not affected by a disturbance in the adjacent island. For the purpose of lateral communication between the automation islands, a high speed redundant bus (the so-called control bus) should be provided which should be solely responsible for the automation (control) signal exchanges.
12. Alarms shall be provided for all abnormal conditions over which the operator has control in the control room, plus those abnormal conditions which are of interest to the operator because they may affect plant operation or security.
13. The following colors shall be selected for equipment status indicating lights:
 - Red----energized, running, valve open
 - Green----de-energized, stopped, valve closed
 - Light yellow ----abnormal, discrepancy
 - White----control power available
14. The functions of DDCMIS System are achieved through bus communication units, bus interfaces, process controllers, I/O modules and computers. The system shall be versatile and provide the user, the flexibility to freely choose configuration and redundancy. The system shall ensure very high reliability and safety through complete distribution and decentralization which goes right down to the individual I/O level.
15. Interposing relays with suitable contact rating shall be provided between DCS/PLC and MCC/Swgr in Interposing relay panels for giving command signals ON/OFF or OPEN/CLOSE. Interposing relays shall have minimum 2 NO and 2 NC contacts.
16. All parameters on which protection is achieved through pressure/ temperature/ flow switches; the measurement shall also be made available through transmitters. “ **Provision of transmitter/remote sensor will be applicable for 70% of total protection signals for such important services which will be decided during detailed engineering**”
17. Also the system shall have the flexibility to easily reconfigure any controller at any time, without requiring additional hardware or system wiring changes and without disabling the devices from their normal operating mode.
18. The system shall execute all control functions with the help of a set of pre-programmed functions resident in controllers.



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

19. The system shall be provided with extensive diagnostic features so that a system failure can be diagnosed down to the module level giving location and nature of fault. Ease of maintenance and trouble-shooting shall be a primary consideration in equipment selection.
20. The system shall provide inherent safe operation under all plant disturbances and component failures so that under no circumstance safety of the plant personnel or equipment is jeopardized.
21. The design of the control system and related equipment shall adhere to the principle of "fail safe" operation at all system levels and provide reliable and efficient operation of the plant under dynamic conditions and attainment of maximum station availability.
22. The DDCMIS shall be fully capable to operate plant in all regimes of plant operating conditions, including emergency operation/trip conditions, block out conditions etc. without resorting to manual control. The DDCMIS shall be capable of bringing the plant to safety state automatically without operator interventions.
23. All process input/output cards shall have built in galvanic/optical/electronic isolation for each input and output channel.
24. The failure of controller module and each I/O module shall be indicated on control cubicles and all operator stations.
25. For all the trip signals (very high/very low) employed for the boiler/Turbine Control System, **the alarms (High/Low) shall appear for correcting the process by the operators.**
26. For measurement of boiler metal temperature flue gas temperature, air pre-heater grid temperature etc., The bidder shall provide permanent/removable duplex type mineral insulated thermo-couples terminated in junction boxes at boiler platforms. Remote I/O unit has been envisaged for these inputs. The remote I/O panel shall be provided with I/O cards, redundant power supply unit and redundant communication modules etc. These parameters are brought to DDCMIS via DDCMIS I/O bus or via redundant soft link (either TCP/IP on OPC or MODBUS with RS485) to have real time data. This remote I/O panel shall be powered from UPS or 24V DC source of respective unit. The unit enclosure shall be of weather proof, dust tight and water proof. Bidder shall provide necessary air conditioning unit, if require for the system. This panel shall also be accommodate able for 4-20 mA and RTD signals of monitoring parameter and not for control parameters. The quantities **of remote I/O panels** shall be decided during detailed Engineering.
27. For measurement of turbine metal temperature turbine casing temperatures, stator winding temperature, Generator seal oil system, Turbine bearing temperature, Turbine oil temperature, Turbine bearing drain oil temperature, BFP turbine measurement parameters, MDBFP measurement parameters etc., The



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

28. **8 Nos. temperature elements/sensors in each units control room** shall be provided for monitoring the room temperature.
29. On unit tripping, about hundred Engineers shall be informed through SMS automatically from DDCMIS. In case of tripping of major fans/pumps/HT drive the concerned Engineer configured in such a way shall get the SMS information.
- To achieve the automatic SMS facility, GSM (global system for mobile Communication) with redundant Ethernet connectivity shall be provided by bidder for SMS facility. Same shall be connected with DDCMIS/OPC server/MIS server as decided during detailed engineering.
30. For Auto generation of trip message of unit & major fans/pumps/HT drive through Email, Email facility in DDCMIS/OPC server shall be provided by bidder.
31. All the 4 nos. 40" LED TV monitors per unit and 2 nos. 40" LED TV monitors for common system at CCR shall be erected at the false roof top of central control room.

4.02.02 CONTROL SYSTEM PHILOSOPHY

- 4.02.02.1 In order to minimise the burden on the unit operator, all control functions within the operational load range shall be fully automated. The control system shall be structured in accordance with a well-defined control hierarchy to permit operator intervention at appropriate levels during abnormal modes of operation.
- 4.02.02.2 The automation shall meet the following objectives as minimum:
- (a) Consistent start-up, shut down and running of the plant under all operational condition
 - (b) Achieve minimum run-up and loading time
 - (c) Maximize fuel economy during start-up, shut down and normal on load operation cycle
 - (d) Maximize plant life expectancy



- (e) Contribute to power grid during normal and disturbance condition
- (f) To meet the operational and safety requirements, the control system hardware and software shall conform to a modular, hierarchical architecture. The system hierarchy shall be at four levels.

4.02.03 Different Level of Controls

4.02.03.1 Drive Level

- 4.02.03.1.1 The first and lowest level shall cover all the modulating, sequence and protection control functions directly associated with all remotely controlled plant items. It shall also incorporate all necessary interlocks, initiations and trip functions for starting and stopping a main drive motor.
- 4.02.03.1.2 Control at this level shall either be initiated directly from the remote manual control interface or automatically by the next hierarchical level.

4.02.03.2 Subgroup Level

- 4.02.03.2.1 The second level shall coordinate the control of all first level drives, both closed loop and open loop, associated with a particular functional subgroup. In the case of a pump subgroup, for instance, the permissive checks, the coordination of the operation of the suction and discharge valves, the main drive initiations and the basic modulating control loops shall be executed at this control level. The major monitoring functions (e.g. turbine supervisory measurements) shall also be identified with this level.
- 4.02.03.2.2 Typical control functions associated with this level are:
 - i. Auto- Start and stop initiation or set point guidance from the next higher control level
 - ii. Start-stop- Normal initiation of the auxiliary start and stop sequence.
 - iii. Auto Standby-Start initiation in the event of duty item failure.
- 4.02.03.2.3 A functional group consists of different units, which individually represent and control a part of the complete plant and can be divided into two or more groups. Every sub group is controlled by an independent sub group control, which controls the operation of various drives. Once a start signal issued by a functional group, the sub group control brings the sub group from one state into another operating condition by issuing command signals in a programmed sequence. It brings the sub group from a shut down state into a working condition and vice-versa. The functional group instrumentation and control system co-ordinates the entire sub group controls belonging to one functional group.

4.02.03.2.4 Group Level

- 4.02.03.2.4.1 The third and penultimate level shall coordinate the individual subgroup control function (both modulating and sequence controls) within the main functional groups of the system.
- 4.02.03.2.4.2 The group co-ordinate the sub group of a functional group. Its main function is to



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

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

4.02.03.2.5 Unit Co-Ordination Level

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

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

- i. The sequential initiation of the subordinate functional group sequences for automatic start up and shutdown.
- ii. The sequential initiation of the subordinate functional group sequences for automatic start up and shutdown of a part/full.
- iii. The sequential transition to the various combination of subordinate functional Groups.

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

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

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

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

4.02.04 CONTROL SYSTEM - LEVEL OF AUTOMATION

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

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



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

4.02.05 CLOSED LOOP CONTROL SYSTEM (CLCS)

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

4.02.05.2 The CLCS shall have the following features:

- (a) Provision of predictive and/or adaptive controls in addition to PID controls as required by the system. Availability of **advance control techniques/Algorithms** ensuring process optimization.
- (b) Set point adjustments and indication from operating work stations/ KBs for process variables which need to be changed during load changes, start-up, shutdown, normal or under any other emergency conditions.
- (c) Fixed set point at the software level/hardware level (only changeable by the maintenance engineer) and indication for those process variables which need not be changed with respect to load or otherwise.
- (d) Bias adjustment with indication where a single controller is controlling more than one final control element (control valve, control damper, speed drive etc.) to maintain the same process variable.
- (e) Auto and manual control facility shall be transferable in both directions without bump of the value of the process variable to control the parameter during manual operation. Both master Auto Manual station and Auto / Manual station for individual control element shall be provided in OWS. Auto tuning facility shall be an inherent feature of the DDCMIS. Availability of control loop of process parameters in aut o for different loads. If required, the system shall have the feasibility of **auto changing of P ID const ants (K const ants)** in micro-processor/controller for different loads so as to avoid hunting of control valve.
- (f) Characterization of final control element to suit the various applications with respect to load or otherwise as dictated by the process.
- (g) Function generator to provide necessary characterization or variation of set points with respect to load, speed or any other requirement.
- (h) Soft Auto /Manual station interlocks to drive the final control elements to a suitable position for safe plant operation in the event of process/equipment abnormal conditions.
- (i) Blocking/Interlocking function as dictated by process/equipment.
- (j) Monitoring of loop failures or any hardware failure in the loops.
- (k) Fail safe operation of final control elements in case of failure of motive power or



Signal.

- (l) Redundancy criteria of sensors for CLCS shall be dictated as per NIT, Vol. V, Cl. No. 2.05.05.
- (m) Redundancy criteria of I/O cards and Wiring for redundant or non redundant signals from field to control system (I/O cards & controllers) shall be dictated as per NIT, Vol. V, Cl. No. 4.02.08.02 and 4.02.08.02.1 respectively.

4.02.06 OPEN LOOP CONTROL SYSTEM (OLCS)

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

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

Features-General Requirements

- (a) The logic and sequence control shall be Digital distributed microprocessor based and programmable.
- (b) Enable the operator to start/stop various unidirectional motors, to open/close various valves and dampers and carry out inching operation of bypass valves or any other similar equipment both from control room and local areas.
- (c) The system shall be designed based on the philosophy of command to energise a relay or solenoid valve.
- (d) Where there is more than one pump or fan for the same service (say 2 pumps), auto standby features shall be provided to select the standby unit and this standby unit shall start automatically on failure of running pump or on applicable process criteria (say low discharge pressure) with an annunciation.
- (e) All the contacts of the sensors used in protection circuit shall be monitored.
- (f) Triple redundant sensors shall be provided when used in protection circuits for major critical equipment and 2 out of 3 logic shall be derived for further use in protection circuit

4.02.06.3 Features-Interlock Requirements

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



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

- (c) Selection of standby equipment and starting the equipment automatically on the tripping of running equipment and/or desired process parameter conditions (say loss of discharge pressure or low level in the discharge tank etc.)
- (d) Isolation of the tripped equipment from the main process.
- (e) Any other conditions for safe starting and shutting down the equipment.

4.02.06.4 Features-Sequence Control Requirements

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

- (a) Once the start-up or shutdown of an equipment is initiated either manually or automatically from the system, the control of associated auxiliaries shall be automatic with facility for manual operation at each stage (step).
- (b) Criteria check up for each stage of operation with monitoring and displaying.
- (c) Bypass facility for each criteria when only the feedback signal/display is incorrect but the actual condition is fulfilled. This activity shall be logged and annunciated in control system (DCS / PLC).
- (d) Adequate time delay between the steps as dictated by the process to establish an operating parameter or healthiness of an equipment.
- (e) Normally, the auxiliaries of the standby equipment should be running (as applicable) so that the standby equipment is started without loss of time.

4.02.06.5 Features-Protection Control Requirements

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

- (a) Any condition which endangers the safety of the plant personnel
- (b) Any of the permissive conditions becoming abnormal thereby producing a dangerous condition in operating the equipment.
- (c) The conditions from process such as dry flow conditions, flashing conditions or any other conditions that may create cavitation.

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



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

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

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

4.02.07.01 Option 1 – For Unified DDCMIS

4.02.07.01.01 Operating Work stations:-

- i. 6 nos of Operating Stations (one no. of boiler control system like MFT, two nos., for BMS (FSSS), Boiler auxiliaries, two nos. for Turbine auxiliaries and one no. for electrical system & BOP) shall be connected directly on Proprietary/ preferably Industrial Data Highway/higher level network of DDCMIS with 2 LJP A4 B/W and 1 LJP A4 Color.
- ii. 2 nos. of Operating Stations for Turbine Control System (governing system), like DEHGC, ATRS, ATT, ETS from the respective system shall be connected directly on Proprietary/ preferably Industrial Data Highway/higher level network of DDCMIS with 1 LJP A4 B/W & 1 LJP A4 Color.
- iii. 1 no. of Operating Station for TSE for Unit incharge (shift supervisor) with 1 LJP A4 Color (if this is not integral of DDCMIS, TSE shall be connected with DDC MIS through redundant OPC connection).
- iv. 1 no. of Operating Station for Unit incharge (shift supervisor) - Printer not required
- v. 1 no. of Operating Station for Station incharge (in the cadre of Executive Engineer) with 1 LJP A4 B/W.
- vi. 1 no of Operating Station for performance calculations & optimization for Unit incharge (shift supervisor) shall be provided with 1 LJP A4 B/W.
- vii. 1 no. of Operating Station for performance calculations & optimization at the Office of Executive Engineer/Efficiency shall be provided with 1 LJP A3 B/W.
- viii. 1 no. of Operating Station for water chemistry parameters connected with performance calculations & optimization at the SWAS / Chemical Express lab shall be provided with 1 LJP A4 B/W.
- ix. 1 no. common Operating Stations at Factory manager, and 1 no. common Operating Stations at Electrical System incharge room shall be provided for both units, operation/ command shall not be executed from these three consoles to start/stop the equipments. Software and hardware security lock shall be provided not to use these controls for any operations. 1 LJP A4 Color with each Operating station shall be provided.



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

4.02.07.01.02 Engineering Work stations & Servers:-

- i. 2 nos. of Engineering Stations for system maintenance Engineer for unit DDC MIS system with 2 LJP A4 Color, 1 No. A3 sized Scanner, copier cum printer, 1 LJP Heavy Duty Industrial grade A3 Color.
- ii. 1 no. Engineering Station for system maintenance Engineer for Turbine Control System with 1 LJP Heavy Duty Industrial grade A3 Color.
- iii. 1 no Engineering Station for Turbine Stress Evaluation with 1 LJP A4 Color (if this is not in integral of DDCMIS, TSE shall be connected with DDC MIS through redundant OPC connection).
- iv. 1 no. of Engineering Station for Sequential Event Recording with 1 no. A3 sized DMP
- v. Redundant Historian server (Historical Data Storage & Retrieval system) with Work station and 2 no. A3 sized DMP.
- vi. 1 no. redundant server system for performance calculation & optimization (PADO) with Engineering work Station and Heavy Duty Industrial grade A3 Color printer.
- vii. Redundant OPC server for OPC connections with DDCMIS from other systems with Work station & 1 LJP A4 B/W.
- viii. Redundant MIS server with one no. MIS work station, and 1 no. LJP A4 B/W.
- ix. Common Redundant OPC server for OPC connections with both units DDCMIS from other common systems with Work station & 1 LJP A4 B/W.

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

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

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



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

4.02.07.02 Option – 2

- i. Separate DCS based control system is provided for Turbine integral control and DEHGC, ATT, same shall be provided with complete configuration (OWS & EWS with printers) as specified above at cl. No. 4.02.07.01.01 (ii) & 4.02.07.01.02 (ii) and TSE's work stations & TSE's Engineering stations with printers & TSI work station with printers as specified else where in the specification.
- ii. Separate DCS based control system is provided for Turbine protection (ETS – Emergency trip system), same shall be provided with one no. operating station and one no. operating cum engineering station and one no. A4 sized B/W LJP.
- iii. Separate DCS based control system is provided for MFT & Boiler protection controls, same shall be provided with one no. operating station, one no. operating cum engineering station and one no. A4 sized B/W LJP and one no. A4 sized color LJP.
- iv. For option 2, Quantities of OWS & EWS shall remain same with DDCMIS as specified above at cl. No. 4.02.07.01.01 (i & iv to viii), 4.02.07.01.02 (i & iv to vii) & 4.02.07.01.03 irrespective of separate control systems (DCS) for Boiler integral controls and Turbine integral control respectively.
- v. In case bidder provide separate Turbine control system & Boiler control system from DDCMIS. Then configuration of LVS shall be 4 no. LVS with Display controller as part of DDCMIS package, 1 no. LVS with display controller as part of Turbine control system and 1 no. LVS with display controller as part of Boiler MFT control system.

4.02.07.03 Option – 3

- i. Separate DCS based control system is provided for DEHGC, TSC, ATT & Turbine protection (ETS – Emergency trip system), same shall be provided with complete configuration (OWS & EWS with printers) as specified above at cl. No. 4.02.07.01.01 (ii) & 4.02.07.01.02 (ii), one no. OWS for ETS/Turbine protection, and TSE's work stations & TSE's Engineering stations with printers & TSI work station with printers as specified else where in the specification.
- ii. MFT & Boiler protection controls shall be part of DDCMIS.
- iii. For option 3, Quantities of OWS & EWS shall remain same with DDCMIS as specified above at cl. No. 4.02.07.01.01 (i & iv to viii), 4.02.07.01.02 (i & iv to vii) & 4.02.07.01.03, irrespective of separate control systems (DCS) for Turbine integral control system.



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

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

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

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

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

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

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

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

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



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

4.02.08 Redundancy & Availability Requirements

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

4.02.08.01 Controller Redundancy

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

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

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

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

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

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

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



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

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

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

4.02.08.02 Redundancy in Input/output Modules

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

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

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

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

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

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



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

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

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

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

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

4.02.09

DDCMIS/DCS Controller Grouping/Partitioning

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

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



- f) TDBFP - A integral controls per redundant processor
 - i. ATRS 1 SGC & Turbine Protection
 - ii. ATRS 2 SGC, TSI & CLCS
 - iii. DEHC (Digital Electro Hydraulic Governing System)
- g) TDBFP - B integral controls per redundant processor
 - i. ATRS 1 SGC & Turbine Protection
 - ii. ATRS 2 SGC, TSI & CLCS
 - iii. DEHC (Digital Electro Hydraulic Governing System)
- h) MDBFP – C & Aux and Boiler fill up Pumps
- i) Deaerator (three element controls), CEP, hot well, & Hot well makeup Pumps.
- j) HP heaters 5, 6, 7 & 8.
- k) LP Heaters 1, 2, & 3.
- l) SH steam temperature control (multi variable control) & RH steam temperature control (multi variable control), Metal Temp.
- m) DMCW Pumps & DMCW system for SG & TG and CPU* (* CPU incase DDCMIS controlled) .
- n) COLTCS, HP & LP Dosing System and Cooling Tower & Aux.
- o) Electrical system 1
- p) Electrical system 2
- q) Electrical system 3
- r) **Remote I /O panel** with r edundant pr ocessor f rom D DCMIS f amily is to be implemented with following grouping for CW & ACW system
 - i. CW Pump – A, CW Pump – C, ACW Pump A & CW lines to/from unit # 1 Condenser/Hotwell.
 - ii. CW Pump – B, ACW Pump B, CW makeup system & CW lines to/from unit # 2 Condenser/Hotwell.
- s) Turbine integral controls per redundant processor
 - i. ATRS SGC Oil Supply, Turbine & Drains
 - ii. ATRS SGC Condensate & Evacuation System
 - iii. GSPC (Gland Steam Pressure Control), LP Bypass
 - iv. GAMP (Generator Aux. Monitoring)
 - v. TSC (Turbine Stress Evaluation Control System) & TSI
 - vi. ATT (Automatic Turbine Tester)
- t) SG integral controls per redundant processor
 - i. Oil A B & Oil CD
 - ii. Oil E F & Oil G H
 - iii. Oil J K & Oil M N
 - iv. Coal A B
 - v. Coal C D
 - vi. Coal E F
 - vii. Coal GH
 - viii. Coal JK
 - ix. Coal MN



- x. SADC & APRDS
 - xi. SBC controls, SBC PR & Drain Temp. controls.
 - xii. HPBP
-
- u) Steam Turbine controls like DEHGC (TMR – Triple modular Redundant philosophy) and Turbine Protection (TMR – Triple modular redundant philosophy) with fail safe design cards can be Integral or separate stand-alone.
 - v) Triple Modular Redundant (TMR) processors for MFT & Boiler protection with fail safe design cards can be Integral or separate stand-alone.

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

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

- i) BTG (FOPH) Fuel Oil System

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

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

4.02.10 Response Times

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

- a) Key board command to field equipment shall be executed and its confirmation shall be displayed on the screen within 1 second.
- b) The response for operator requested display (time between pressing of last key and appearance of last character on screen) shall be of the order of one to two seconds under all loading conditions.
- c) Dynamic parameters in the OS displays shall be updated in one second interval.



- d) The cycle time for open loop and closed loop controls shall be as follows:-
- i) For critical closed loops like Steam Separator level control, main steam temp. control, feed water flow control, HRH steam temp. control, HP/LP bypass control, furnace draft control & combustion control, the loop cycle time shall be max. 100 milli seconds preferably 50 milli seconds.
 - ii) For non-critical closed loops it shall be max. 250 milli seconds (preferably 150 milli seconds).
 - iii) For all open loops, sequential interlocks & protection it shall be max. 100 milli seconds.
- (The loop cycle time is defined as the time taken from change at input module to change in output module for command).
- e) All analog inputs to CLCS shall be acquired and data base updated within an interval of 50 milli seconds. Data for critical loops shall be acquired & data base updated at a faster rate to suit the requirements of (d) above.
 - f) The digital inputs for SOE shall be monitored at 1 milli second resolution.
 - g) The system shall acquire & check all inputs at the input scan rate. If the input is in alarm state (i.e. the input is in an off normal condition) the alarm status shall be annunciated, printed out and displayed within 1 second after the input is scanned.

4.02.11 Established Reliability

- i) All components and systems offered by the Bidder shall be of established reliability. The minimum target reliability of each component shall be established by the Bidder, considering its failure rate/mean time between failures (MTBF) & mean time to repair (MTTR), such that the availability of the complete system is assured for 8700 hours / year (99.7%) or better.
- ii) In order to ensure the target reliability the bidder shall perform necessary availability tests and burn in tests for major systems. Surge protection for electronic control systems, annunciator system and other solid state systems conforming to SWC test per ANSI C 37.90a (IEEE standard 472) and selection of proper materials, manufacturing processes, quality controlled components and parts, adequate derating of electronic components and parts shall be ensured by the Bidder to meet the reliability and life expectancy goals.
- iii) Continuous self checking features shall be incorporated in system design with automatic transfer to healthy/redundant circuits to enhance the reliability of the complete system.
- iv) In general, failure of equipment used for alarm purpose will cause switching to the alarm state.



4.03.03.04 Specifications for Operator Station, Engineering Work Stations

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

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



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

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

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

4.03.03.04.02 Full flat Monitors with LED back lighting

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

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

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

4.03.03.04.03 Key Board:

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

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

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

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



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

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

4.03.03.04.04 PRINTERS

Line Impact Heavy Duty Dot Matrix Printers

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

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

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

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

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

Coloured Laser Jet printer

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



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

Laser Jet printer (B & W)

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

Ink Jet Printers (Coloured)

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

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

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

4.03.03.04.05 External DAT Drive

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

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

4.03.03.04.06 Hard Copy Facilities

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

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



4.03.03.04.07 USB Port Pen Drive

Twenty Five (25) no. USB Port pen drive per unit having 32 GB memory with read/write facility shall be provided.

Preferred makes of USB pen Drive are HP, Sandisk, Kingston, Strontium.

4.03.03.04.08 Scanner, Copier cum Printer (A3 size)

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

4.03.03.04.09 DVD Writer

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

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

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

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

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



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

4.03.03.05 Lap Top

The LapTop shall meet following minimum requirements:

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

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

4.03.03.06 General Specification of the server:

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



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

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



4.03.03.07 Industrial grade managed type Ethernet switches

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

4.03.03.08 The Firewall shall meet following minimum requirements:

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

- i. The firewall should contain following features:
 - (a) Stateful inspection of packets.
 - (b) NAT functionality, including dynamic and static NAT translations
 - (c) Latest version of SNMP
- ii. The firewall must send log information to a separate log server via an encrypted connection. Firewall logging must not impact firewall performance.
- iii. Remote network access to the firewall should only be possible through the administration interface.
- iv. The firewall administration station must be capable of pushing firewall security policies and configurations to individual or multiple firewalls through a secure, encrypted connection to the firewall administration interfaces.
- v. Graphical User Interface (GUI) and a Command Line Interface (CLI) for making changes to the firewall rules set should be provided. (Access to the firewalls via the GUI or the CLI must be through an secure encrypted channel).
- vi. Any changes or commands issued by an authenticated user should be logged to a database configured on any of the machines in the LAN. The administration station must allow for a hierarchical architecture for rules set administration and viewing of firewall configurations Management.
- vii. The firewall must not support any unencrypted means of access to the firewall.
- viii. It should Monitor ALL network traffic-traffic at Firewalls (Internet and external networks), in the DMZ and detect known threat through deep packet inspection.
- ix. Detects unknown threats via anomaly scanning.
- x. Detect unknown threats via behavior pattern to protect from zero day attacks.
- xi. Keeps up-to-date on new threats and vulnerabilities.

4.03.03.09 Software License:

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



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

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

Software Upgrades

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

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

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

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

4.03.03.11 SOFTWARE DOCUMENTATION AND SOFTWARE LISTINGS

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

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

4.03.04 Programming, Diagnostic and Engineering Work Station

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

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

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

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



4.05.00 Design Criteria for BOP packages' Control System**4.05.01 Design Criteria for Programmable Logic Controller (PLC) System**

The PLC for BOP packages shall have following features:

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

4.05.02 Technical specification for PLC

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



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

- 4.05.02.2 Redundant CPUs in hot standby mode shall operate on fault tolerant mode with continuous self and cross monitoring facility. Redundant CPU/controllers shall be placed separately and shall not share the same motherboard. Failure of the active CPU shall not adversely affect the operation of the plant in any perceptible way. Failure of the active CPU will lead to transfer of the tasks being performed to the other healthy CPU within fastest possible transfer time (i.e. ≤ 50 m sec.) without causing any output to drop during the Transfer period. In the Event of the both the CPU failure, the system shall revert to the Fail-safe mode. The CPUs shall not be loaded over 60% of the Individual capacity even under worst data loading conditions. It shall be possible to switch from the active to the back-up CPU and vice versa from Operating station as well from the CPU front panel. (The worst data condition of PLC means all modules in active mode, printer in operation, OLCS&CLCS logics active and process in running condition). Data bus loading shall not be more than 50%. This configuration shall be applicable for each type of PLC based control system. Engineered solutions for redundancy in CPU & I/O cards are not acceptable.
- 4.05.02.3 The system shall be of modular construction and expandable by adding hardware modules and incorporating them in the address register. Bidder shall provide at least 20% overall with minimum two no. spare channels as hot-on-rail spares in each configured cards / Modules. In addition to this 10% or minimum one no. extra assigned complete spare cards mounted on rails in sub-racks for each type of I/O modules shall also to be provided. The spare channel and cards shall be fully wired up to termination cabinets. Spare Philosophy as detailed in cl. No. 4.03.11 for DDCMIS/DCS system shall be applicable for each PLC based control systems.
- 4.05.02.4 The memory unit of the CPU shall be field expandable. The memory capacity shall be sufficient (min. 8 MB per CPU) for system operation and shall have the capability for future expansion at least to the tune of 40%. The application program / sequence logic etc. shall be stored in non-volatile memory (EPROM). However all the dynamic memories shall be provided with battery back up with at least for 96 hours. Lithium or Ni-cd battery shall be used. The quantities of Hot standby redundant CPU/controllers for each PLC system shall be finalized during detailed engineering by owner depending upon CPU/controller's worst data loading conditions and CPU/controller's functional distribution.
- 4.05.02.5 The max number of Input / Output points per card shall be 32 for digital and 16 for Analog / Thermocouple / RTD. No. of channels may also reduced to meet the I/O cards feature specified in NIT. Individual input channels shall have galvanic isolation. Output points shall also have optical / galvanic isolation. Merely fusing of individual or a group of channels is not acceptable. The I/O cards shall be rack mounted. Failure of Analogue I/O cards, binary cards / modules shall also be displayed on the Engineering cum diagnostic station.



- 4.05.02.6 The data communication system of the PLC including that of its redundant system bus with hot back up and other allied buses such as I/O bus, local bus etc., shall fulfill the following minimum features. The bidder shall furnish all the calculation details of CPU utilization and Bus loading. Bidder shall also furnish communication protocol used for the offered PLC.
- Communication links (I/O bus) between CPU and individual Input & Output (I/O) modules rack shall be dual redundant with 10 Mbps speed and 16 bit CRC data protection feature. In no case failure of a link shall affect the control of the plant.
 - The communication system design shall ensure that any single point failure on the system bus / media shall not disrupt more than single message and disrupted message shall be automatically retransmitted after the standby communication link takes over control.
 - Failure of physical removal of any station / modules connected on the system bus shall not lead to any loss of communication.
 - Diagnostics display both at operating workstation and module front end shall be provided for easy fault detection.
 - Bus change over from active bus to standby bus, during failure of active bus shall be performed automatically and bumpless. Such event shall be suitably logged or alarmed.
 - The system communication between PLC controllers and the operators stations shall be conducted at high speed minimum 100 Mbps with Ethernet based open protocol with no collision feature to avoid data jamming / overloading of the system. The communication bus, serial link etc. shall have adequate protection against electrical noise and mechanical damage.
 - System should have open bus structure and should allow further extension facility and connection with any third party system.
 - PLC Network shall also be provided with external surge protection system and industrial firewall.
- 4.05.02.7 Man Machine Interface (MMI) shall be industrially ruggedised Operator's station based on latest window based market available software along with its peripherals like LED monitor, printer, mouse. Engineering functions shall normally be carried out from dedicated workstation or operating station as per annexure-A "control system for BOP". In case a dedicated engineering station is provided, EWS shall also be worked as operating station through password / Hardware lock. The monitor refresh time i.e. latency time should be ≤ 2 second.
- 4.05.02.8 The Operator's station shall perform the following minimum requirements.
- Selection of Auto / Manual, Open / Close operation, sequence auto, start / stop operation etc.
 - Dynamic Mimic display detecting the entire process for control monitoring purpose.



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

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

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

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

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

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

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

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

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

4.05.02.11 PLC shall specifically meet the following requirements:

- (a) PLC shall have extensive self-diagnostic capability. Self diagnostics shall include both module level diagnostics as well as channel level diagnostics
- (b) PLC shall have hot standby redundant processors/controllers. This shall mean the fulfillment of the following requirements:



- (i) Automatic synchronisation of primary processor/controller of PLC with secondary processor/controller
- (ii) Bumpless switchover to secondary processor/controller of PLC when the primary fails.
- (c) Automatic program and data equalisation in the event of any on-line program / edit executed in the primary processor/controller of PLC.
- (d) Automatic “Forcing Bit” update in the secondary processor/ controller of PLC when any “ Forcing is applied in the primary processor/controller of PLC.

4.05.03 **SYSTEM REQUIREMENT & SPECIFICATION**

- 4.05.03.1 The system shall have high MTBF and shall be hot maintainable. The system hardware shall be designed to be fault avoidant by selecting high grade components of proven quality and properly thermally de-rated design. The system shall have extensive fault monitoring, self surveillance & on-line self diagnostic capability so that failure up to module / card level is immediately detected. Each of the modules shall have its self – diagnostic system. The operator station located at the area control room shall be used for fault data presentation and monitoring purpose.
- 4.05.03.2 The system shall have capability to automatically check & correct gain & drift for ADCs on-line.
- 4.05.03.3 All data exchanged in a bus shall be fully monitored & checked for validity.
- 4.05.03.4 Loop Cycle time in PLC shall be equal to or less than.
- a. OLCS : 100 ms or less
 - b. CLCS : 250ms or less
- 4.05.03.5 Following operations will be performed on I/Os, as required:
- 1. Square root extraction
 - 2. Pressure & Temperature compensation
 - 3. Responsibility check of all inputs (analog specially), validate and quality tagging like good, bad, suspects etc
 - 4. Channel wise engineering unit conversion.
 - 5. Contact bounce filtering with adjustable time constant.
- 4.05.03.6 All controllers shall be freely configurable with respect to requisite control algorithms. An extensive library of macros shall be included for the purpose adequate software capability shall be provided to implement closed loop control functions as follows:
- i) P, PI, PD and PID control and their variations.
 - ii) Open loop (On- Off, sequence control)
 - iii) Cascade control
 - iv) Ratio control
- 4.05.03.7 For open Loop Controls, the system shall have, as a minimum, the following features:



- a) Logic functions like AND/OR/NOT gates, timers (on-delay, off-delay), shift registers, counters, latches, flip-flops, mono – shots, tantalizers etc.
- b) The automatic sequence control to ensure sequential start up and shut down of auxiliaries / equipment. Sequence control shall be performed in groups initiated by command from operator's console. A sequence shall be made of steps executed in predetermined order according to logic criteria. For each step there shall be a provision for 'waiting time' and 'monitoring time', and it shall output an action on the process. System shall have the capability to bypass one step if desired by the operating personnel by forcing an input or output from the operator's station. Such action however will be registered as an exception or alarm.
- c) Increase the reliability and availability of the plant as a whole, for example, by timely and correct switchover to standby drives etc.
- d) Basic interlock and protection logic related to safety of individual drive and plant equipment. All inputs required for protection system shall be on high priority basis. In the event of either loss of control power or control signal input to the drive, the drive shall remain in its last position unless specifically required otherwise. The system shall be designed such that no upset occurs either to process or to the drive when the power is restored.

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

4.05.03.9 **Displays**

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

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

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

- a. Calling up a mimic : 1 sec or better
- b. Updating status signal in mimic : 1 sec or better
- c. Updating variables in a mimic : 1 sec or better.
- d. Issuance of command to output : 2 sec. or better
(without considering travel time and process lag)

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



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

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

- a) Overview display – This display is to enable the operator to set an overview of the entire plant section.
- b) Group display – The group display page shall display several sub-sections & present status information.
- c) Point display – Along with the specified parameter value, this page should indicate historical trend of the parameter.
- d) Trend display – This display include real time/historical trend display facility including Dynamic Graphic Display & Bar Graph Display.
- e) Alarm Message Display – It shall be possible to display process as well as system and diagnostic alarms for operator's attention and action. Alarm shall appear immediately on the operator station as and when they occur on priority basis. In addition to alarms appearing on displays, the system shall also be able to display alarm summary and alarm history listing the date and time of occurrence, tag number, point description, type of alarm (absolute value or deviation), serial number of alarm in the sequence of occurrence etc. Alarm shall disappear from display only when they are acknowledged and cleared. Any abnormal condition in any sub-system or any other function devices shall be displayed as system alarm message on the operator console irrespective of display selected.

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

Shift/Daily Log

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

4.05.04 Salient hardware / software features of the PLC system

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

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



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

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

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

4.05.04.2 **Input / Output Modules:**

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

a)	All I/O Cards		
	1. Ambient temp.	:	0-50 degree C
	2. Surge withstand capability	:	IEC-255.4
	3. Power Supply	:	Dual redundant at each I/O rack
b)	Digital General		
	1. No. of channels / card	:	32 max
	2. Interrogation voltage	:	24/48 VDC
	3. Status Indicator	:	LED Type./channel
	4. Isolation	:	Optical (channel to channel)
	5. Electrical Isolation	:	between system and field
c)	Digital Input Module		
	1. Contact bounces filtering	:	Adjustable time constant of 15m.sec.
	2. Self Diagnostic	:	Wire break, Short Circuit
d)	Digital Output Module		
	1. Output protection	:	Short ckt protected and individual fuse
e)	Analog General		



1. No. of channels/card : Input /output – 16 channel
 2. Isolation : Galvanic/Optical (channel to channel)
 3. Status Indicator : LED Type./channel
 4. Fuse protection for failure : Individual for each signal
- f) Hi-Level Analog Input Module
1. Type of input : 4-20mA DC & 1-5VDC
 2. A/D Converter : 14 bits + Sign (or better)
 3. Accuracy : 0.1% or better
 4. Diagnostic : A to D / Channel fault, Short circuit, wire break
 5. Power of transmitter : 24 V DC 2W type
- g) Low Level Analog input Module
1. Type of output : PT-100; T/C (As required)
 2. C-J-C : On Module
 3. Accuracy : 0.1% or better
 4. A/D converter : 14 bits + sign (or better)
 5. Diagnostic : A to D / Channel fault, short circuit, wire break
- h) Analog Output Module
1. Type of output : 4-20mA DC
 2. Accuracy : $\pm 0.1\%$ or better
 3. Load : 600 OHM
 4. Diagnostic : Channel fault
- i) The maximum number of channels with LEDs indications that can be provided in a single module shall be:
- (i) Digital input module/ Digital output module - 32
 - (ii) 4-20mA input/output modules - 16
 - (iii) Thermocouple / RTD input module - 16
- j. Input/Output modules shall have the following features:
- The functions performed on digital inputs shall include:
- (i) Signal isolation (optical)
 - (ii) Fuse protection & monitoring
 - (iii) Short circuit protection
 - (iii) Contact bounce protection
 - (iv) Contact monitoring for trip and causes of trip inputs
 - (v) Contact interrogation at 24/48 V DC
 - (vi) Configurable as status input, latched input or pulse input
 - (vii) Direct or reverse sense
 - (viii) Alarming of abnormal state



- k. Digital outputs shall have the following characteristics:
- i) Individually fused
 - ii) Individual contact suppression
 - iii) Configurable as momentary, latched or pulse- width modulated Outputs
 - iv) Individually definable default state
 - v) Output read back verification
 - vi) Short circuit protection
- l. Analog inputs can be 4-20 mA DC, RTD, thermocouple. A/D converter shall have a minimum resolution of 14 bits. Functions performed on analog inputs shall include
- i) Signal isolation (Galvanic/opto coupling)
 - ii) Fuse protection and fuse failure detection
 - iii) Transmitter power supply at 24 V DC
 - iv) Input filtering for noise level
 - v) Cold junction compensation for thermocouples
 - vi) Transmitter monitoring for parity, wire break, live zero and end limit values
 - vii) Monitoring of A/D conversion
 - viii) Test for substituted value
 - ix) Conversion to engineering units
 - x) Test for normal or extended range
 - xi) Detection of open circuit for thermocouples
 - xii) Alarm limit testing for high, low, high high and low low substituted values
 - xiii) Rate of change - positive and negative dead band
 - xiv) All analog signals fed to the control system shall be acquired and validated.
- m. Analog outputs shall be 4-20 mA DC with the following characteristics:
- i) Direct or reverse operation
 - ii) D/A per output and power regulator per output
 - iii) Loop check back of output
 - iv) Default options upon failure
 - v) 5-segment output characterization
 - vi) Go to zero current

4.05.05

PLC Configuration:

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

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



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

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

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

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

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

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

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

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

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

- i. Operating console desks for OPERATING STATION's and KB shall be provided by bidder along with their printers in AC control room.
- ii. OPERATING STATION/KBD shall generally be used for control and monitoring.
- iii. Complete industrial grade Furniture for mounting Operating stations, Swivel Chairs, Printers, Keyboards, Computer etc. shall be furnished by bidder.



- iv. In the Back up Control desk and relay based system following operator interface devices shall be provided as per Annexure A.
- a) Control station (illuminated P.B. stations, Desk P.B., control switches etc).
 - b) Hardwired Annunciator with push buttons.
 - c) Coloured Mimic with LEDs for Drive status (ON, OFF, & trip) and level (Low & High) of tanks.
 - d) Process recorders, indicators & Ammeters as decided during detailed engineering.
- v. Control panels housing the control cards/equipment marshalling cabinets shall be located in a control room; and shall have IP-32 min. degree of protection as per IS-13947 offering dust and vermin protections, 2 mm thick steel sheets (CRCA) shall be adopted for fabrication, consistent with weight of devices, control equipment to be mounted. UPS panels shall be with 2 mm thick steel sheet (CRCA). Cable gland plate thickness size shall be 3mm. Mimic shall be made of Acrylic sheet with thickness of minimum 6/7 mm.
- vi. Panels shall be furnished complete with requisite accessories such as transformers, regulators, switch fuse units, MCB, MCCB and other power supply equipment to adopt the sources of power supply to requirements of panel mounted instruments and devices.
- vii. All panels, cabinets and enclosures shall be furnished, fully, wired with necessary provisions for convenience outlets, internal lighting, grounding, ventilation, space heating, and vibration isolation pads, double compression cable glands, integral piping and other accessories as per IS: 5039- 1969.
- viii. The sealing of panel s/cabinets/enclosures bottom with bottom plate. Double compression cable glands and suitable sealing material to prevent entry of dust shall be in the Bidder's scope. Suitable arrangement for preventing fire propagation through cable entry points like fire seals etc. shall also be provided at cable entry points.
- xi. Fire/Smoke Detector, Neoprene/silicon Gasket, Exhaust Fans with louvers & filters shall be provided in all consoles and panels.
- x. All the panels shall be equipped with Anti vibration pad of 15 mm size.
- xi. PLC with OWS –**
- a. All winding/Bearing Thermocouple/ RTD shall be connected to PLC.
 - b. All analog inputs i.e. Temperature, Pressure, flow, level, vibration etc. shall be connected to PLC.
 - c. Only important parameters shall be display on desk / Panel.
 - d. Bidder shall provide Ammeter on panel for all HT Motor current & ≥ 15 KW LT Motor and very important LT drives as decided during detail engineering.



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

A Device Specific :

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

B Electrical Specific :

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

C Application Specific : *

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

D Hardware Specific :

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

E Device Documents :

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

***Notes:**

A6 To identify converter requirement and cable length.

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

C1 What is the primary purpose of the communications link?

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

[illegible]

बीएचएल PEM :: C&I		STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER						QUALITY PLAN NO.: PE-QP-999-145-I036__				
								VOLUME IIB				
								SECTION D				
								REV. NO. 01		DATE: 24.08.2007		
								SHEET 1		OF 8		
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records P	Agency \$			Remarks
										W	V	
1.0	Materials /Components											
1.1	Panels & Control Desks	Physical Inspection for Dimensions, Painting, Cutouts, Lifting / Locking Arrangements, Components, Drawing Pocket, Mounting accessories, Plinth & AV Pads, Cable Gland Plates, Hardwares, Hinges, Louvers & Filters, Fans & Panel Lamps	MA Visual	I	100%	Contract specifications, Approved GA Drawings, BOQ	As per ref documents. No physical damage.	BHEL Quality Inspection Report.	3/2 2		1	
1.2	Power Supply/Packs, Battery & Battery charger, Transformer, UPS.	Physical Inspection Physical Damages Dimensions Mounting Accessories	MA Visual	I	100%	Contract specifications, BOQ.	As per reference documents, Test Report	BHEL Quality Inspection Report.	3/2 2		1	
1.3	Indicating Lamp, Annunciator, Meters, Transducers, Signal Converters, Instruments, Single Loop Controllers	Physical Verification Physical Damages Dimensions Accessories	MA Visual	I	100%	Contract specifications, BOQ.	As per ref documents No physical damage. Test/ Calibration report.	BHEL Quality Inspection Report	3/2 2		1	
1.4	PLC processors, I/O modules, Power Supply modules, Communication modules, Mounting Racks, Ethernet	Physical Inspection • Identification Labels • Physical Damages • Quantity • Spare Capacity	MA Visual	I	100%	Product Catalogue, Data sheets, Approved Configuration diagram, BOQ	As per ref documents. Test Certificates	BHEL Quality Inspection Report.	3/2 2		1	

LEGEND: * CR - Critical characteristics
 MA - Major characteristics
 MI - Minor characteristics

\$ P - Agency Performing the Test.
 W - Agency Witnessing the Test.
 V - Agency Verifying the Test.

1 - BHEL
 2 - Vendor
 3 - Sub-vendor

 PEM :: C&I		STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER						QUALITY PLAN NO.: PE-QP-999-145-I036				
								VOLUME IIB				
								SECTION D				
								REV. NO. 01 DATE: 24.08.2007				
								SHEET 2 OF 8				
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records P	Agency \$			Remarks
1.5	CPU, Monitor, Keyboard, Mouse, CD Drives, Printers, OS, System Software, Engineering software in the form of Licensed CD.	Physical Inspection Identification Labels, Tech. Specification Physical Damages Accessories Installation arrangements for Computers & Printers	MA	Visual	100%	Contract specifications, Product Catalogue, Approved GA / Configuration drawing, BOQ.	As per reference documents.	BHEL Quality Inspection Report.	3/2 2		1	

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 PEM :: C&I		STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER						QUALITY PLAN NO.: PE-QP-999-145-I036				
								VOLUME IIB				
								SECTION D				
								REV. NO. 01		DATE: 24.08.2007		
								SHEET 3		OF 8		
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records P	Agency \$			Remarks
										W	V	
2.0 Assembly												
2.1	Functional Test for HMI/OVS devices such as Monitors, Keyboards, Mouse, Printers etc.	Operation	MA	Functional	100%	Approved Configuration Diagram & BOQ and FAT	Correct Operation of interconnected Devices of HMI system.	BHEL Quality Inspection Report.	2 1		1	
2.2	Hardware Functional Verification.	Physical arrangement, Wiring check & labeling, Continuity Checking, IR & HV test	MA	Visual/ Electrical	100%	Approved GA Drawing, Panel Wiring Diagram, IR & HV as per relevant International standard	Test Certification	BHEL Quality Inspection Report.	2 2		1	
2.3	Powering Up	Healthiness of all the modules/equipment, associated with Powering of PLC system	MA	Visual /Electrical	100%	Approved power supply scheme	All equipment to be healthy on power ON	BHEL Quality Inspection Report.	2 1		1	
2.4	Burn in test for PLC modules	Healthiness of PLC modules on Continuous Energisation, Temperature maintenance	MA	Visual/ Electrical	100% F	AT Procedure	Test certification as per FAT	BHEL Quality Inspection Report.	2 2		1	

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बीएसडीएल  PEM :: C&I		STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER						QUALITY PLAN NO.: PE-QP-999-145-I036__				
								VOLUME IIB				
								SECTION D				
								REV. NO. 01		DATE: 24.08.2007		
								SHEET 4		OF 8		
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records P	Agency ^{\$}			Remarks
										W	V	
3.0	Factory Acceptance Test (FAT)											
3.1	Input Output Functional Verification	I/O configuration, I/O operation	MA	Visual/ Eletrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.2	Processor Verification	Processor configuration, Powering up, standby operation (as applicable) and Loading	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.3	Power Supply Module Verification	Redundancy Operation	MA	Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.4	Communication System Verification	Redundancy operation of Communication System, Measurement of Response Time, Communication with third party system	MA	Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.5	Diagnostic Verification	Self Diagnostic features of PLC system	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.6	Control Panel/Desk Verification	Operation of PLC driven annunciation system, Mosaic, Push buttons & selector switches, Indicating lamps	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.7	Software Verification	(i) Control Logics (ii) Engineering Features (iii) HMI Features	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	

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QUALITY PLAN NO.: PE-QP-999-145-I036		
VOLUME IIB		
SECTION D		
REV. NO. 01	DATE: 24.08.2007	
SHEET 5	OF	8

FACTORY ACCEPTANCE TEST (FAT) PROCEDURE

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

- a) Technical Specification of PLC.
- b) PLC System Configuration
- c) General Assembly Drawings.
- d) Panel Wiring Diagrams.
- e) Bill of Quantity for PLC System.
- f) Logic Diagram.
- g) HMI Schematics.
- h) Input / Output List.

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

APPLICABLE TEST PROCEDURE:

1. Input/Output Functional Verification.

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

2. Processor Verification

PLC Configuration drawing to be referred for ascertaining

- i) Redundancy

**STANDARD QUALITY PLAN
FOR
PROGRAMMABLE LOGIC CONTROLLER**

QUALITY PLAN NO.: PE-QP-999-145-I036		
VOLUME IIB		
SECTION D		
REV. NO. 00	DATE: 23.03.2005	
SHEET 6	OF	8

ii) Type (Hot or Cold)

Both the processors are to be checked for healthiness in case of redundant configuration as per vendor's standard practice. In case of hot redundancy, switchover of control from primary processor to standby processor shall be demonstrated for uninterrupted control and data processing as per vendor's standard practice. Switchover shall be witnessed, by manual power off or resetting the Primary CPU or simulating failure of primary processor. Checking should be by witnessing the lighting up of Processor's LEDs as per manufacturer's product standard.

Vendor shall demonstrate, as per Vendor's standard practice, adequate Loading (Spare Capacity) of Processors, as mentioned in contract specs. This shall be done, by simulating worst load operation of fully integrated PLC system.

3. Power Supply Module Verification

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

4. Communication System Verification

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

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

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

5. Diagnostic Verification

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

STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER

QUALITY PLAN NO.: PE-QP-999-145-I036		
VOLUME IIB		
SECTION D		
REV. NO. 00	DATE: 23.03.2005	
SHEET 7	OF	8

6. Control Panel /Desk Verification

- i) PLC driven annunciation system should be checked by alarm signal simulation.
- ii) Push Button and selector switch operation should be checked by verification of corresponding change of status of Data Base point.
- iii) Indicating lamp / MIMIC should be checked by corresponding Data Base point simulation.

7. Software Verification

- i). Control Logics:– Software switches, lamps and Analog sources shall be used for simulation of field conditions .Control logics shall be checked for its correct functionality as per approved logic schemes
- ii). Engineering features:-
 - a) Online changing of parameters, set points.
 - b) Online modification in Control Logic Diagrams.
 - c) Online configuration of Graphics, Trends, Logs, HSR.
- iii). HMI features:-
Check for configuration & operation of Graphics, Trends, Logs, HSR and Alarms, in the form of Displays and Printouts, by simulation of Inputs as per approved documents.

8. Burn in **Elevated Temperature test**

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

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

**STANDARD QUALITY PLAN
FOR
PROGRAMMABLE LOGIC CONTROLLER**

QUALITY PLAN NO.: PE-QP-999-145-I036		
VOLUME IIB		
SECTION D		
REV. NO. 00	DATE:	
23.03.2005		
SHEET 8	OF	8

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

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

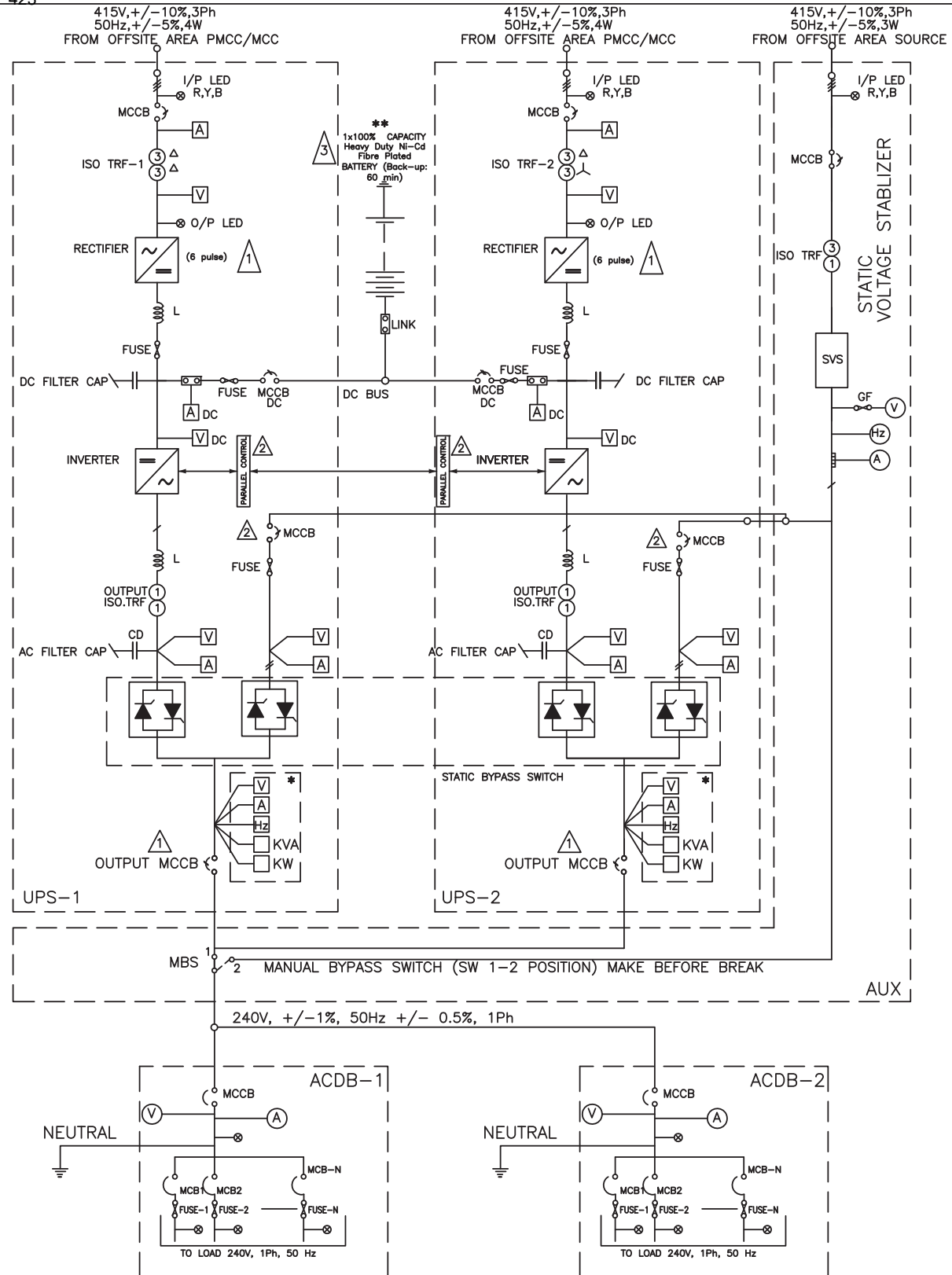
F. SPECIFICATION

FOR

UN-INTERRUPTED

POWER

SUPPLY



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

** SINGAL SET OF BATTERY FOR LOAD < 15KVA & 2-SETS OF BATTERY FOR UPS RATING > 15KVA SHALL BE PROVIDED. ⚠



PROJECT:- 2 X 660 MW ENNORE SEZ STPP

TITLE:- UPS SCHEME
FOR OFFSITE

GENERAL NOTES:

1. ACDB-1&2 NEUTRAL TO BE GROUNDED TO A DEDICATED GROUND.
2. ALL OUTPUT FEEDERS OF ACDB SHALL BE PROVIDED WITH AN LED AFTER THE FUSE FOR 'FEEDER ON' INDICATION WITH FEEDER DESCRIPTION.
3. REDUNDANT FEEDERS SHALL BE PROVIDED FOR EACH LOAD. 
-  4. ONLINE BATTERY HEALTH MONITORING SYSTEM SHALL BE PROVIDED FOR MAIN PLANT & OFFSITE UPS.
5. SINCE, THIS DIAGRAM IS AN SLD FOR UPS, DETAILS REGARDING SIZING HAVE NOT BEEN SHOWN. BHEL-EDN SHALL DO THE SIZING AND PREPARE TECHNICAL SPECIFICATION FOR PROCURING THE UPS.
6. FILTER CIRCUITS SHALL BE PROVIDED ON AC & DC SIDE AS REQUIRED.
7. UPS DB SHALL HAVE 1Ø240V MCB OUTGOING FEEDER.
8. RECTIFIER SHALL HAVE FACILITY FOR BOOST CHARGING THE BATTERY.
-  9. TRANSDUCERS SHALL BE PROVIDED FOR GIVING 4-20mA ISOLATED SIGNALS FOR DDCMIS & PLC.
10. POTENTIAL FREE CONTACTS FOR ALARMS/FAULTS SHALL BE PROVIDED FOR USE IN DDCMIS & PLC.
11. BOTH STATIC TRANSFER SWITCHES SHALL BE SELECTED ON AUTO MODE FOR AUTOMATIC TRANSFER TO BACKUP SUPPLY.
-  12. UPS SYSTEM SHALL WORK IN "CRISS -CROSS REDUNDANCY" CONFIGURATION. HENCE THE UPS SYSTEM DESIGN SHALL ENSURE THAT IN CASE OF ONE OF THE CHARGER FAILURE, THE OTHER HEALTHY CHARGER, SHALL FEED TO ONE OF OR BOTH THE INVERTORS AS THE CASE MAY BE AND CONTINUE TO CHARGE THE COMMON/INDIVIDUAL DC BATTERY BANKS AT ALL LOAD CONDITIONS.
-  13. SURGE PROTECTION DEVICE (SPD) SHALL BE PROVIDED AT INPUT SIDE OF EACH UPS & STATIC VOLTAGE STABILIZER.
-  14. BATTERY JUNCTION BOXES SHALL BE AS PER CUSTOMER SPECIFICATION REQUIREMENT.
-  15. THE REQUIREMENT OF INDICATION OF ON, OFF & TRIP SHALL BE AS PER CUSTOMER SPECIFICATION.
-  16. FOR A.C. POWER DISTRIBUTION PANELS(INCLUDING 20% SPARE FEEDERS ON EACH PANEL WITH 2 Nos. MINIMUM SPARE FEEDER OF EACH RATING) AND DIGITAL TYPE AMMETER, VOLTMETER, FREQUENCY METER, PF METER, WATT METER & VA METER QTY OF UPS FOR BTG & FOR EACH INDIVIDUAL BOP PKG IS 2 SETS QTY OF FEEDERS SHALL BE AS ON REQUIRED BASIS.

LEGEND:

 ISO. TRF

 CAPACITOR

 INVERTER

 STATIC BYPASS SWITCH

 INDUCTOR

 FUSE

 MCCB

 SELECTOR SWITCH



PROJECT:- 2 X 660 MW ENNORE SEZ STPP

TITLE:-
UPS SCHEME
NOTES & LEGEND

△ UPS SIGNAL INTERFACING WITH DDCMIS/DCS & PLC

1. ALARMS AND STATUS INDICATIONS, CURRENT, VOLTAGE ,FREQUENCY, PF ETC SHALL BE PROVIDED THROUGH SERIAL LINK WITH MODBUS OR ANOTHER COMPATIBLE PROTOCOL .
2. LIST OF 4–20 mA SIGNALS TO DDCMIS/PLC :
 - I) INVERTER A & B OUTPUT VOLTAGES
 - II) INVERTER A & B OUTPUT CURRENTS
 - III) INVERTER A&B OUTPUT FREQUENCY
3. LIST OF ALARMS (MIN.) TO DDCMIS THROUGH POTENTIAL FREE CONTACTS :-
 - I) RECTIFIER – 1 TRIP.
 - II) INVERTER – 1 TRIP.
 - III) UPS BATTERY LOW.
 - IV) RECTIFIER – 2 TRIP.
 - V) INVERTER – 2 TRIP.
 - VI) LOAD ON STATIC BYPASS.
 - VII) STATIC BYPASS FAILURE
 - VIII) ACDB – 1 INCOMER TRIPPED.
 - IX) ACDB – 2 INCOMER TRIPPED.
 - X) UPS – 1 FAN TRIPPED.
 - XI) UPS – 2 FAN TRIPPED.



PROJECT:— 2 X 660 MW ENNORE SEZ STPP

TITLE:— UPS SCHEME

CHAPTER-7**UNINTERRUPTIBLE POWER SUPPLY SYSTEM & 24 V DC SYSTEMS****7.01.00 GENERAL REQUIREMENTS**

- 7.01.01** This subsection covers design, construction and performance requirements of parallel redundant industrial grade Uninterruptible Power Supply (UPS) System & parallel redundant 24 V DC System to be furnished by the Bidder for BTG, Station C & I Package & BOP/offsite packages & any other control system/sub system specified elsewhere in the specification. The Bidder shall furnish separate parallel redundant industrial grade UPS System for each unit DDCMIS/DCS Package and separate parallel redundant industrial grade UPS System for each BOP package including static inverters, static switches, manual bypass switch, chargers, A.C. Power distribution panels and Batteries with all required isolating and protecting devices and all other equipment and accessories required for completeness of this system. Bidder to note that there will be no common component like in phase transformer (IPT), common power supply to any redundant component and common point of failure in the UPS & 24 V DC system.
- 7.01.02** The requirements of UPS system & 24 V DC system are specified herein on system basis. The Bidder shall be responsible for engineering and furnishing a complete and operational system fully meeting the intent and requirements of this specification and Owner approved drawings.
- 7.01.03** The equipment furnished under this subsection shall meet the requirements of all applicable codes and standards including ANSI, NEMA, IEEE, NEC and IS.
- 7.01.04** The UPS System & 24 V DC system hardware shall be from the latest established product range of a qualified manufacturer. The Bidder shall furnish documents to satisfy the owner that the design, performance and high availability of the proposed UPS System, 24 V DC system and all system components have been established by a considerable record of successful operation in utility power station for similar application. All UPS system & 24 V DC system cabinets, enclosures and distribution boards shall be manufactured, assembled, wired and fully tested as a complete assembly as per the requirements of this specification in the manufacturing works of a qualified manufacturer prior to shipment to the project site. Class of insulation of wound components (All transformers, chokes/inductances etc.) shall be class H with temp rating up to class B.
- 7.01.05** The UPS, 24 V DC system equipment and the complete system shall have surge withstanding capability (SWC) to meet the requirements of ANSI C 37.90a – IEEE Standard 472 –1974. UPS & 24 V DC charger system should be provided with Class C type surge protection device. The Class C type surge arrester should be single MOV type, pluggable, should have fault indication and should be tested as per IEC 61643-1 to withstand 40KA 8/20 μ s pulse. The arresters should have potential free contact to ensure maintainability.
- 7.01.06** All non-interrupting components of UPS system & 24 V DC systems shall be capable of withstanding all available short circuit current without damage. Additionally, all circuit interrupting components shall be capable of withstanding and interrupting all encountered short circuit currents without damage.



- 7.01.07** All control and instrument circuits shall be fused. Fuses shall be mounted inside the enclosures and shall have easy accessibility. Fuses shall be Bussman low-peak type or Owner approved equivalent. All load fuses shall be to Owner's approval equal. The Bidder shall co-ordinate all load and line fuses applications to ensure that load fuses operate properly.
- 7.01.08** The bidder shall be responsible for ensuring that UPS System, 24 V DC system and the downstream power distribution system for equipment to be serviced by are coordinated such that UPS loads continue to operate without interruption and in accordance with the power supply tolerance requirements (both voltage and frequency) for these UPS loads as long as at least one source is within the limits of voltage and frequency as specified herein. The Bidder shall furnish single line diagrams with his proposal to demonstrate how this requirement is met for all equipment and system covered under Bidders scope.
- 7.01.09** The UPS system & 24 V DC System shall be installed in AC room.
- 7.01.10** Acoustic noise at rated linear load shall be < 75 dBA at 1 meter distance from UPS as per ISO 3746.
- 7.02.00** **FUNCTIONAL REQUIREMENTS OF UPS**
- 7.02.01** **CAPACITY OF UPS SYSTEM FOR main plant PACKAGE, remote I/O panels and BOP/OFF-SITE PACKAGES**

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

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

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



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

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

- 7.02.02** The parallel redundant Uninterruptible Power Supply (UPS) system of continuous duty shall supply, regulated, filtered and uninterrupted 240 V , 50 H z, single phase power, within specified tolerances, to system AC loads, UCB mounted monitoring system, and other critical loads. Each of these critical loads shall receive one feeder from the AC Distribution Board of Inverter-"A" and another feeder from the AC Distribution Board of Inverter-"B". However, each inverter shall supply only 50% loads under normal conditions as indicated below. SLD of UPS as per NIT drawing # 114-17-0100 shall also be referred by bidder.
- 7.02.03** All necessary equipment required for protecting UPS equipment and connected inputs and outputs shall be furnished by the Bidder as an integral part of this system. Complete UPS system shall be automatic without any manual interference at any time of operation.
- 7.02.04** True, 100 % parallel redundant configuration also means availability of "Criss-Cross Redundancy". Hence The UPS system design shall ensure that in case of one of the charger failure, the other healthy charger, shall feed to one of or both the invertors as the case may be and continue to charge the common/individual DC battery banks at all load conditions. UPS system shall work in "Criss-Cross Redundancy" configuration to safeguard the battery bank from unnecessary drainage. The bidder should note that this situation should not in any way lead to the discharge of the DC battery and maintain the UPS power supply to all loads.
- 7.02.05** The industrial grade UPS system for BTG & for each individual BOP package shall include the following equipment:

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



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



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

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

7.02.06

NORMAL OPERATION

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

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

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

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



7.02.07

EMERGENCY OPERATION

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

1. In case of failure of any inverter the static switch shall automatically transfer the UPS Loads of faulty inverter (say Inverter – “A”) to the healthy Inverter-“B” which will start working at 100% capacity. Thus the feeding of UPS power is continued automatically to all load connected to both inverters despite power supply to all UPS loads connected to both inverters shall be maintained without interruption. Isolation of faulty inverter shall be automatic and achieved in less than 4 milli seconds.
2. Based on inverter failure alarm, the operator will transfer manual by-pass switch to “Position-1” bringing in the plant AC source as the standby source to healthy Inverter –“B” now working at 100% capacity. In this mode the healthy Inverter-“B” shall get the synchronizing signal from the stand by-AC source and automatic synchronization, operation on internal oscillator and transfer / retransfer to standby source shall be as follows:
 - i) The output frequency of the concerned inverter shall be automatically synchronized with the plant stand-by source by using synchronizing signal from the standby source. The frequency limits for this synchronism are specified in clause 7.03.05. If the frequency of the standby source is beyond these limits, the Inverter frequency control shall be automatically disconnected from stand-by synchronizing signal and the inverter shall maintain the output frequency at 50 H z within ± 0.1 per cent under all conditions of load and input voltage by working on their own internal oscillators.
 - ii) During operation on its own internal oscillator, the inverters shall continuously monitor the frequency of standby source. Upon restoration of proper frequency conditions of stand-by source, the inverter shall automatically start using stand-by source frequency as the synchronizing signal for inverter output frequency control.
 - iii) During the operation of any inverter on its internal oscillator due to synchronising frequency being beyond the specified limits, the transfer of static switch from “Inverter” to “Standby” shall be inhibited.
3. During any fault in the branch circuit feeders or inverter output bus, the inverter shall be capable of clearing a fast acting fuse of largest rating in 4 milliseconds and simultaneously provide UPS power to all connected loads (i.e. 50% capacity). In view of the above fault clearing capability of each inverter and due to availability of plant AC source as standby source for inverters the static switches shall not transfer the loads to the other inverter for fault clearing purposes.
4. Retransfer of static switch shall be manual in all cases and shall be accomplished only after synchronism of the inverter output with the stand-by source has been automatically accomplished.



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

7.03.00 STATIC INVERTERS AND AUXILIARY EQUIPMENT

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

7.03.02 INVERTER CAPACITY

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

- 1) Continuous full load rating
- 2) Over load capacity: 125% of full load rating as above for 10 minutes, 150% for 1 minute, 200% for 10 seconds minimum & 300% for 4 msec for all specified input voltages.
- 3) Fuse clearing capacity : Upon a fault in any branch circuit lateral feeder, the inverter shall have the capacity to carry a load equal to one half of its full load rating plus it shall clear the largest rated fast acting fuse in 4 milliseconds or less. All fuses used in inverter power and control circuit shall be fast acting type operating in less than 5 millisecond and each of these fuses shall be provided with kick fuse and alarm contact. Indication and alarm shall be provided to enable fault location.
- 4) Step load pick up: Upon transfer of full load, the inverter output voltage shall not drop below 85% of nominal voltage during the first half cycle after transfer and 90% of nominal voltage in the next half cycle. The recovery to within $\pm 1\%$ of voltage shall be in less than 50 milliseconds.
- 5) The inverter shall have sufficient I²t capacity to clear a slow acting HRC fuse having a continuous current rating equal to at least 20% of the continuous full load current rating of the inveter, while feeding 100% rated loads of the inverter.

7.03.03 INPUT VOLTAGE

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



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

7.03.04**OVER LOADS, SHORT CIRCUITS AND LOAD LOSS PROTECTION**

1. The inverters shall be provided with suitable fuses at the input and output which will permit proper co-ordination with other protective devices and at the same time protect the inverter against damage due to internal faults. All necessary equipment shall be provided to protect the inverters against over loads, short circuits and 100% loss of load. The inverter shall be self protecting against damage if energized with full load connected.
2. The inverter shall be provided with current limiting circuitry which will limit the output current to a value which will not damage the inverter or blow its fuses.
3. The inverter shall have sufficient $I^2 t$ capability to prevent damage to itself until short circuit conditions on the output are cleared.
4. Each inverter shall be capable of operation with nonlinear loads. For bidder loads bidder shall detail the nature of non linearity. For loads provided by owner, bidder may assume a nonlinear waveform with a current crest factor of 3.0 occurring coincident with voltage peak. With nonlinearity consisting of third, fifth and seventh order harmonics. Output waveform of the inverter(s) shall remain within specified limits when operating with nonlinear loads at 100 per cent rated load.
5. The inverters shall be self protecting against all AC and DC transients, voltage surges and steady state abnormal voltages and current likely to be encountered in utility power station.

7.03.05**Automatic Synchronisation**

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

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

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

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



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

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

7.03.06

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

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



- c) Synchronization : 48 Hz to 52 Hz (factory test)
limits (for maintenance & synchronism between the inverter and standby AC source).
- d) Field adjustment : 50 ± 0.5 Hz to 50 ± 2 Hz
range for (c) above
- e) Total harmonic content : <4% max.
- f) Harmonic content : <2.5%
max.for any single harmonic
6. Rated output current at rated output voltage with current limit not operating :
- a) Current : 200%
- b) Duration : 10 seconds
7. Overload capacity at 100% voltage :
- a) For 4 ms (fuse clearing): App. 300%
- b) For 10 seconds : 200%
- c) For 10 minutes : 125%
- d) The proposed inverter has : ---
the capacity to clear largest acting fuse in 5 milli second & without entering into current limiting mode
8. Efficiency (watt output/watt input)
- a) at 100% load 1.0 P.F. / 0.8 P.F: >91%/ 91%
- b) at 75% load 1.0. P.F. / 0.8 P.F. : >90% / 90%
- c) at 50% load 1.0 P.F. / 0.8 P.F. : >89% /89 %
9. Duty : Continuous
10. Cooling : Natural convection or forced cooling using redundant fans.
- Equipment to be designed for operation with full load even without cooling availability.
11. Ambient temperature : 50 deg C, maximum
12. SCR derating from : 50%



peak voltage and peak ratings.

7.03.06 STATIC INVERTER AUXILIARY EQUIPMENT

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

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

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

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

The following indications shall be provided as a minimum :

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

7.04.00 STATIC TRANSFER SWITCHES AND AUXILIARY EQUIPMENT



2 x 660 MW ENnore SEZ Supercritical Thermal Power
Project at Ash Dyke of NCTPS
Spec. No. CE/C/P&E/EE/E/OT.No.03/2013-14

Vol. V /Sheet - 281



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

- 1) To transfer the load automatically without any break between the inverter to the standby inverter as required to maintain the continuity of power supply to UPS connection loads. The load shall be automatically transferred from "Inverter" to the inverter source upon any malfunction of one inverter.
- 2) To transfer UPS load under manual control from standby AC source to inverter when placing the UPS System in service and from inverter to standby AC source when taking the UPS out of service.

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

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

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

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

7.04.05 **TRANSFER INITIATION**

- 1) The transfer of static switch from normal "Inverter" position to "Stand-by" position shall be initiated by one of the following causes :
 - a) Inverter failure and UPS System trouble
 - b) Inverter output voltage failure
 - c) Over current
 - d) Manual push button operation
 - e) Static Output voltage failure.
- 2) The UPS bus shall be monitored by two voltage detectors. One fast acting circuit shall be used for detecting a complete and instantaneous, voltage loss while the other slower acting averaging circuit with adjustable trip level shall be employed to detect voltage deviation beyond selected limits. Both voltage detector circuits shall automatically initiate operation of static transfer switch.



- 3) The static switch shall automatically transfer the load from inverter to stand-by AC source when the maximum capability of the inverter is reached when the inverter output voltage drops below 90%.
- 4) UPS bus current shall be continuously monitored by a current monitoring detector. This detector shall operate the static transfer switch when the load current exceeds the overload rating of any inverter. The detector shall rest when the load current falls below the rated current of the inverter resulting in retransfer of static switch with inverter position.
- 5) Over current transfer limit shall be continuously adjustable from inverter continuous rating to inverter current limit rating.

7.04.06 TRANSFER INHIBIT

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

- 1) Automatic or manual transfer of load from inverter to stand-by AC source or vice versa, shall be inhibited when the inverter frequency is not synchronized to the alternative source.
- 2) Transfer resulting from overload shall be inhibited when the standby AC source is not available. In this case the load fed by the inverter shall be automatically disconnected

7.04.07 RETRANSFER TO NORMAL

- 1) The retransfer to normal shall be manual in all cases.
- 2) Manual transfers shall be initiated by push button actuation.

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

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

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

7.05.00 MANUAL BY-PASS SWITCH

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

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



- 7.05.03** The manual by-pass switch shall be rated for 600 Volts, 50 Hz, single phase operation. It shall have continuous load carrying capacity equal to full load inverter current and necessary short term load carrying and interrupting capacity to meet the requirements of the UPS system.
- 7.05.04** All other by-pass and disconnect devices shall be provided by the Bidder as required for orderly start up and shut down and maintenance of UPS system and system components.
- 7.05.05** The Bidder shall provide potential free contacts, one closed in each position, for use in DDCMIS & PLC system.
- 7.05.06** The manual by-pass switch and required disconnect devices shall be furnished duly mounted and wired in enclosure, furnished by the Bidder.
- 7.06.00** **FLOAT-CUM-BOOST CHARGERS AND AUXILIARY EQUIPMENT**
- Two no. 100 % capacity SCR based fully controlled 12 pulse float cum boost chargers shall be furnished for main BTG UPS system and Two no. 100% capacity SCR based fully controlled 6 pulse float cum boost chargers shall be furnished for BOP packages UPS system. Each charger shall confirm to the following requirements.
- 7.06.01** **CHARGER CAPACITY**
- Each charger furnished for UPS system shall be adequately rated to ensure that any one shall meet full DC load of UP system operating at 100% rating plus recharge the fully discharged UPS battery within 8 hours.
- The Bidder shall furnish the charger rating calculations to the Owner to satisfy that this requirement is met. The charger shall be furnished as per rating approved by the Owner during engineering stage.
- 7.06.02** The chargers shall be supplied from a 415 volt, 50 H z. 3 phase system. The chargers shall maintain the output voltage within plus and minus 0.5 percent from no load to full load with an input power supply deviation in voltage level of plus or minus 10 percent and input power supply deviation in frequency of plus or minus 5 percent and with both deviations present in any combination.
- 7.06.03** In addition to supplying DC power for inverters, the chargers shall be designed to charge a fully discharged battery without over loading or causing over voltage or without causing interrupting operation of AC or DC circuit breakers for the entire range of intended operating regimes. Suitable solid state electronic circuits shall be provided to ensure that the charging current is voltage regulated and current limited. After the battery is recharged the charger shall maintain the battery at full charge until the next emergency operation when the UPS battery is again required to provide DC power.
- 7.06.04** Float and equalizing controls shall have an adjustment range of $\pm 5\%$ continuous (without steps).



- 7.06.05** The chargers shall be self-regulating, solid state, silicon controlled, full-wave rectifier type designed for single and parallel operation with the battery specified under clause 7.07.00. The chargers shall be designed for automatic load sharing during parallel operation.
- 7.06.06** The charger shall be current limited at 125% of full load to reduce output voltage for charger circuit protection and for protection of battery from overcharge. The current limit shall be continuously adjustable from 80% to 125%.
- 7.06.07** All necessary equipment and devices shall be provided to protect the charger from short circuits, transient voltage surges, load and supply fluctuation including sudden loss of input or load.
- 7.06.08** The charger shall have a slow walk-in circuit which shall prevent application of full load DC current in less than 10 seconds after AC power is energized.
- 7.06.09** The minimum full load efficiency at nominal input and float output shall be 96 %. The output regulation, ripple content and power factor shall meet the requirements of UPS system as well as the inverters furnished by the Bidder as per clause 7.03.00.
- 7.06.10** Chargers and auxiliary equipment shall be mounted in free standing cabinets furnished by the Bidder. Charger cabinets shall be folded steel construction with top, front, back and sides fabricated from not less than 3 mm thick sheet steel. The cabinet front, back, end sides shall extend to the floor to present a finished appearance. Cabinet door shall be provided to permit easy access to all components for maintenance or replacement. Doors shall have concealed hinges and three-point latches. Louvers shall be provided for ventilation as required for operation at the specified ambient but the cabinet top shall be solid. All louver openings shall be covered with corrosion resistant fine screen coverings.

7.06.11 **GROUND DETECTOR SYSTEM**

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

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

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

- a) The bidder shall provide alarms and status indications, current, voltage, frequency, P F etc through serial link with MODBUS or another compatible protocol.
- b) The Bidder shall furnish 4-20 mA signals to DDCMIS/PLC for the following:
- i) Inverter A & B output voltages
 - ii) Inverter A & B output currents
 - iii) Inverter A&B output frequency



- c) List of alarms (min.) to DDCMIS through potential free contacts shall be as follows:-
- i. Rectifier – 1 Trip.
 - ii. Inverter – 1 Trip.
 - iii. UPS battery low.
 - iv. Rectifier – 2 Trip.
 - v. Inverter – 2 Trip.
 - vi. Load on static Bypass.
 - vii. Static Bypass failure
 - viii. ACDB – 1 Incomer Tripped.
 - ix. ACDB – 2 Incomer Tripped.
 - x. UPS – 1 Fan Tripped.
 - xi. UPS – 2 Fan Tripped.

7.07.00**UPS/24 V DC System BATTERY AND ACCESSORIES**

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

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

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

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

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



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

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

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

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

7.08.00 **VOLTAGE STATIC STABILISER**

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

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



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

7.08.03 The stabilizer shall meet the following characteristics as a minimum

- Fast rate of correction - within 5 cycles
- Output distortion - less than 5% under worst conditions
- Efficiency - better than 95%
- Overload Capacity – 300% for 200 mSec.

The make and rating shall be subjected to Owners approval.



7.10.00 AC & DC Power supply for BOP packages

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

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

The UPS power supply shall be extended to Parallel redundant 240 V AC to 24 V DC convertor thru redundant UPS feeders.

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



7.11.00 CONSTRUCTIONAL FEATURES FOR CABINETS/ENCLOSURES

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

7.11.01 Grounding

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

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

7.12.00 DC DISTRIBUTION BOARD PANEL

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

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

7.13.00 AC DISTRIBUTION BOARDS PANEL

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

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

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



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



2 x 660 MW ENNORE SEZ Supercritical Thermal Power
Project at Ash Dyke of NCTPS
Spec. No. CE/C/P&E/EE/E/OT.No.03/2013-14

Vol. V /Sheet - 292



G. SPECIFICATION FOR CONTROL PANELS

CHAPTER-6**SUPERVISORY CONTROL PANELS, SUPERVISORY CONTROL DESKS,
EQUIPMENT PANELS****6.00.00 PANEL AND DESKS****6.01.00 GENERAL REQUIREMENTS**

All DDCMIS/PLC/any other control system's electronic modules, power supply components, other control devices (except field mounted sensors/transmitters) and required for completeness of the system shall be housed in cabinets furnished by the Bidder. All equipment and dedicated cabinets required for termination, marshalling and proper interface within Bidder's system and also with other systems shall also be provided by the Bidder.

The cabinet mounted equipments shall be fully assembled, installed in mounting racks, wired and fully tested as per specification requirements and Owner approved drawings in the manufacturing works of a qualified manufacturer prior to shipment to the project site. The Bidder shall ensure that the cabinets are complete and ready for installation before dispatch from manufacturing works. The installation work at project site for these cabinets should only involve connections through multi pair cables from marshalling cabinets (wherever provided) to system cabinets and inter-cabinet/cabinet to UCD/UCP/BUP.

The Control cabinets shall house all types of modules / hardware to achieve all functions of Control System including signal conditioning modules, controller modules, I/O modules, communication controller modules, and all other requisite hardware for a complete system.

6.02.00 SUPERVISORY CONTROL PANELS AND DESKS**6.02.01 Control Desks & Other Furnitures**

Supervisory control desks for DDCMIS and other systems shall be supplied for mounting the required operating station as specified elsewhere in the specification. Also control desk will be provided for balance work stations – located in computer room, supervisor room etc. All furniture including chairs and tables for printers etc. shall also be provided by the bidder.

Also control desk & complete furniture will be provided for work stations & printers – located in respective control room for BOP packages.

Industry standard Cushioned revolving, wheel, independently, adjustable seat and back chairs with provision for adjustment of height shall be provided for the operator & unit in charge & other personnel in central control room area & BOP's control rooms, simulator rooms, Conference room, meeting room, documentation room, staff room, CAAQMS shelters, CAAQMS room etc. These shall be designed for sitting for long duration such that these are comfortable for the back. The exact details shall be finalised & approved by Owner during detailed engg.

The actual nos., placement and profile of the main plant control room desk shall be decided during the detailed Engineering.



The tentative layout of central control desk, LVS & consoles are shown in the Drg. No. 114-05-0108, 0105 & 0111.

Control Desk for programmer's, Maintenance Engineer's, EWS, Serves, P C & diagnostic OWSs: -

Required numbers of control desks for accommodating programmer's/main-tenance engineer's/diagnostic etc shall be supplied. These shall preferably have the same dimension as that of supervisory control desks. Also required nos. of control desk will be provided for work stations & printers – located in respective control room for BOP packages.

Desks for accommodating printer:

Adequate number of table/desks/stands for accommodating printers in bidder's scope shall be supplied. Each printer shall be on a separate table / stand.

Care shall be taken to ensure ergonomically aspects so as to create ergonomically ideal work place considering physical aspects such as an average Indian person's size and reach, physiological aspects such as line of sight and field of vision and cognitive factors such as concentration and perceptivity. Extreme care shall be taken to design the desks with correct angles and dimensions.

Glass top teak wood office table with lockable drawers shall be provided for Chief Engineer room and all other executive rooms.

6.02.02

Supervisory Panel Unit Control Panel

In addition to the LVS and OWS, a limited operation from backup unit control panel is envisaged for emergency operation and to provide safe shut down of plant. The Unit control panel shall housed Conventional Push-button (ILPB) stations, Console inserts (for SG, TG & Generator like FSSS, HPBP, SADC, APRDS, ATRS, ATT, DEHC, LPBP etc), Trip Push Buttons, EWLI, Ammeters, chartless recorders, & min. 15 nos. programmable digital display units for Boiler, Turbine & Generator's parameters. The mosaic grid shall be heat resistant, flame retardant, self extinguishing, and shrinkage free, non reflecting type. Finish of mosaic grid shall be mat type with out flaring. Hard wired emergency trip pushbuttons shall be arranged on operator station desk & in parallel on UCP.

Unit control Panel (UCP), shall be located suitably in the CCR.

In addition to above, 21 nos. Programmable digital display units common for both units showing total MW shall be provided by bidder at different locations of plant. The data to this DDU will be fed from DDCMIS through MOD BUS/PROFI BUS /RS 485 protocol and not hard wired. The **digit size** of the display unit will be **300 mm for 6 Nos.** and **200 mm for 15 Nos.** The placements/locations shall be decided during detailed Engineering.

Control panel cum desk with HW annunciation windows, ILPBs, Ammeters, Annunciation & desk PBs, mimic, lamps, Indicators, recorders, etc. shall be provided as per Annexure A – Control System Philosophy for BOP packages.



(Exact service & quantities will be worked out & approved during detailed engineering by owner).

- 6.02.03 Two (2) nos. vertical Steel Almirahs shall be provided for keeping documents in each BOP package's control room. Glass doors for each rack shall be provided such that the documents are visible from outside. Size of the rack shall be sufficient to easily fit technical manuals. The exact details shall be approved by Owner during detailed engg.

Suitable lockers (min. 24 nos. per unit) shall be provided in the room adjacent to the each central unit control room for storing of personal articles of control room personnel. Similarly suitable lockers (min. 8 nos. in each control room) shall be provided in BOP package control rooms for storing of personal articles of control room personnel. Also, vertical steel almirahs (min. 4 nos. per unit) shall be provided in Documentation Room for storing of documents.

Vertical Steel Almirahs shall also be provided for the following rooms, wherein final quantity may be decided by owner during detailed engineering

- a. Maintenance room – 6 nos. min. (per Unit)
- b. ERP room – 2 nos. min (Common for both unit).
- c. PADO Room – One (1) no. min.(per unit)
- d. Station In charge room – One (1) no. min (common for both unit).
- e. Simulator room – 4 nos. min. (per Unit)

Thickness of steel almirah sheet shall be 18 gauges.

In addition to above, All industry grade furniture including chairs, control tables, tables for printers etc. & Almirahs for storage of consumables/catalogues/manuals shall also be provided by the bidder as on required basis and finalized by owner any where in power plant. Details shall be finalised and approved by Owner during detailed engineering.

- 6.02.04 Control panels for service system like C.W. Pumps etc. will be located in the respective control room. In addition, some local panels will be provided near respective system/equipment such as Boiler Feed Pump, Hydrogen seal oil system, Electrostatic precipitator etc.

6.03.00 TERMINATION/Marshalling CABINETS & Interposing Relay Panel

Marshalling/Termination cabinets for the control system shall be supplied for terminating all cables originating from the field, MCC/SWGR or any other source of signal and for distributing the signals to different functional panels, MCC/SWGR and control cubicles.

Incoming cables from the field, MCC/SWGR or any other source of signal shall be terminated in suitable terminal blocks in logical sequence.

Prefabricated cables with plug in connectors at both ends shall be used for extending the signals to the functional panels. Matching plug sockets shall be provided in the termination cabinets for terminating the plugs.



Interposing relay panels for the system shall be supplied for mounting interposing relays & terminating all cables originating from the DO cards in case of solenoid valves, and other required services etc. IPR panels shall be placed in CER and LCR.

Interposing relay shall be mounted in respective SWGR/MCC/integral starter required for commands signals of HT/LT unidirectional drives and bidirectional drives, breakers, isolators & bus couplers etc from DDCMIS/DCS/PLC or any control system.

Terminal blocks shall be located inside the cabinets on support wings fabricated of metal plates.

The plug socket shall be mounted on hinged plates to provide an access to the rear pins of the plugs.

General features of termination cabinets and accessories shall conform to the general design and construction specification of panels. Terminal blocks shall be Rail mounted Terminal blocks (Screw less cage clamp type) with markers.

6.04.00 CONSTRUCTIONAL FEATURES OF PANELS, CONSOLES, CONTROL DESK, CUBICLES & ENCLOSURES

All panels, cubicles, consoles, SOV panels and enclosures furnished as per this specification shall be of free standing type and shall be constructed of specified gauge of steel plates. The panel sheet thickness shall be not less than 2 mm unless otherwise specified herein.

The panels, consoles/desks shall be reinforced as required to ensure true surfaces and adequate support for instruments mounted thereon. All instrument cutouts, mounting studs, and support brackets shall be accurately located. All welds on the exposed panel surfaces shall be ground smooth. Finished panel surfaces shall be free from waves, bellies, or other imperfections. Unless specified, otherwise, panel doors shall be 4 points hinged and shall have turned back edges and additional bracing where required to ensure rigidity. Door hinges shall be of the concealed type. Door latches shall be of the three-point type to ensure tight closing. Door locks shall be furnished which will allow actuation of all locks by a single master key. All panels shall have removable lifting eyebolts for safe lifting from top during storage and installation handling.

Cabinet doors shall be hinged and shall have turned back edges and additional bracing where required ensuring rigidity. Hinges shall be of concealed type. Door latches shall be of three/four-point type to assure tight closing. Detachable lifting eyes or angles shall be furnished at the top of each separately shipped section and all necessary provisions shall be made to facilitate handling without damage. Front and rear doors shall be provided with locking arrangements with a master key for all cabinets. If width of a cabinet is equal or more than 800 mm, double doors shall be provided.

All panels shall be mounted on vibration dampers, which are secured to channels mounted on the floor. The channels shall be field welded to steel plates set into the concrete flooring. The steel plates shall be located such as to approximate the outline of panel bases. The exact mounting details shall be as approved by the owner during detailed engineering stage. All panels shall be provided with adequate ventilation and packaging density of components shall be restricted so as to limit the temperature rise



above ambient to 10° C under the worst conditions. All panels shall have auto on/off switch for internal lighting. All the power supply circuit for control panels shall be provided with auto changeover circuitry.

In each panel /cabinet, a 24 VDC Voltmeter digital type shall be provided to check the Field Interrogation voltage.

Exhaust Fans with louvers & filters shall be provided on door's (front & Rear) upper side to remove hot air in all consoles, control desk and panels.

Fire/Smoke detectors shall be provided inside the Control room mounted system/control cabinets.

UPS, 24 V DC & non UPS's Feeder failure/ healthy indication shall be provided in each cabinet & remote indication shall be hooked up to DDCMIS/ PLC/annunciation & suitably grouped.

All the panels shall be equipped with Anti vibration pad of min. 15 mm size. Cable gland plate thickness shall be 3 mm.

Doors shall be provided with neoprene/polyurethane gasket only.

All the cable entries shall be at the bottom of electronic cubicles/control panels.

Protection class of panels shall be as specified at Vol. V, chapter 2.

6.04.01 Operator Control Desk

6.04.01.1 In CCR, Operator work station consoles/desk shall be of granite top of curved nature with powder coated frame. OWS consoles shall be provided with the facility for locating the CPU, document etc with all required utilities.

Unit In charge desk/consoles shall be of granite top of curved nature with powder coated frame. OWS consoles shall be provided with the facility for locating the CPU, document etc with all required utilities.

Station In charge desk/consoles shall be of granite top of curved nature with powder coated frame. OWS consoles shall be provided with the facility for locating the CPU, document etc with all required utilities.

6.04.01.2 Engineer work station and all other consoles/desk shall be ergonomically designed industrial grade type with swivel chairs for use at the various Programming stations and all other plant locations. All the equipment like Programmers stations, P C's, various peripherals & similar devices shall be complete with desks and they shall be of industrial grade stands and other mounting accessories and the same shall be completely erected & commissioned by the bidder. Details for other operating and engineering stations shall be as below:

- i. Operator Control desk shall be free standing table top type with doors at the back and shall be constructed of 3 mm thick CRCA steel plates. It shall have concealed cable & wire way management system. The top surface of control



desk shall be 30mm thick with the top 12mm of acrylic solid surface and the remaining 18mm of laminated medium density fibre board. Control desk shall consist of vertical, horizontal and base supports with their coverings for work surface, keyboard trays, Mouse pads, Monitor shelf and concealed cable and wire way management, perforated trays with covers in both horizontal & vertical directions.

- ii. To achieve durable & water resistant finish, a sheet of "plastic PVC membrane" on the surface of control desks shall be provided. Final paint finish with proper smoothening is to be ensured. Final finish of CD should be in line with relevant International standards. For more durability, the membrane sheet of the Control desk should extend 200 mm more into the underside of the desk. The cabling / wiring between OWS & CPU's, power supply cables etc. shall be aesthetically routed and concealed from view.
- iii. All the control desk shall be equipped with Anti vibration pad of min. 15 mm size. Cable gland plate thickness shall be 3 mm.
- iv. Doors shall be provided with neoprene/polyurethane gasket only.

6.05.00 SURFACE PREPARATION AND PAINTING

All panel exterior steel surfaces shall be ground smooth, and painted as specified below:

Suitable filler shall be applied to all pits, blemishes and voids in the surfaces. The filler shall be sand blasted so that surfaces are level and flat, corners are smooth and even. Exposed raw metal edges shall be ground burr free. The entire panel surface shall be sand blasted to remove rust and scale and all other residue due to the fabrication operation. Oil grease and salts etc. shall be removed from the panels by one or more solvent cleaning methods. Alternatively 7 tank process shall be followed.

Two spray coats of inhibitive epoxy primer – surface shall be applied to all exterior and interior surfaces, each coat of primer surfacer shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish colour (Catalysed epoxy finish) shall be applied to all surfaces of dry film thickness 2.0 mil. The finish colours for exterior and interior surfaces shall conform to the following shades:

- a) Exterior - RAL 7032/RAL 7035.
- b) Interior - Glossy white two coats/RAL 7035 with fire resistant paint

One uniform colour shade as finalized shall be applicable for complete plant.

Paint films, which show sags, checks, blisters teardrops, fat edges or other painting imperfections, shall not be acceptable and if any such defects appear, they shall be repaired by and at the expenses of the Bidder.

6.06.00 PANEL WIRING

Interconnecting wiring shall be provided between all electrical devices mounted in the panels, and between the devices and terminal blocks if the devices are to be connected



to equipment outside the panels by cabling and through pre-fabricated plug in cables. All alarm contacts located within a panel shall be wired to terminal blocks. Thermocouple and other special circuits shall be field wires direct to instrument terminal blocks without the use of panel wiring.

All control and instrument wiring used within the panels shall conform to NEC and NEMA standards and shall be factory installed and tested at the works of a qualified manufacturer. All interior wiring shall be installed neatly and carefully, and shall be terminated at suitable terminal blocks. Sufficient clearance shall be provided for all control and instrumentation leads, and all incoming and outgoing leads shall be connected to terminal blocks suitably located for connecting external circuits.

All panel wiring shall have appropriate ferruling for clear identification. Interior wiring shall be so arranged that the external connections can be made with only one wire per terminal point. Any common connections shall be made internal side of the terminal blocks. Common connections shall be limited to two wires per terminal. Instrumentation cable shield wires shall be connected to separate terminal at the terminal block. Signal circuit shields shall be grounded separately.

All internal wiring (except low level instrument wiring) shall be National Electric Code Type SIS, Polymeric/Elastomeric insulated, tinned copper stranded conductor, switchboard wire, or owner approved equal.

Panel wiring shall have a flame resistant insulation with adequately sized 650/1100 V grade tinned copper stranded conductor based on current carrying capacities as etc forth by the National Electric Code.

Wire sizes shall be as specified herein and suitable for intended applications.

Wiring to door mounted devices shall be provided with (49 strand minimum) adequate loop lengths of hinge wire so that multiple door openings will not cause fatigue braking of the conductor.

Wiring shall be arranged to enable instruments or devices to be removed and/or serviced without unduly disturbing the wiring. No wire shall be routed cross the face or rear of any device in a manner, which will impede the opening of covers or obstruct access to leads, terminals or devices.

Panel wires shall be identified with wire number and each termination by means of Action craft products split sleeve or Borden Chemical Co. indelible tubing markers or owner approved equal. Corrections and modifications of all panel wiring shall be Bidder's sole responsibility. Any corrections/modifications required at site for successful commissioning shall be done by the Bidder without any additional costs. Terminal lugs furnished must be of the compression, insulated sleeve, half ring tongue type. Open-ended terminal lugs will not be accepted. Wires shall not be looped around the terminal screws or studs.

Wires shall not be tapped or spliced between terminal points.

Panels, cabinets, consoles/desks will be provided with removable, gasketed cable gland plates and cable glands, for all floor slots used for cable entrance. Split type grommets shall be used for prefab cables.



Internal wiring in factory prewired electronic systems cabinets may be installed according to the Bidder's standard as to wire size, insulation, and method of termination on internal equipment except that insulation for all wiring power supply wiring, and interconnecting cables between devices shall pass the following tests.

- a) Flammability test IEEE 383/1974
- b) When tested under UITPP test method or ASTM 2893/77 light transmittance of 80%
- c) When tested under IEC 754 -1 maximum acid gas generation shall be 2% by weight
- d) Oxygen index not less than 30 as per ASTM D 2863.

All terminations for intra panel wiring inter panel cabling and connecting the Bidders panels, PB stations, control stations etc. shall be with cage clamp Screwed less connections. Soldered connections are not acceptable. All field side or external input connections shall also preferably of Cage clamp/Spring Clamp/ Screwed less connection.

Conductor Clamping shall also confirm to Standard IEC – 60947-1 & IEC-60947-7-1.

Identification of conductors may be done by insulation colour coding identified on drawings or by printed wiring lists. Terminal blocks for connection of external circuits in to factory prewired electronic system cabinets shall meet all the requirements as described elsewhere in the specification. For all multicore cables, the outer sheath shall satisfy the properties identified above. However, for panel wiring, the wiring insulation shall also satisfy the properties identified above. The internal wiring shall be done in coloured wiring.

6.06.01

Following Wire size shall be utilized for internal wiring:

- a. Current (4-20 mA) : 0.75 sq.mm
Low voltage signals :
(AI/AO & DI signals)
- b. DO signals, Ammeter/ : 1.5 sq.mm
voltmeter circuit, control
switches, indicator, recorder
- c. Internal Illumination : 2.5 sq.mm
- d. Size of Power supply cables shall be as below:-
 - i. 1 to 16 Amp. - 2.5 sq. mm
 - ii. 17 to 20 Amp. – 4 sq. mm
 - iii. 21 to 32 Amp. - 6 sq. mm
 - iv. 33 to 40 Amp. - 10 sq. mm.
 - v. 41 to 60 Amp. - 16 sq. mm
 - vi. Power earth - 4 sq. mm

6.07.00

INSTRUMENTS MOUNTING



2 x 660 MW ENnore SEZ Supercritical Thermal Power
Project at Ash Dyke of NCTPS
Spec. No. CE/C/P&E/EE/E/OT.No.03/2013-14

Vol. V /Sheet - 260



6.07.01 Instruments and relays mounted on the panels shall be easily accessible for repair and replacement without disturbing other equipment their connected wiring. No special tools shall be needed for the purpose.

6.08.00 PANEL ILLUMINATION

Panels shall be provided with LED based illuminating lamps with door switch and six (6) point 6/ 16A, 240V A C uni versal t ype po wer so ckets with sw itch f or m aintenance purposes. These switches shall be with quick make and break mechanism. 100 % spare LED l amps shall be p rovided with each panel , t hese a re i n a dditional t o mandatory spares.

6.09.00 FUSE BLOCKS

Where fuse blocks rated 30 amp. 250 Volts are required by the specifications or the manufacturer's design, they shall be modular type with bakelite frame and reinforced retaining clips. Blocks shall be class H.2 pole, screw terminal fuse blocks. Blocks for other current and voltage ratings shall be similar in construction.

6.10.00 FUSES & MCB

All fuses shall be fast acting semiconductor types for AC supply and compatible to the UPS f uses. For al l D C P owered dev ices, si milarly t he f uses shall be f ast ac ting compatible to DCDB fuse provisions. All the AC power supplies shall be provided with the protection of Fast acting semi conductor fuses & 2 P thermomagnetic type MCB. Make of Fuses shall be GE or Siemens. For all the DC power supply circuits, electronic type DC MCB shall be use d only. Make of DC MCB shall be S iemens, P hoenix contacts, Murr, Weidmuller, or Lutze.

50 % spare fuses shall be provided with each panel, these are in additional to mandatory spares.

6.11.00 MOULDED CASE CIRCUIT BREAKERS

Moulded ca se ci rcuit br eakers used i n e quipment co vered under t hese sp ecifications shall have not less than 5000 amp. Interrupting capacity at 220 Volts DC 10,000 Amp. Symmetrical interrupting capacity at 240 Volts AC. MCCB shall be provided at each main feeder line like ACDB & DCDB main feeders, PLC main feeder, control panels, UPS circuits etc.

6.12.00 GROUNDING

All panels and cabinets shall be provided with a continuous bare copper ground bus of minimum 6 mm x 25/50 mm cross section. The ground bus shall be bolted to the panel structure and effectively ground the entire structure. Each Ground bus shall have provision at each end for co nnection o f ground l eaks (6 m m x 50 mm GI Fl ats) by suitable bolting. All system cabinets shall be brought to a common system ground by the bidder. Electronic earthing resistance shall be < 0.5 ohms.

Each circuit requiring grounding shall be i ndividually and di rectly connected to the panel ground bus by ring tongue type co mpression l ugs. For electronic system cabinets the system ground bus shall be insulated from the cabinet enclosure and shall be separately



connected to the system ground. All system cabinets shall be brought to a common system ground by the bidder.

The Bidder shall furnish his recommendations regarding grounding requirements for all equipment/systems and shall specifically indicate the deviations if any from the above requirements as a part of his proposal.

6.13.00 TERMINAL BLOCKS

For all inputs to the system emanating from the field or other systems, the bidder shall furnish terminals suitable for correct size of field cables.

6.13.01 All outputs going to MCC/SWGR terminal blocks, shall be rated 600 volts minimum and shall have strap screw less terminals suitable for connection of wires with ring tongue type lugs. Standard terminal blocks shall be screw less cage clamps type. Terminal blocks shall be approximately sized for larger wire size of higher voltage insulated incoming conductors as necessary. All the TBs used shall be 6.6 polyimide to withstand corrosion and the metallic portion shall be coated against rust /corrosion. All metal parts should be non –ferrous in nature.

6.13.02 Terminal blocks shall be provided with white marking strips and re permitted by the safety codes and standards shall be without covers.

6.13.03 Fuses shall not be mounted on terminal blocks. Neither step type terminal blocks nor angle mounting of terminal blocks will be acceptable.

6.13.04 At least 20 per cent spare unused fully wired terminals shall be provided on each terminal block for circuit modifications and for termination of all conductors in a multi-conductor control cable with each panel, enclosure, cubicle, SOV Boxes etc.

6.14.00 NAME PLATES AND LABELS

Name plates of adequate size shall be provided for each panel on front and rear of the panel. Instruments/other accessories mounted inside the panels shall have identification marking clearly visible from inside.

Devices to be mounted on the panels shall also be labeled on the panels shall also be labeled on the outside of the panel. Name plates shall be of polyamide sheets with black letters on white background. Name plates shall be attached to the boards by means of stainless steel panhead screws. Fuses provided for protection of various boxes shall be accessible for replacement. Fuse boxes shall be provided with circuit label and fuse rated current and voltage.

Markings/Labels

All markers/labels shall be made of halogen & silicon free polyamide material with inflammability class V2 as per UL 94, ensuring scratch proof printing with the use of environment friendly solvent free ink & latest BLUEMARK UV technology so as to comply the WIPE RESISTANCE according to DIN EN 61010-1/VDE 0411-1.



**H.DRIVE
CONTROL
PHILOSOPHY
FOR
ANALOG
&
BINARY
DRIVES**

	DOCUMENT TITLE	DOCUMENT NUMBER	PE-DM-412-145-I002
	DRIVE CONTROL PHILOSOPHY	REVISION NUMBER	05 DATE 20.12.2016
	PROJECT: 2 X 660 MW ENnore SEZ STPP	SHEET	2 OF 12

A. DRIVE CONTROL PHILOSOPHY

The control philosophy for different type of Drives is detailed below:

1 Bi-directional drives with Integral Starter(Open/Close duty and inching/regulating duty)

- a) All bi-directional drives shall have integral starter. These drives shall be operable from Remote i.e. from Central Control Room (CCR). Local operation facility is provided for initial testing/commissioning only.
- b) Remote manual operation of all drives shall be done from Operator Works Station (OWS/LVS).
- c) Remote control commands i.e. open/close generated from DDCMIS/DCS/PLC shall be issued to Integral Starter through interposing relays, mounted in Integral Starter. For open/close duty bi-directional drives Start & stop command shall be latched at integral starter end, except for inching duty bi-directional drives where latching is not required.
- d) Necessary electrical protections shall be realized at Integral Starter, whereas process interlocks and protection shall be realised in DDCMIS/DCS/PLC.
- e) Following signal exchange shall take place between Integral Starter & DDCMIS/DCS/PLC.
- Open & close command
 - Integral Starter Disturbed (Loss of power supply/Loss of control supply/ Motor thermostat trip/ Thermal O/L /Local/off/Remote S/S in Local or Off mode/Stop PB optd/Torque open/close cutoff).
 - Actuator in Remote Mode.
 - Valve status feedback by means of limit switches (open/close).
 - Valve position feedback (4-20mA) for inching duty drives.
- f) The Control & Operation from Backup Control Desk/UCP shall be envisaged for critical Drives.
- g) For Bidirectional drives of ≥ 15 KW, CURRENT TRANSDUCER shall be located in MCC.

The above signal exchanges are diagrammatically represented in sheet no. 7.

2 Unidirectional LT Drives (Contactor Operated)

- a. Unidirectional LT drives shall be operable from Remote i.e. from Central Control Room (CCR). Drives shall be provided with Local Emergency Stop Push Button (EPB). Local start operation of the drive can also be done through the start push button provided near the drive when the drive is in local mode.

	DOCUMENT TITLE	DOCUMENT NUMBER	PE-DM-412-145-I002
	DRIVE CONTROL PHILOSOPHY	REVISION NUMBER	05 DATE 20.12.2016
	PROJECT: 2 X 660 MW ENNORE SEZ STPP	SHEET	3 OF 12



- b. Remote manual operation of all drives shall be done from OWS/LVS and Local/remote selection of drives shall be done in DDCMIS/DCS/PLC. Back up remote operation from PB station mounted on UCP is provided for some essential drives for safe shutdown of plant.



- c. Control commands i.e. start/stop, shall be generated from DDCMIS/DCS/PLC and shall be issued to MCC through interposing relays located in respective MCC. DDCMIS/DCS/PLC output command shall be latched in MCC. EPB (stay put type), in MCC supplier's scope, shall be wired directly to MCC to stop the motor irrespective of motor being in remote/local mode. The EPB shall be provided with press to lock and turn to release type, keyless mechanism. Under its locked position, the drive operation shall be inhibited. The local start push button shall be wired to the DDCMIS/DCS/PLC to ensure interlock/protection requirement.

- d. Necessary electrical protections for the drives shall be realised at MCC, whereas process interlocks and protections shall be realised in DDCMIS/DCS/PLC.

- e. Following signal exchange shall take place between MCC & DDCMIS/DCS/PLC



- i. Drive Start & Stop commands.
- ii. Drive ON & OFF feedback.
- iii. MCC disturbed (Thermal O/L /Control supply fail/ MCC switched off).
- iv. MCC available(In Remote)
- v. EPB operated



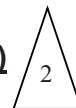
- f. Current transducers, 4-20mA types (in MCC suppliers scope), shall be mounted in the MCC for monitoring the current in DDCMIS/DCS/PLC for all drives ≥ 15 KW and for important drives < 15 KW. Auxiliary power supply to these transducers shall be provided from the control power supply of the respective MCC.



- g. The Control & Operation from Backup Control Desk/UCP shall be envisaged for critical Drives.
- h. Start & Stop command shall be latched at MCC end.

The above signal exchanges are diagrammatically represented in sheet no. 8.

3 Solenoid Operated Drives (24V DC/220V DC/240V AC)



- a. Solenoid operated drives shall be operable from remote i.e. CCR only.
- b. Remote manual operation of all drives shall be done from OWS.

	DOCUMENT TITLE	DOCUMENT NUMBER	PE-DM-412-145-I002
	DRIVE CONTROL PHILOSOPHY	REVISION NUMBER	05 DATE 20.12.2016
	PROJECT: 2 X 660 MW ENnore SEZ STPP	SHEET	4 OF 12

c. Remote control commands i.e. open/close shall be generated from DDCMIS/DCS/PLC and shall be issued to the respective solenoid through interposing relays located in Interposing Relay panels.

d. Necessary process interlocks shall be realized in DDCMIS/DCS/PLC.

1

e. Following signal exchange shall take place between solenoid operated drive & DDCMIS/DCS/PLC

i. Valve open & close command.

2

ii. Valve status feedback by means of limit switches (open/close), wherever available or from relay contact of interposing relays if limit switches are not provided. 1No. contact for single coil & 2 No. contact for dual coil (open Limit switch & closed limit switch) shall be provided.

3

f. BHEL will take care of de-energize to trip philosophy for fail safe control system (wherever required).

4

g. UCP/backup interface shall be provided for critical solenoid drives.

The above signal exchanges are diagrammatically represented in sh. no. 9.

4 HT/LT Unidirectional Drives (Breaker operated)

1

a. Remote manual operation of Breaker operated drives shall be normally from remote i.e. Station DDCMIS/DCS/PLC in main Control Room through OWS/LVS and Local/remote selection of drives shall also be done in DDCMIS/DCS/PLC. Back up remote operation from PB station mounted on UCP is provided for some essential drives for safe shutdown of plant.

b. Remote/Switchgear (SWGR) selection shall be realized from SWGR mounted R/S selector switch.

c. Following are the operational combinations for breaker operated drives:

-SERVICE POSITION – Drive Operation (Start/Stop) shall be from CCR with R/S (Remote/SWGR) selector switch in Remote position.

-TEST POSITION – SWGR Testing (Start/Stop) from SWGR.

Switchgear mounted 'Trip/Neutral/Close' switch shall be provided for testing of switchgear when 'R/S' selector switch is selected as 'SWGR' and SWGR is in test position.

d. Remote control commands i.e. start/stop, pulse type, shall be generated from DDCMIS/DCS/PLC and shall be issued to Switchgear through interposing relays located in respective Switchgear. Further

	DOCUMENT TITLE	DOCUMENT NUMBER	PE-DM-412-145-I002
	DRIVE CONTROL PHILOSOPHY	REVISION NUMBER	05 DATE 20.12.2016
	PROJECT: 2 X 660 MW ENnore SEZ STPP	SHEET	5 OF 12

there is Local/remote selection in DDCMIS/DCS/PLC. Local selection in DDCMIS/DCS/PLC means, command from local PB, provided near the drive, will be executed through DDCMIS/DCS/PLC whereas in case of remote mode of selection in DDCMIS/DCS/PLC, the command from OWS will be processed, not through local PB.



- e. The EPB shall be wired directly to switchgear to stop the motor irrespective of motor being in remote/local mode. The EPB (stay put type), in SWGR supplier's scope, shall be provided with press to lock and turn to release type, keyless mechanism. Under its locked position, the drive operation shall be inhibited. The local start push button shall be wired to the DDCMIS/DCS/PLC to ensure interlock/protection requirement.

- f. Necessary electrical protections for the drive shall be realised at Switchgear, whereas process interlocks and protections are realized in DDCMIS/DCS/PLC.

- g. Following signal exchange shall take place between switchgear and DDCMIS/DCS/PLC: -

- i. Drive Start & Stop commands.
- ii. Drive ON & OFF status feedback.
- iii. Switchgear Disturbed (Control power supply fail/Trip coil Unhealthy/Master trip relay operated).
- iv. Switchgear Available (Breaker in Service & Trip ckt Healthy & Master Trip Relay Reset & Spring Charged)
- v. Master Trip Relay (86 Relay) operated.
- vi. Emergency Stop PB operated.
- vii. Local start Push Button shall be wired to DCS from LPBS near Drive.

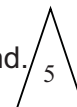


- h. Current transducers, 4-20mA types (in SWGR suppliers scope), shall be mounted in the SWGR for monitoring the current in DDCMIS/DCS/PLC. Auxiliary power supply to these transducers shall be provided from the control power supply of the respective switchgear.



- i. The Control & Operation from Backup Control Desk/UCP shall be envisaged for critical Drives.

- h. Latching as required shall be done at MCC/SWGR end.



The above signal exchanges are diagrammatically represented in sh. no. 10.

B. ANALOG DRIVE CONTROL PHILOSOPHY

Analog Drives Control

- 1.1 A drive control function residing in Distributed Processing Units (DPUs) is used to position the pneumatically operated control valves/Dampers through SMART positioner (conventional positioner for Burner Tilt).

	DOCUMENT TITLE DRIVE CONTROL PHILOSOPHY	DOCUMENT NUMBER PE-DM-412-145-I002	
		REVISION NUMBER 05	DATE 20.12.2016
	PROJECT: 2 X 660 MW ENnore SEZ STPP	SHEET 6	OF 12

Interlock and protection Open/Close Commands, originating from field or generated internally in Control Logics (ACS), are interfaced with the drive control function residing in processors.

1.2 Control Valve actuator design shall take care of fail safe condition i.e. bringing valve to full open/full close or stay put mode, on signal (pneumatic/electric) failure.

1.3 Auto/Manual operator control and display for various control loops shall be provided through OWS, using Analog Displays.

1.4 Analog Displays have following functionality:

- Auto/Manual selection with control device “Raise/Lower Buttons”
- Set point indication with “Raise/Lower Buttons”
- Indication for deviation between set point and measured value
- Measured value indication
- Final control element portion indicators



1.5 The Control & Operation from Backup Control Desk/UCP shall be envisaged for critical Drives.

1.6 All required accessories i.e. Solenoid or any other hardware required to achieve the stayput position at controller signal failure shall be provided.



1.7 DI for fault signal of the smart positioner shall be provided.

The above signal exchanges with DDCMIS/DCS/PLC are diagrammatically represented in sh.no. 11.

C. CABLE



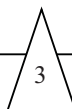
For interconnection of analog signals (4-20mA) to DDCMIS/DCS/PLC, in general “armoured” 0.5sq mm color coded individually and over all screened twisted pair shall be used (F Type). However for position feedback signals of bidirectional drives and current feedback signals of HT/LT drives 2P, F type cable shall be used.

For interconnection of binary signals (24V DC) to DDCMIS/DCS/PLC, “armoured” 0.5sq mm color coded over all screened twisted pair cable shall be used (G Type).



D. IO REDUNDANCY

- (1) IO redundancy shall be as per specification requirement.
- (2) Start command/stop command/trip command towards safety of process or process equipment shall be hardwired parallel from two different cards.
- (3) In case of redundant/multi Pumps/Drives for same service, all related Inputs & outputs of main pump/drive shall be in separate I/O cards and



	DOCUMENT TITLE	DOCUMENT NUMBER	PE-DM-412-145-I002
	DRIVE CONTROL PHILOSOPHY	REVISION NUMBER	05 DATE 20.12.2016
	PROJECT: 2 X 660 MW ENNORE SEZ STPP	SHEET	7 OF 12

similarly all related Inputs & outputs of respective standby pump/drive shall be in separate I/O cards. Inputs/outputs of any two same services pumps/drives shall not be mixed in one common I/O car



Notes: 1) (a) Drive Control Philosophy will be generally used for total project except for few cases where OEM recommendations prevail.

(b) This scheme shall be applicable for PLC as well as DDCMIS/DCS/PLC based Offsite packages.



2) Email & Message alert

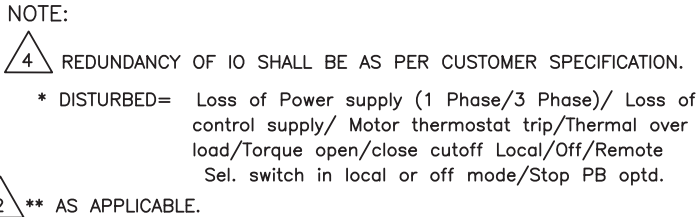
Intimation through message & E-mail shall be provided for tripping of all HT drives & critical LT drives.

3) Drives with VFD will have the following signal exchange:-

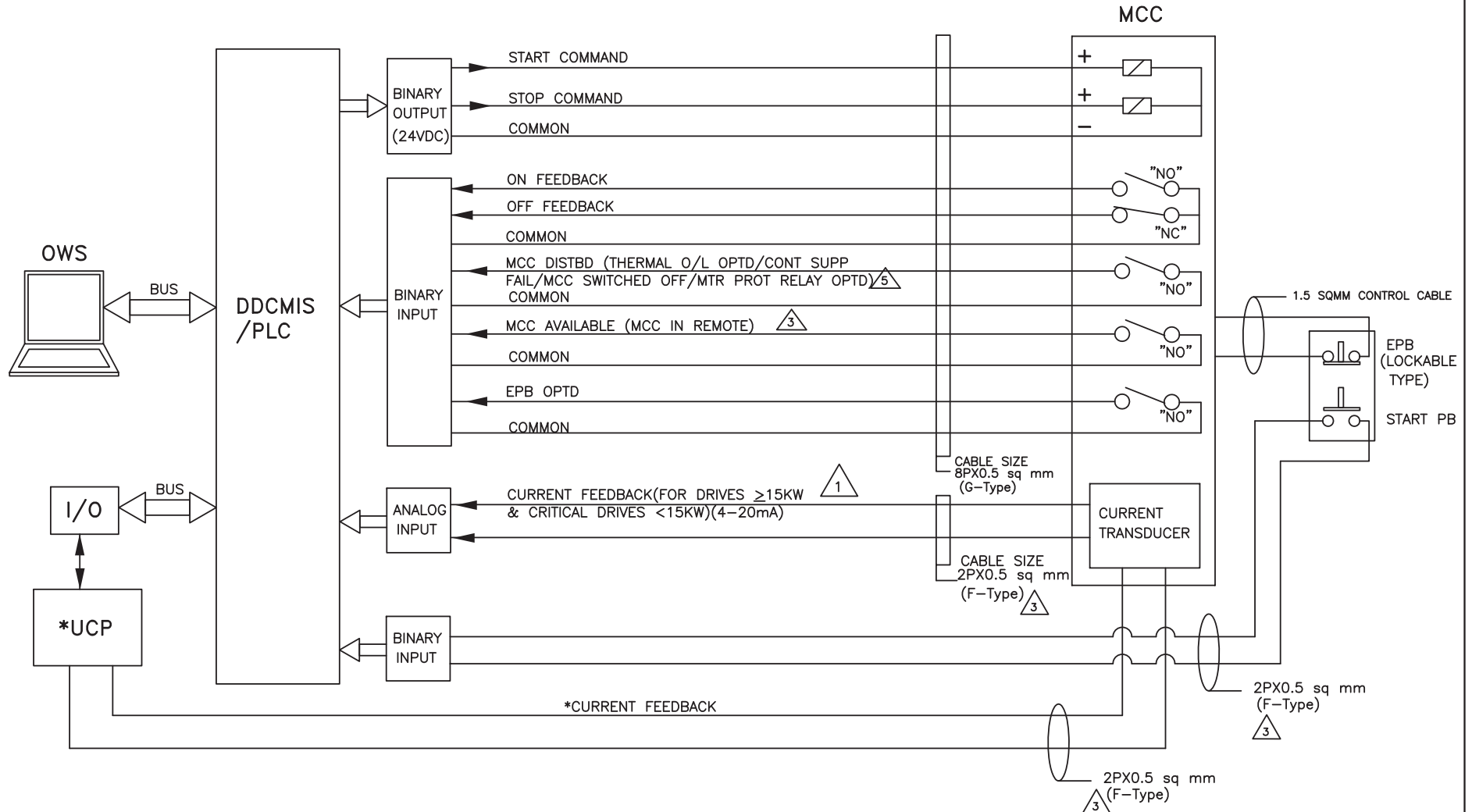


a) Speed Input	AI
b) Speed Output	AO
c) VFD Mode/Bypass Mode selection	DI
d) VFD Mode/Bypass Mode command	DO

	PROJECT: 2X660 MW ENNORE SEZ STPP		DRG.NO.	PE-DM-412-145-I002	
	TITLE	DDCMIS INTERFACE FOR BIDIRECTIONAL DRIVE	DATE	20.10.2016	
			REV.NO.	05	
		SHT	8	OF	12



DCS INTERFACE FOR UNIDIRECTIONAL LT DRIVE



NOTE:

- * CURRENT FEEDBACK IN DDCMIS SHALL BE PROVIDED FOR ALL DRIVES $> 15\text{ KW}$ AND FOR IMPORTANT DRIVES $< 15\text{ KW}$.
 I/O REDUNDANCY SHALL BE AS PER SPECIFICATION REQUIREMENTS.



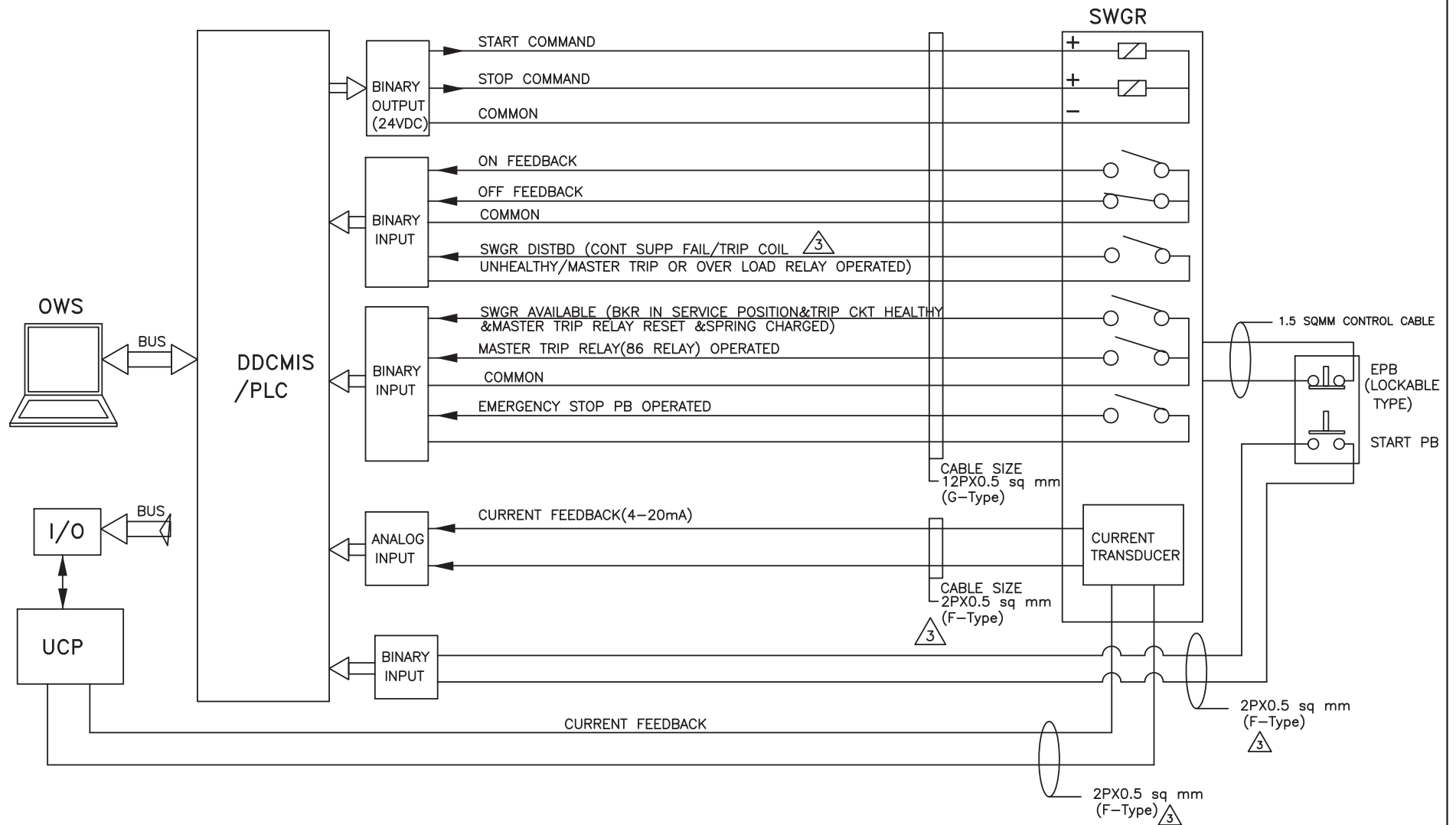
PROJECT: 2X660 MW ENNORE SEZ STPP

TITLE
DDCMIS INTERFACE FOR
UNIDIRECTIONAL LT DRIVE

DRG.NO.	PE-DM-412-145-I002
DATE	20.10.2016
REV.NO.	05
SHT	9 OF 12



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



NOTE:

VIBRATION, WINDING & BEARING SIGNALS SHALL BE INTERFACED WITH DDCMIS AND INCLUDED IN EDN'S DOCUMENT.

I/O REDUNDANCY SHALL BE AS PER SPECIFICATION REQUIREMENTS.



PROJECT: 2X660 MW ENNORE SEZ STPP

TITLE

DDCMIS INTERFACE FOR
UNIDIRECTIONAL HT DRIVE

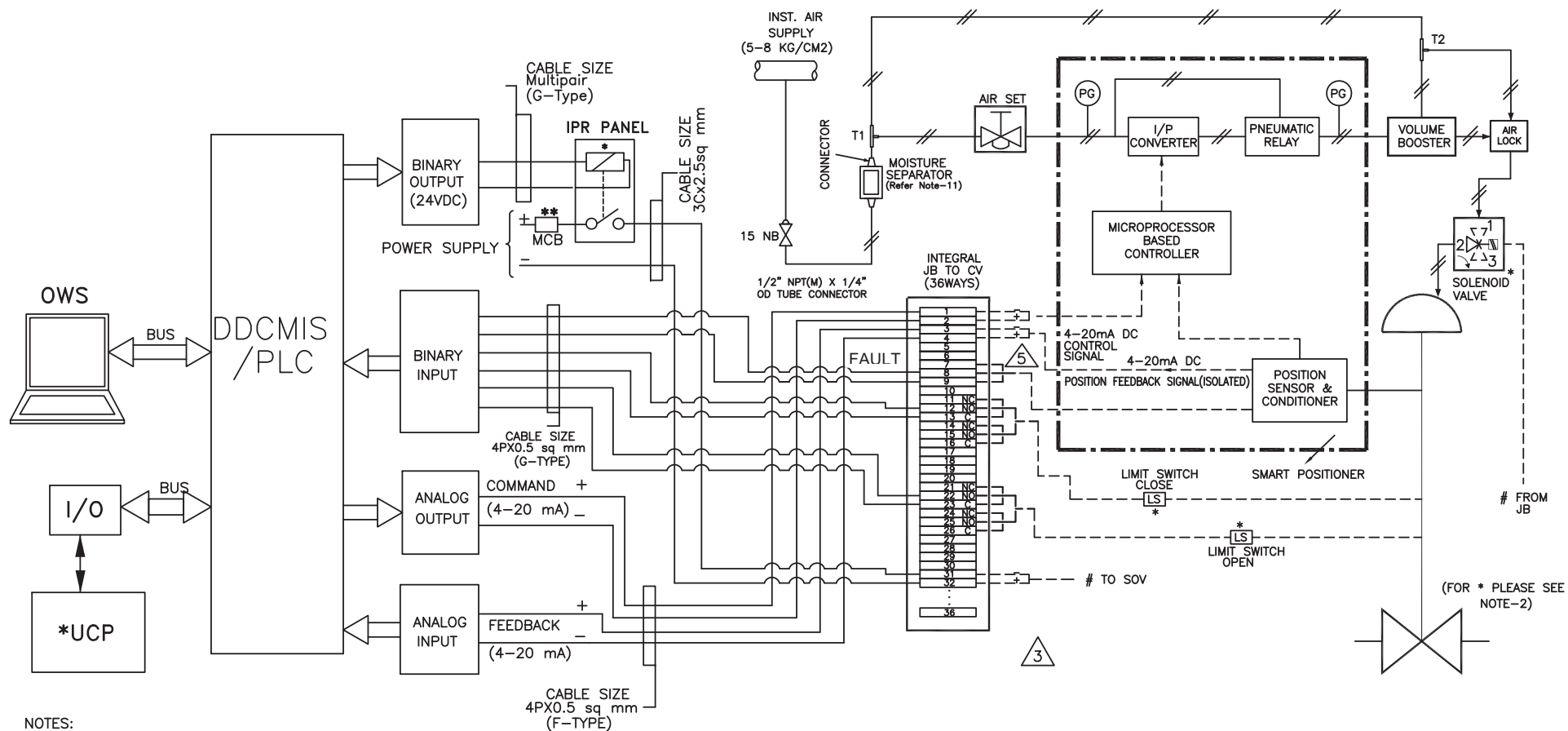
DRG.NO. PE-DM-412-145-I002

DATE 20.10.2016

REV.NO. 05

SHT 11 OF 12

DCS INTERFACE FOR ANALOG DRIVE (WITH SMART POSITIONER)



NOTES:

- * WHEREVER APPLICABLE.
 - ** APPLICABLE TO VALVES WHERE PROTECTION OPEN/CLOSE ACTION FOR CONTROL DEMAND OVERRIDING IS REQUIRED.
- 3 I/O REDUNDANCY SHALL BE AS PER SPECIFICATION REQUIREMENTS.

ALL REQUIRED ACCESSORIES i.e. SOLENOID OR ANY OTHER HARDWARE
REQUIRED TO ACHIEVE THE STAYPUT POSITION AT CONTROLLER SIGNAL
FAILURE SHALL BE PROVIDED.

DI FOR FAULT SIGNAL OF THE SMART POSITIONER SHALL BE PROVIDED.



PROJECT: 2X660 MW ENNORE SEZ STPP

TITLE TYPICAL HOOK-UP DIAGRAM
 ANALOG DRIVE (WITH SMART POSITIONER)

DRG.NO.	PE-DM-412-145-1002

DATE	20.10.2016

REV.NO.	05

SHT	12	OF	12

**I.SPECIFICATION
FOR
QUALITY ASSURANCE
&
TESTING**

CHAPTER-14**QUALITY ASSURANCE AND TESTING AND GUARANTEES****14.01.00 GENERAL REQUIREMENT**

- 14.01.01** All equipment furnished under this specification shall be subject to test by authorized quality assurance personnel of the Bidder, representatives of the Owner during manufacture, erection and on completion. Bidder's quality assurance personnel for these shop and site tests shall be identified in advance and shall be acceptable to the Owner. The approval of the Owner or passing of such inspection of tests will not, however, prejudice the right of the owner to reject the equipment if it does not comply with the specifications when erected or fails to give complete satisfaction in service.
- 14.01.02** The Bidder shall furnish details of shop and site tests proposed to be conducted by him at various stages to meet the specification requirements for each type of instrument/system along with his proposal. Bidder shall also furnish details of his proposed shop and site quality assurance organization for this contract
- 14.01.03** Bidder shall prepare a detailed shop and site 'Quality Assurance Programme' to meet the requirements of these specifications for Owner's approval. This document shall also contain the formats for reports and maintenance of test records specification of test equipment to be used for site tests.
- 14.01.04** All equipment and systems furnished under this specification shall be subjected to shop & site tests in accordance with the Quality Assurance Program approved by the Owner and shall be adequate to ensure full compliance with these specification, all applicable codes & standards and detailed engineering drawings and documents approved by the Owner.
- 14.01.05** The Bidder shall provide all required test equipment and simulation devices for performing all shop and site tests. All test equipment shall be of reputed make, required accuracy class and shall be recently calibrated. The record of calibration of test equipment shall be made available to the Owner on demand.
- 14.01.06** The cost of all tests as per the requirements of this specification and approved quality assurance programme shall be included in Bidder's lump sum price for this package and no extra price shall be payable by the Owner for conducting any test as per the intent and requirements of this specification.
- 14.01.07** All approval/Inspection are to be carried out by the Owner only.

14.02.00 SHOP TESTS**14.02.01 General Requirement**

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



14.02.01.01 Individual components, instruments and devices furnished in accordance with specification sheets, and I&C device list enclosed with these specifications shall be shop tested by manufacturer prior to shipment. The manufacturer shall conduct these tests for certifying compliance with published specifications for the equipment and provide test results to the Owner in writing. These tests and test certificates shall be in accordance with the agreed 'QA' programme for major systems/equipments. However, manufacturer's standard methods shall be followed if details of tests for any equipment are not covered under this agreed 'QA Programme'.

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

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

14.02.02 Material Tests

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

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

14.02.03 Test at Manufacturer's Works

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

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

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

14.02.04 Factory Tests



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

14.02.04.02 **Surge Protection Test for Solid State Equipment**

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

14.02.04.03 **Burn-in and Elevated Temperature Test**

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

During the first 48 hours of testing the ambient temperature shall be maintained at 50 deg.C and relative humidity at 95%. The equipment shall be interconnected with all devices, which will cause it to repeatedly perform all operations; it is supposed to perform in actual service, with load on various components being equal to those, which will be experienced in actual service.

The 48 hours tests period shall be continuous but shall be divided into four 12 hours segments. The input voltage during each 12-hour segment shall be nominal voltage for 11 hours, followed by 110% of nominal voltage for 30 minutes followed by 90 percent of nominal voltage for 30 minutes.

The 48 hours elevated temp test shall be followed by 120 hours of burn in test as specified in the above paragraphs except that the temperature is reduced to ambient temperature prevalent at that time. Alternatively copy of type test certificate for burn-in test shall be submitted.

14.02.04.04 The Bidder shall furnish full details regarding shop tests and site tests, as per good engineering practices. The Owner shall approve all such tests and the supplier shall conduct all such tests without calling for additional price.

The tests shall cover factory tests, burn-in and elevated temperature tests, simulation and functional tests, insulation tests as applicable, the rating of the contact devices and components, surge withstand capability test, conformity of interconnection cables, testing and checking of other conditions deemed to be necessary with the system/equipment items.

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



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

- 14.02.04.06 All panels, instruments enclosures, junction boxes, etc. shall be type tested for degree of protection and applicable in accordance with IS: 2147. 8.02.04
- 14.02.04.07 Type, routine and acceptance testing of all equipments, supplied under this contract, shall be in accordance with relevant N EEA/IS/IEC/ANSI/BS/ISA standards, in addition to the requirements of Owner approved Quality Plans. Six (6) copies of test reports shall be submitted to the Owner for approval prior to dispatch of respective equipment
- 14.02.04.08 The representative of Owner shall be given opportunity to witness the factory tests which shall be mutually finalized during the progress of the contract.
- 14.02.04.09 All control systems to be furnished for this project, shall be factory tested for circuit continuity and direction of response. The Components to be tested shall include all controllers, HAND/AUTO station, other system modules, alarm contactors and multi-conductor interconnecting cables. The tests shall be performed with all of the system components supplied by the Bidder connected to form a complete system with the sole exception of transmitters. The tests shall include a means of confirming the mathematical design response of the control system by simulating changes in system input. The tests shall be a qualitative functional test of each component of control system, which simulates dynamic inputs and monitors system outputs.
- 14.02.04.10 Certain control loops shall be factory tested using closed loop mathematical simulation techniques. Control loops to be tested by closed loop methods are broadly as under. However, owner has discretion to test and all control loops during simulation testing.
- ii) Firing rate control (fuel and air flow control)
 - iii) Furnace draft control
 - iv) Boiler separator level control
- (d) **Response time for Turbine Control System.**
- The input simulation equipment shall be designed to produce effects from control system outputs based on mathematical model of the predicted performance and process dynamics of the main unit equipment. The control constants of various control loop components shall be adjusted to produce a stable and optimum control adjusted to produce a stable and optimum control when connected to the simulation equipment.
- 14.02.04.11 Simulation data including factory adjustment of control system constants, and simulation equations shall be tabulated and shall be made available by the Bidder for owner's use during field check out and the start up of the control system.
- 14.02.04.12 Availability of a simulated type test for automatic control loops specified with a detailed description of testing methods utilized, shall be indicated.



- 14.02.04.13 The availability of facilities for carrying out the model test for the control systems shall be indicated by the bidder. Also details of test procedures and copies of test results conducted for a similar fossil fuel fired unit shall be furnished. The data required from Boiler and Turbo generator supplies shall also be furnished by the Bidder.
- 14.02.04.14 Brief description of all tests proposed to be conducted on each control system components during various stages of manufacture, installation and commissioning shall be furnished. Copies of test data accumulated during the tests shall be submitted to the mutually agreed formats.
- 14.02.04.15 The owner shall witness the factory tests which shall be performed at a time mutually agreeable to the Bidder and the owner.



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

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



	24	OPERATING STATION LOGGING FUNCTION CHECK	✓
	25	OPERATING STATION / RESPONSE / UPDATING CHECK	✓
	26	KEYBOARD LOCK FUNCTION CHECK	✓
	27	OPERATING STATION INTERCHANGEABILITY and ASSIGNABILITY CHECK	✓
	28	PRINTER ASSIGNABILITY and BACK-UP FUNCTION CHECK	✓
	29	FLOPPY DISK/ STD / OPTICAL DISK UNIT STORAGE and RETRIEVAL CHECK	✓
	30	OPERATING STATION ASSIGNABILITY CHECK FOR HARD COPIER FUNCTION	✓
	31	PLANT PERFORMANCE CALCULATION CHECK	✓
	32	COMMUNICATION INTERFACE TO OTHER'S SYSTEM SIMULATION CHECK	✓
	33	-	
	34	DATA BUS DISTANCE BUILDING CHECK (REFER NOTE- 3)	✓
	35	GRAPHIC DISPLAY BUILDING FUNCTION CHECK	✓
M A I N T E N A N C E	36	CLOSED LOOP CONTROL SYSTEM MODIFICATION CHECK	✓
	37	OPEN LOOP CONTROL SYSTEM MODIFICATION CHECK	✓
	38	ALARM DISPLAY PRIORITISATION CHECK	✓
	39	SYSTEM SECURITY CHECK	✓
	40	SYSTEM ALARM CHECK	✓
	41	SYSTEM DIAGNOSTIC FUNCTION CHECK	✓
	42	POINT DETAIL CONFIGURATION CHECK	✓
	43	CONTROL LOOP TUNING CHECK	✓
	44	SYSTEM SELF DOCUMENTATION CHECK	✓
N O T E S	1.	THE INTENT OF THE FAT IS TO DEMONSTRATE AND ENSURE THAT THE I&C SYSTEM MEETS ALL THE FUNCTIONAL REQUIREMENTS AS INTENDED IN THE SPECIFICATION / CONTRACT. A COMPLETED INTEGRATED TEST OF THE SYSTEM SHALL BE CARRIED OUT AT VENDOR'S WORKS IN THE PRESENCE OF OWNER, ON COMPLETION OF INTEGRATION/MANUFACTURING OF THE SYSTEM. THE SHIPMENT OF I&C EQUIPMENT TO SITE WILL BE EFFECTED ONLY AFTER THE FAT HAS BEEN ACCEPTED BY THE OWNER.	
	2.	FAT PROCEDURE SHALL BE PREPARED BY VENDOR AND TO BE SUBMITTED FOR OWNER'S/ APPROVAL WELL IN ADVANCE PRIOR TO THE COMMENCEMENT OF FAT	
	3.	FAT SHALL BE CONDUCTED WITH THE DISTANCE BETWEEN THE PROCESSOR AND OTHER SUPPORTING PERIPHERALS AS PER THE FINAL LAYOUT IN THE CONTROL ROOM.	
	4.	ALL THE RELEVANT APPROVED DOCUMENTS REQUIRED FOR FAT SHALL BE SUBMITTED BY THE BIDDER IN ADVANCE PRIOR TO COMMENCEMENT OF FAT.	

14.02.04.17 Tests to be performed during FAT of PLC system

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

- 1) Hardware Inspection of PLC Sub System
 - i) Heat run test
 - ii) Hardware check / physical software package check
 - iii) I/O loading specification
 - iv) PLC start-up and power fail restart
 - v) PLC processor back-up function
 - vi) Communication redundancy
- 2) Application Inspection for Logic Functions
 - i) Ladder logic functional check and graphic screen check
- 3) Application Inspection for PLC Panels
 - i) General arrangement
 - ii) Appearance and construction
 - iii) Panel wiring
 - iv) Panel functional check
 - v) Power supply redundancy check



2 x 660 MW ENNORE SEZ Supercritical Thermal Power
Project at Ash Dyke of NCTPS
Spec. No. CE/C/P&E/EE/E/OT.No.03/2013-14

Vol. V/Sheet - 436



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

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

14.02.04.19 FACTORY ACCEPTANCE TEST FOR SIMULATOR

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

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

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

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

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

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

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



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

d) Functional tests for HMIPIS

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

All calculations shall be tested to demonstrate that these are in accordance with the specification and I/O schedule. The Bidder shall prepare all test cases for calculations (3 for each calculation at low, mid and upper ranges of inputs) and submit them for the owner's approval. Test cases shall include performance calculations, flow and level calculations, pressure and temperature compensations, etc.
- iv. Checking historical storage and retrieval functions including long-term storage.
- v. Checking healthiness of processor, main memory. Testing of initialization and loading of configuration data, etc.
- vi. Verification of all programmers' stations functions for HMIPIS and Control System, as well as for documentation facility as specified.
- vii. Various display response time / System accuracy etc.
- viii. Display update time on OWS

e) Functional test for networking & communication devices

- i. Verification of various features as per approved documents.
- ii. Verification of throughput after creating high communication traffic.

f) Instructor's workstation Functions

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

g) Programming and Documentation functions



- i. Verification of all programming function like, modification of application software, database, administrator's function etc. in line with specification and approved documents.
- ii. Verification of all documentation functions in line with specification and approved documents.

14.02.04.19.2 FAT Procedure

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

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

1. Colour Graphic Video Display Unit (OWS)
 - i. Functional tests (As per FAT procedure. Note-1)
 - ii. Test for capabilities of OWS including error detection for the complete system (Both hardware & software) simulating worst conditions
 - iii. Noise test
 - iv. Surge withstanding capacity as per IEEE or equivalent
 - v. Quality assurance as governed by BS 5750 or equivalent
 - vi. Design, construction, components, finishes and testing of electronic equipment as per EES-1980 (General specification of electronic equipment) or equivalent

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

Note-1: Test to be witnessed by Owner.
3. Printers
 - i. Noise level test for the printer
 - ii. Test of interlock performance and error detection feature.
 - iii. Quality assurance as governed by BS 5750 or equivalent
 - iv. Design, construction, components, finishes and testing of electronic equipment as per EES-1980 (General specification of electronic equipment) or equivalent



4. Floppy / Tape Drive Unit / Bulk Memory Unit / DVD, CD drive Unit / DAT Drive
 - i. Noise test
 - ii. Surge withstanding capacity as per IEEE or equivalent
 - iii. Quality assurance as governed by BS 5750 or equivalent
 - iv. Design, construction, components, finishes and testing of electronic equipment as per EES-1980 (General specification of electronic equipment) or equivalent
 - v. Test of Control unit and drive for all features, date checking features.
5. Vibration Monitoring & Analysis System
 - i. Simulated functional test (Note-1)
 - ii. Tests for server, LED monitor, Printer, KeyboardNote-1: Test to be witnessed by Owner.
6. PADO (Performance & Optimization System)
 - i. Simulated functional test (Note-1)
 - ii. Tests for server, LED monitor, Printer, KeyboardNote-1: Test to be witnessed by Owner.
7. ERP System
 - i. Simulated functional test (Note-1)
 - ii. Tests for server, LED monitor, Printer, KeyboardNote-1: Test to be witnessed by Owner.
8. MIS System
 - i. Simulated functional test (Note-1)
 - ii. Tests for server, LED monitor, Printer, KeyboardNote-1: Test to be witnessed by Owner.
9. HMS System
 - i. Simulated functional test (Note-1)
 - ii. Tests for server, LED monitor, Printer, KeyboardNote-1: Test to be witnessed by Owner.

NOTES:

1. The intent of the FAT is to demonstrate and ensure that the I & C system meets all the functional requirements as intended in the specification / contract. A completed integrated test of the system shall be carried out at vendor's works in the presence of Owner or Owner's representative, on



completion of integration / manufacturing of the system. The shipment of I&C equipment to site will be effected only after the FAT has been accepted by Owner.

2. FAT procedure shall be prepared by vendor and to be submitted for Owners approval well in advance prior to the commencement of FAT.

14.02.04.21 Calibration of Instruments

The Bidder shall carry out the calibration of instruments as indicated below by submitting the test procedure and quality assurance plan for the Owner's approval. Bidder shall also prepare detailed checklist/calibration sheets for each of the systems/equipment clearly indicating the step-by-step procedures to be carried out for calibration pre commissioning, loop checking, powering and commissioning.

The calibration of all instruments shall be checked and calibration records prepared for the Owner's use. If the instruments require recalibration, Bidder shall recalibrate the instruments and revise the calibration records and submit to the Owner.

i TESTS TO BE PERFORMED FOR FIELD INSTRUMENTS

1.	Pressure Gauges
	Calibration Hydro test (1.5 times max. pr.)
2.	Pressure switches
	Calibration test / Hydro test / Contact rating test / Accuracy test / Repeatability
3.	Differential Pressure Gauges
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
4.	Differential Pressure Switches
	Calibration test / Hydro test / Contact rating test / Leak test / Accuracy test / Repeatability test.
5.	Thermometers
	Calibration / Material test / Accuracy test / Bore concentricity : $\pm 5\%$ of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
6.	Temperature switch
	Calibration / Material test / Accuracy test / Bore concentricity : 1.5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.) / Contact rating test.
7.	Resistance temperature detector assembly.
	Calibration / Material test / Bore concentricity test / Insulation test ($\leq 500 \text{ M}\Omega$ at 500V DC) as per ISA, Hydro test for TW. Bore concentricity: $\pm 5\%$ of wall thickness, Accuracy test.
8.	Thermocouple assembly
	Calibration / Material test, Insulation test ($\geq 500 \Omega$ at 500 V, DC) as per ISA, Hydro static test (1.5 times max. pr.), Bore concentricity : $\pm 5\%$ of wall thickness.
9.	Thermowells
	Material test / Bore concentricity : $\pm 5\%$ of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)



10.	Level Guages
	Hydrostatic test / Material test / Seat leakage test / Ball check test.
11.	Level switches (Magnetic)
	Material test / Contact rating test / Hydro test / Calibration test.
12.	Flow Switch
	Material test / Hydro static test (1.5 times max. pr.) / function test.
13.	Flow glasses
	Material test / Hydrostatic test (1.5 times max. pr.) / function test.
14.	Variable area flow meters
	Calibration test / Material test / Hydrostatic test (1.5 times max. pr.)
15.	Flow element
	100% Radiography test / Hydro test / Calibration test, IBR Certificate.
	Calibration test for flow element shall be witnessed by Owner.
16.	Control valves/Pneumatic block valve/Pressure regulating valve – Refer chapter 11.
17.	Position transmitters
	Calibration / hysteresis and Accuracy test
18.	Electro Pneumatic Convertors
	Calibration test / Accuracy test
19.	Solenoid valves
	Hydrotest / Seat leakage test / CV test / Coil insulation test
20.	Air filter regulators
	Calibration test / Accuracy test
21.	Junction Boxes
	Test for degree of protection / Material test
22.	Tests for terminal blocks
	Test for moulding for flame resistant, Non-hygroscopic and Decarbonised / Insulation test between terminals / Insulation between terminal block and frame.
23.	Thermocouple extension cable
	Thermo-emf characteristic / Continuity test / Measurement on capacitance, inductance and loop resistance / Insulation resistance / High voltage test as per latest IS / Tensile and elongation test / Oxygen index test / Any other test applicable.
24.	Mass flow meter
	Performance test / Calibration test / Hydrostatic test.
25.	Boiler Level Gauge
	Hydrostatic test / Material test / Seat leakage test / IBR Certificate
26.	pH/Conductivity measurement / Silica / Dissolved oxygen analysers:
	Calibration test, Accuracy test
27.	Sample cooler :



	Hydro test, IBR Certificate
28.	Sampling racks :
	Hydro test, IBR Certificate for tubes and fittings.
29.	S02 / Nox analyser / SPM analyser:
	Calibration test, accuracy test
30.	Interposing relay
	Functional test, temperature rise test, H.V test, Insulation test
31.	Transmitter Racks :
	Hydro test, air leak test for piping / tubing and fittings. IBR certification as required for tubing / piping and fittings.
32.	Pressure Transmitter
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
33.	Differential pressure transmitter
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
34.	Temperature Transmitter
	Calibration test / Accuracy test / Ambient temperature error test
35	Pneumatic Block Valves
	a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test
36.	Pressure Regulating Valve



	a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test
37.	Local Panels : Visual inspection, wiring & continuity check, H.V. and I.R. tests on panels, checking of bill of materials, functional tests.
38	Wiring Termination & Accessories Routine test: Conductor resistance test/High voltage test/Impulse dielectric test/insulation test/Humidity test/Temperature rise test on power circuits/short time current test on power circuits. Type test: Annealing test/Test for insulation and sheath/ Flame retardance test - a) Oxygen index, b) Flammability / Test for acid gas generation/test for water absorption/wet dielectric test
39	Marshalling/System cabinets Verification of degree of protection/Electrical tests as detailed under wiring Termination& accessories/Type test and routine test as per relevant Indian standards.
	Notes:
	1. Test Certificates in addition to inspection at manufacturers works shall be furnished for all the instruments for Owner's review.
	2. Above Test to be witnessed shall be finalized by Owner.
	3. In addition to above test, test as per approved QAP shall also be witnessed by owner.

17.02.05 TYPE TESTING

The BIDDER shall furnish the Type test reports of all type tests as per relevant standards and codes. As well as other specifics test indicated in the specification. A list of such test are given for various equipment in table titled, TYPE TEST REQUIREMENT FOR C&I SYSTEM and under the item special requirement for solid state requirements/systems. For the balance equipments/instruments. type test may be conducted as per manufacturer standards or if required by relevant standards.

A. Out of these test listed , the bidder /subvendor/manufacture is required



to conduct certain type test specifically for this contract (and witnessed by employer or his authorized representative). Even if the same have been conducted earlier as clearly indicated subsequently such tests.

- B. For the rest, submission of type test, results, and certificates shall be acceptable provided following points
- The same have been carried out by the bidder/ subvendor on exactly the same model/rating of equipment. (For control valves this shall be same size, type & design).
 - There has been no change in the components from the offered equipments and tested equipments.
 - The test has been carried out as per the latest standards along with amendments as on the date of bid opening.
- C. In case the approved equipment is different from the one on which the type test had been conducted earlier or any of the above grounds, then the tests have to be repeated and the cost of such tests shall be borne by the bidder/sub-vendor within the quoted price and no extra cost will be payable by the owner on this account.

- 17.02.05.1** As mentioned against certain items, the test certificates for some of the items shall be reviewed and approved by the main bidder or his authorized representative and balanced have to be approved by the employer.

The schedule of conduction of type test/submission of reports shall be submitted and finalized during pre award discussion.

- 17.02.05.2** For the type test to be conducted, bidder shall submit detailed test procedure for approval by owner. This shall clearly specify test setup, instruments to be used, procedure, acceptance norms (wherever applicable), recording of different parameters, intervals of recording precaution to be taken etc. for the test to be carried out.

17.02.05.3 SPECIAL REQUIREMENTS FOR SOLID STATE EQUIPEMNTS /SYSTEMS

The minimum type test report, over and above the requirements of above clause which are to be submitted for each of the major C&I systems like DDCMIS, DCS, PLC etc shall be as indicated below:

- i. Surge Withstand Capability (SWC) for solid state equipments/equipments

All solid state systems/equipments shall be able to withstand the electrical noise and the surges as encountered in actual service conditions and inherent in the power plant. All the solid states systems /equipments shall be provided with all required protection that needs the surge withstand capability as defined in ANSI 37.90.1/IEEE 472. Hence, all front end cards which receive external signals like analog input and output modules, Binary input and output modules etc including power supply, data highway, data links shall be provided with protection that meets the surge withstand capability as



defined in ANSI 37.90.1/IEEE 472. Complete details of the features incorporated in the electronic system to meet this requirement the relevant test carried out, the test certificates, etc shall be submitted along with the proposal. As an alternative to the above, suitable class of EN 61000-4-12 which is equivalent to ANSI 37.90.1/IEEE 472 may also be adapted for SWC test.

- ii. The dry heat test as per IEC-68-2-2 or equivalent
- iii. Damp heat test as per IEC 68-2-3 or equivalent
- iv. Vibration test as per IEC 68-2-6 or equivalent
- v. Electrostatic Discharge test as per EN 61000-4-2 or equivalent
- vi. Radio frequency immunity test as per EN 61000-4-6 or equivalent
- vii. Electromagnetic Field Immunity test as per EN 61000-4-3 or equivalent

Test listed at Item no v, vi, vii above are applicable for electronic cards only as defined under item no. (i) above

17.02.05.4 TYPE TEST REQUIREMENTS FOR C&I SYSTEMS

S.No.	Item	Test requirement	Standard	Test to be specifically conducted	Owner's Approval required on Test Certificate
1	Electrical metering instruments	As per standards	IS 1248	No	Yes
2	Thermocouple	Degree of Protection Test	IS - 13947	No	No.
3	Junction Box	Degree of Protection Test	IS - 13947	Yes	Yes
4	RTD	As per standards	IEC-60751	No	No
5	Electronic Transmitter	As per standards	BS 6447/ IEC 60770	No	Yes
6	E/P convertor	As per standards	Manufacturing standard	No	Yes
7	Instrumentation cable (Twisted and shielded) (Refer Vol. V, Chapter 9)				
8	Battery	As per standard	IS 10918	Yes	YES
9.	Voltage stabiliser	Over load test	Approved procedure	No	YES
		Temp. rise test without redundant fans	Approved procedure	No	YES
		Input voltage variation test	Approved procedure	No	YES
10	DDCMIS				
	CLCS	Model Test	Approved	No	No



	system		procedure		
	BMS & MFT	Safety requirement	VDE 0116, SEC 8.7	No	YES
11	Conductivity type level switch	Degree of protection test	IS 13947	No	No
12	Local gauges	Degree of protection test	IS 13947	No	No
13	Process actuated switches	Degree of protection test	IS 13947	No	No
14	Control valves	CV test	ISA 75.02	No	YES
15	PLCs	As per Standard	IEC 1131	No	YES
16	LIE/LIR	Degree of protection test	IS 13947	YES	YES
17	Flue gas O ₂ analyser, other Flue gas Analysers	Degree of protection test	IS 13947	No	YES
18	Flow nozzles & Orifice plates	calibration	ASME PT C BS 1042	YES	YES

Note:

Type test are to be conducted only for the items, which are being supplied as part of this package.

- A. For batteries with electric power supply system of main plant C&I, the bidder shall submit for owner's approval the reports of all the type tests as per IS-10918 carried out within last 5 years from the date of bid opening and the test should have been either conducted at an independent laboratory or should have been witnessed by a owner/client. The complete type test report shall be for any rating of battery in a particular group, based on plate dimensions being manufactured by supplier.

For batteries with electric power system of auxiliary plants, type test reports for batteries shall be as per standard –practice of manufacturer.

14.02.06 Testing at Site [Prior to commercial operation]

- a. All equipment shall be checked thoroughly in respect of the following:
 - i. Visual and mechanical testing
 - ii. Complete system configuration loading functions; system diagnostics; system proper operation specified power supply specifications.



2 x 660 MW ENNORE SEZ Supercritical Thermal Power
Project at Ash Dyke of NCTPS
Spec. No. CE/C/P&E/EE/E/OT.No.03/2013-14

Vol. V/Sheet - 447



**J.APPLICABLE
CODES
&
STANDRARDS**

1.08.00 CODES AND STANDARDS

1.08.01 All equipments, system and service covered under this specification shall comply with the requirements of the latest statutes regulations and safety codes as applicable in the locality where the equipments/systems will be installed. The Bidder shall fully acquaint himself with these requirements and shall ensure compliance with them.

The equipments, systems and services furnished as per this specification shall conform to the codes and standards mentioned in Cl. no. 1.08.02 of this Section. However in the event of any conflict between the requirements of two standards or between the requirements of any standard and this specification, the more stringent requirements shall apply unless confirmed otherwise by the Owner in writing. The decision of the Owner shall be final and binding in all such cases.

The Bidder's scope of supply shall include some items such as thermowells, and other in-line devices for main steam, hot reheat, cold reheat, feed water system falling under the purview of Indian Boiler Regulation (IBR) Act. It shall be the responsibility of the Bidder to obtain the necessary approval of the concerned Inspecting Authority/Chief Inspector of Boilers for the design and design calculations and manufacturing and erection procedures as called for under the IBR act for all items requiring such certifications.

The requirements of statutory authorities (e.g. MOEF, Inspectors of factories, IBR, TAC, BEE, CPCB/TNPCB etc) with regards to various plants areas like Main plant, Fuel oil plant/system, Chlorination Plant, Fire Fighting system, Emission Measurement, Ambient Air Monitoring system etc. shall be complied, even if not actually spelt out.

1.08.02 Reference Codes and Standards

The design, manufacture, inspection, testing, site calibration and installation of all equipment and systems covered under this specification shall conform to the latest editions of codes and standards mentioned below and all other applicable ANSI,



ASME, IEEE, NEC, NEMA, ISA, DIN, VDE, NFPA, IEC, EIA, TIA and Indian Standards and their equivalents. Bidder to note that in no case, OEM/manufacturers own standards shall be accepted.

1.08.02.01 Temperature Measurement

1. Performance Test Code for temperature measurement ASME PTC 19.3 (1974 – R 1998)
2. Temperature measurement - Thermocouples ANSI-MC 96.1 – 1982, IEC 584
3. Temperature measurement by electrical resistance thermometers - IS-2806.
4. Thermometer-element-platinum resistance-IS-2848, IEC 751/DIN 43760
5. RTD Design Code – DIN EN 60751:1996, BS EN 60751 : 2008
6. Thermowell Design Code – ASME PTC 19.3 TW – 2010

1.08.02.02 Pressure Measurement

1. Performance Test Code for pressure measurement - ASME PTC 19.2 (2010)
2. Bourdon tube pressure and vacuum gauges - IS 3624, IS 3602, ASME B 40.1

1.08.02.03 Electronic measuring Instruments & Control hardware

1. Automatic null balancing electrical measuring instruments - ANSI C 39.4 (Rev. 1973), IS 9319
2. Safety requirements for electrical and electronic measuring and controlling instrumentation - ANSI C 39.5 - 1974.
3. Compatibility of analog signals for electronic industrial process instruments - ISA-S 50.1:ANSI MC 12.1 - 1975.
4. Dynamic response testing of process control instrumentation - ANSI MC 4.1 (1975): ISA-S26 (1968).
5. Surge withstand capability (SWC) tests - ANSI C 37.90A (1974) IEEE Std. 472 (1974). IEC – 255.4.
6. Printed circuit boards - IPC TM-650, IEC 326 C
7. General requirements and tests for printed wiring boards - IS 7405 (Part-I) - 1973
8. Edge socket connectors - IEC 130-11.
9. Requirements and methods of testing of wire wrap terminations DIN 41611 Part-2.
10. Dimensions of attachment plugs & receptacles ANSI C73-1973.
11. Direct acting Electrical Indicating Instruments: IS-1248-1968.

1.08.02.04 Instrument Switches and Contacts

1. Contact rating - AC services NEMA ICS Part-2 125, A600
2. Contact rating - DC services NEMA ICS Part-2-125, N600.

1.08.02.05 DDCMIS & other Control System

1. Application of Safety Instrumented System – ANSI/ISA 84.01 1996
2. Functional Safety - Safety Instrumented System for Process Sector – IEC – 61151

3. IEEE Application Guide for Distributed Digital Control Monitoring for Power Plant – IEEE 1046
4. Fossil Fuel Power Plant Steam Turbine Bypass System – ANSI/ISA – 77.13.01
5. Human System Interface Design Review Guide lines – NUREG – 700
6. Annunciation Sequence and Specification – ANSI/ISA 18.1
7. “IEEE 1050, IEEE guide for Instrumentation & control system grounding in generating station”,
8. ANSI/ISA-77.44.01-2007 - Fossil Fuel Power Plant - Steam Temperature Controls
9. ANSI/ISA-RP77.60.05-2001 (R2007) - Fossil Fuel Power Plant Human-Machine Interface: Task Analysis
10. ANSI/ISA-77.42.01-1999 (R2006) - Fossil Fuel Power Plant Feedwater Control System – Drum-Type
11. ANSI/ISA-77.20-1993 (R2005) - Fossil Fuel Power Plant Simulators - Functional Requirements
12. ANSI/ISA-77.41.01-2005 - Fossil Fuel Power Plant Boiler Combustion Controls
13. ANSI/ISA-RP77.60.02-2000 (R2005) - Fossil Fuel Power Plant Human-Machine Interface: Alarms
14. ANSI/ISA-77.70-1994 (R2005) - Fossil Fuel Power Plant Instrument Piping Installation
15. ANSI/ISA-TR77.60.04-1996 (R2004) - Fossil Fuel Power Plant Human-Machine Interface-Electronic Screen Displays
16. ANSI/ISA-77.43.01-1994 (R2002) - Fossil Fuel Power Plant Unit/Plant Demand Development-Drum Type
17. ANSI/ISA-77.13.01-1999 - Fossil Fuel Power Plant Steam Turbine Bypass System

1.08.02.06 Electronic Cards, Subassemblies and Componets

a) Unpackaged

i)	Vibration	:	IEC-68.2.6
ii)	Shock	:	IEC-68.2.27
iii)	Drop & Topple:	:	IEC-68.2.31

b) Packaged

Vibration, Drop & Static Compression - NSTA

C) Electromagnetic Compatibility

i)	Electrical Fast Transient	:	IEC-801.4
ii)	Surge Withstand	:	IEC-255.4
iii)	Radiated Electromagnetic Field	:	IEC-801.3
iv)	Electrostatic Discharge	:	IEC-801.2
v)	Electromagnetic Emission	:	VDE 0871, Class B

1.08.02.07 UPS System/DC control power supply system:

1. Practices and requirements for semiconductor power rectifiers - ANSI C34.2-1973.

2. Relays and relay systems associated with electrical power apparatus - IEEE Std. 3.13, ANSI C 3790-1983.
3. Surge withstand capability tests - ANSI C37.90a-1974. IEEE Std. 472 - 1974
4. Recommended practice for sizing large lead storage batteries for generating stations & substations - IEEE-485.
5. Performance testing of UPS - IEC 146.
6. IEC 62040 – General & Safety requirement of UPS.
7. IEC 62040-2 - UPS – EMC Requirement.
8. IEC 62040-3 - UPS – Method of specifying the performance and test requirement.
9. IEC 60269-2 – Main Supply Fuse.
10. IEC 60947 – MCCB.
11. IEC/EN 60623– BATTERIES.
IEEE485/IEEE1115
IS : 10918, IS : 1069
12. IEC 60146 - For DC system.

1.08.02.08 Control Valves

1. Control Valve sizing - Incompressible fluids - ISA S39.2 - 1972.
2. Control valve sizing - Compressible fluids - ISA S39.3 - 1973, ISA S39.4 - 1974.
3. Face to face dimensions of control valves - ANSI B16.10
- 1) ISA Hand book of control valves - ISBN B1047-087664-234-2.
- 2) Valves - flanged, threaded and welding end : ANSI B 16.34(2009)
- 3) Casting : ASTM A 216 / A 351 (2008)
- 4) Welded end connection : As per ASME boiler and pressure vessel code / ANSI.B 16.34(2009), B16.25 (2009), B 16.11(2009).
- 5) Defect removal: ANSI B 16.34 2009.
- 6) Cleaning : ASTM A 380 2006.
- 7) CV test : As per ISA procedure S 75.02 (2008).
- 8) Control Valve seat leakage : ANSI/FCI 70.2

1.08.02.09 Enclosures

1. Types of enclosures - NEMA Std. ICS-6-110.15 through 110.22 (Type 4 to 13).
2. Racks, panels, and associated equipment - EIA: RS-310-B (ANSI C83.9 - 1972)
3. Protection Class for Enclosure, Cabinets, Control Panels and Desks - IS-13947-1962.

1.08.02.10 Apparatus, enclosures and installation practices in hazardous areas

1. Classification of hazardous area - NFPA Art. 500, Vol.70-1984.
2. Electrical Instruments in hazardous dust locations - ISA-RP 12.11
3. Intrinsically safe apparatus - NFPA Art.493 Vol.4.1978
4. Purged and pressurized enclosure for electrical equipment in hazardous location - NFPA Art. 496 1982.

1.08.02.11 Sampling System

1. Stainless steel material of tubing and valves for sampling system - ASTM A269-82 Gr TP316.
2. Submerged helical coil heat exchangers for sample coolers ASTM D 11-98.
3. Water and Steam in power cycle - ASME PTC 19.11(2008).
4. Standard methods of sampling system - ASTM D 1066-69.

1.08.02.12 Annunciators

1. Specifications and guides for the use of general purpose annunciators - ISA RP 18.1-1979.
2. Surge withstand capability tests - ANSI C.37.90a - 1974 and IEEE std. 472-1974

1.08.02.13 Interlocks, Protections

1. Relays and relay system associated with electric power apparatus - IEEE std.3.13.
2. Surge withstand capability tests - ANSI C.37.90a - 1974 and IEEE Std. 472 - 1974.
3. General requirements & tests for switching devices for control and auxiliary circuits including contactor relays - IS-6875 (Part-I) 1973.
4. Turbine water damage prevention - ASME - TDP-1980.
5. Boiler safety interlocks - NFPA Section 85B, 85D, 85E, 85F, 85G.

1.08.02.14 Process Connection and Piping:

1. Codes for pressure piping power piping ANSI B31.1
2. Seamless carbon steel pipe ASTM A-106.
3. Forged and Rolled Alloy steel pipe flanges, forged fittings, valves and parts - ASTM A-182.
4. Material for socket welded fittings - ASTM A-105.
5. Seamless ferrite alloy steel pipe - ASTM A-335.
6. Pipe fittings of wrought carbon steel and alloy steel - ASTM A-234.
7. Composition bronze or metal castings - ASTM B-62.
8. Seamless copper tube, bright annealed ASTM B-168.
9. Seamless copper tube - ASTM B-75.
10. Dimensions of fittings - ANSI B-16.11
11. Valves flanged and butt welding ends - ANSI B16.34.
12. Nomenclature for Instrument tube fittings ISA-RP-42.1 - 1982.

1.08.02.15 Instrument Tubing

1. Seamless carbon steel pipe - ASTM - A106.
2. Material for socket weld fittings - ASTM - A105.
3. Dimensions of fittings - ANSI B16.11
4. Code for pressure piping, welding, hydrostatic testing - ANSI B31.1.

1.08.02.16 Cables

1. Thermocouple extension wires/cables - ANSI C 96.1 - 1982.
2. Colour coding of single or multi-pair cables – VDE 0815

3. Guide for design and installation of cable systems in power generating stations (insulation, jacket materials) - IEEE Std. 422 - 1977.
4. Requirements of vertical tray flame test - IEEE 383 - 1974.
5. Standard specification for tinned soft or annealed copper wire for electrical purpose - ASTM B-33 - 81.
6. Oxygen index and temperature index test - ASTM D-2863.
7. Smoke generation test - ASTM D-2843 and ASTM E-662.
8. Acid gas generation test - IEC-754-1.
9. Swedish chimney test - SEN - 4241475 (F3)
10. Instrumentation cables and internal wiring I S-1554 (Part-I, 1976) and I S-5831(1984).
11. Standard for Control, Thermocouple Extension and Instrumentation cable - NEMA WC 57-2004 IEC 60332-1, Rev. 2, 2004)□
12. PVC insulated (heavy duty) Electric cables for working voltages upto and including 1100V - IS:1554 (Part-I)
13. Conductors for insulated electric cables and flexible cords. - IS:8130
14. PVC insulation and sheath of electric cables - IS:5831
15. Mild steel wires, strips and tapes top armoring cables - IS:3975
16. Water Immersion Test - VDE 0815
17. Drums for electric cables - IS : 1048

1.08.02.17 Cable Trays, Conduits

1. Guide for the design and installation of cable systems in power generating station (cable trays, support systems, conduits) - IEEE Std. 422, NEMA VE-1, NFPA-70-1984.
2. Guide for the design and installation of cable systems in power generating station (Cable trays, support systems, conduits) Test Standards, NEMA VE-1 - 1979.
3. Galvanising of Carbon steel cable trays - ASTM A-386-78.

1.08.02.18 Flow measurement

1. ASME Performance Test Code PTC-19.5 (2004), ISA RP3.2
2. BS 1042
3. ISO 5167

1.08.02.19 Surge Protection System

1. Surge withstand capability tests - ANSI C37.90a-1974. IEEE Std. 472 – 1974
2. IEC 61643-1:1998-02 and E DIN VDE 0675 part 6:1996-03/A2: 1996-10
3. IEC 61643-21:2000-09 and E VDE 0845 part 3-1:1999-07

1.08.02.20 Digital Video Recording & Management System (DVRMS)

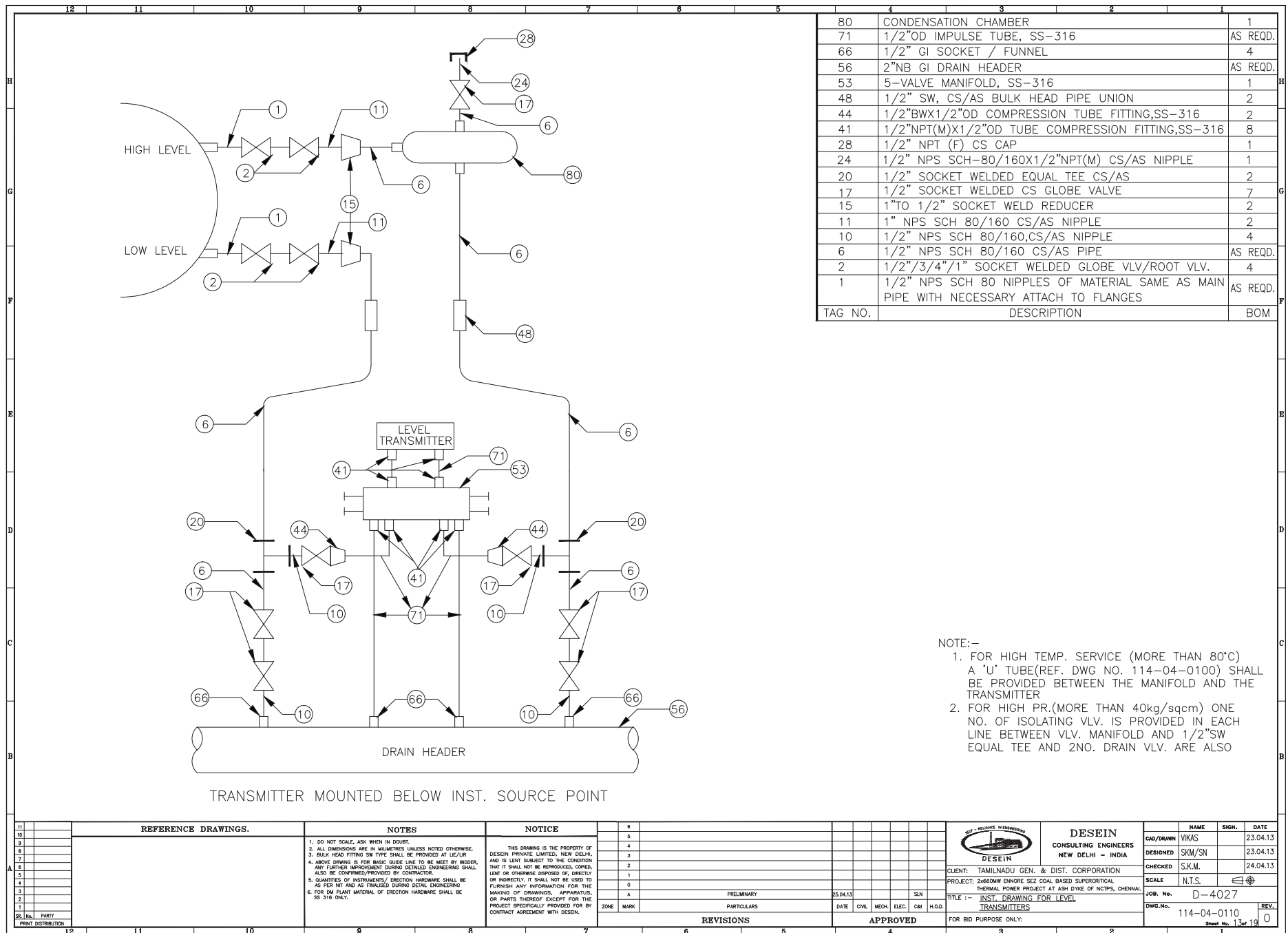
1. ISO 9001 (2000)
2. ISO/IEC15504 Level3 or higher (SPICE 2.0 Software Process Improvement and Capability Determination)

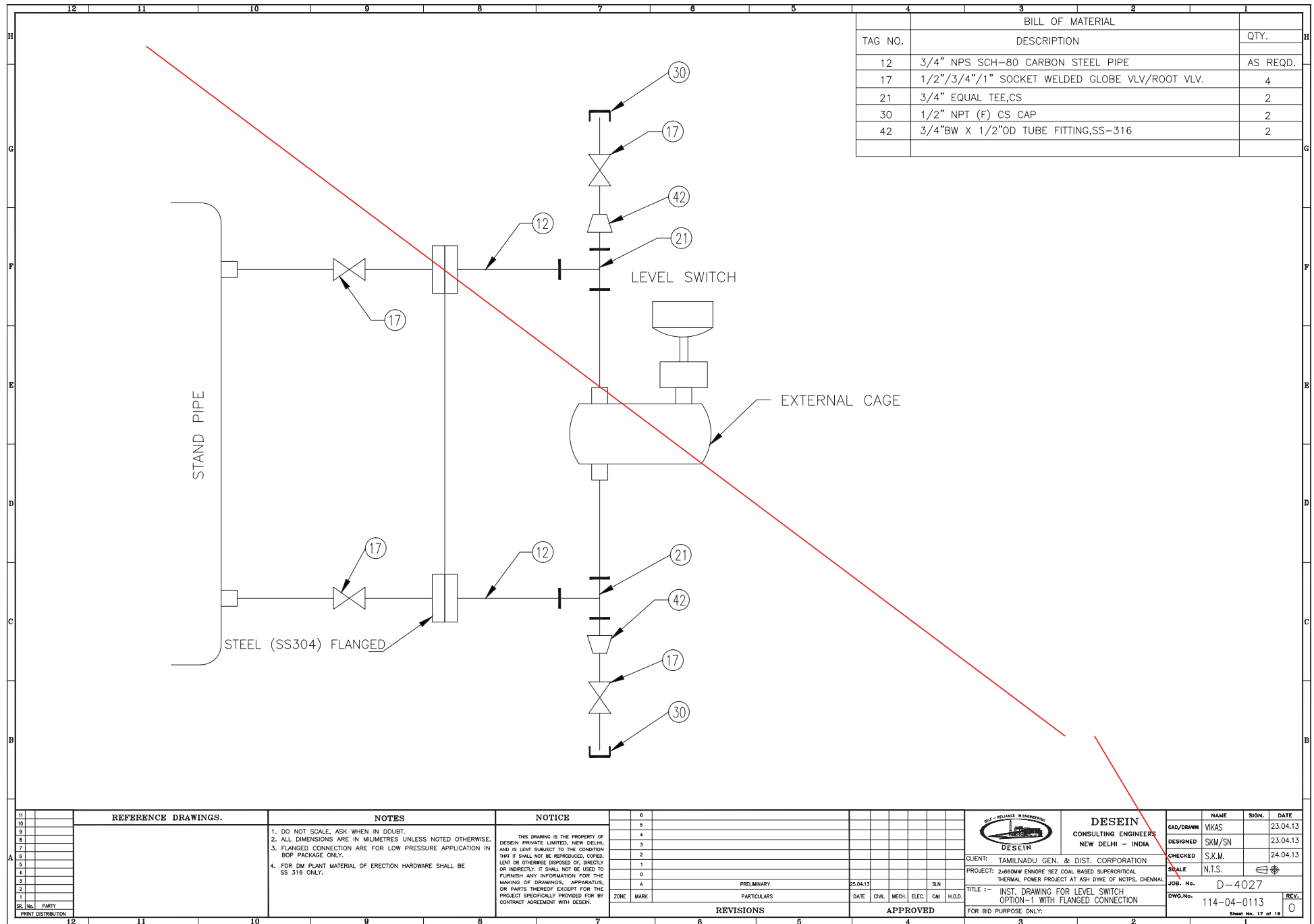
3. SEICMM Level 3 or higher (American Software Engineering Institute - Capability Maturity Model)

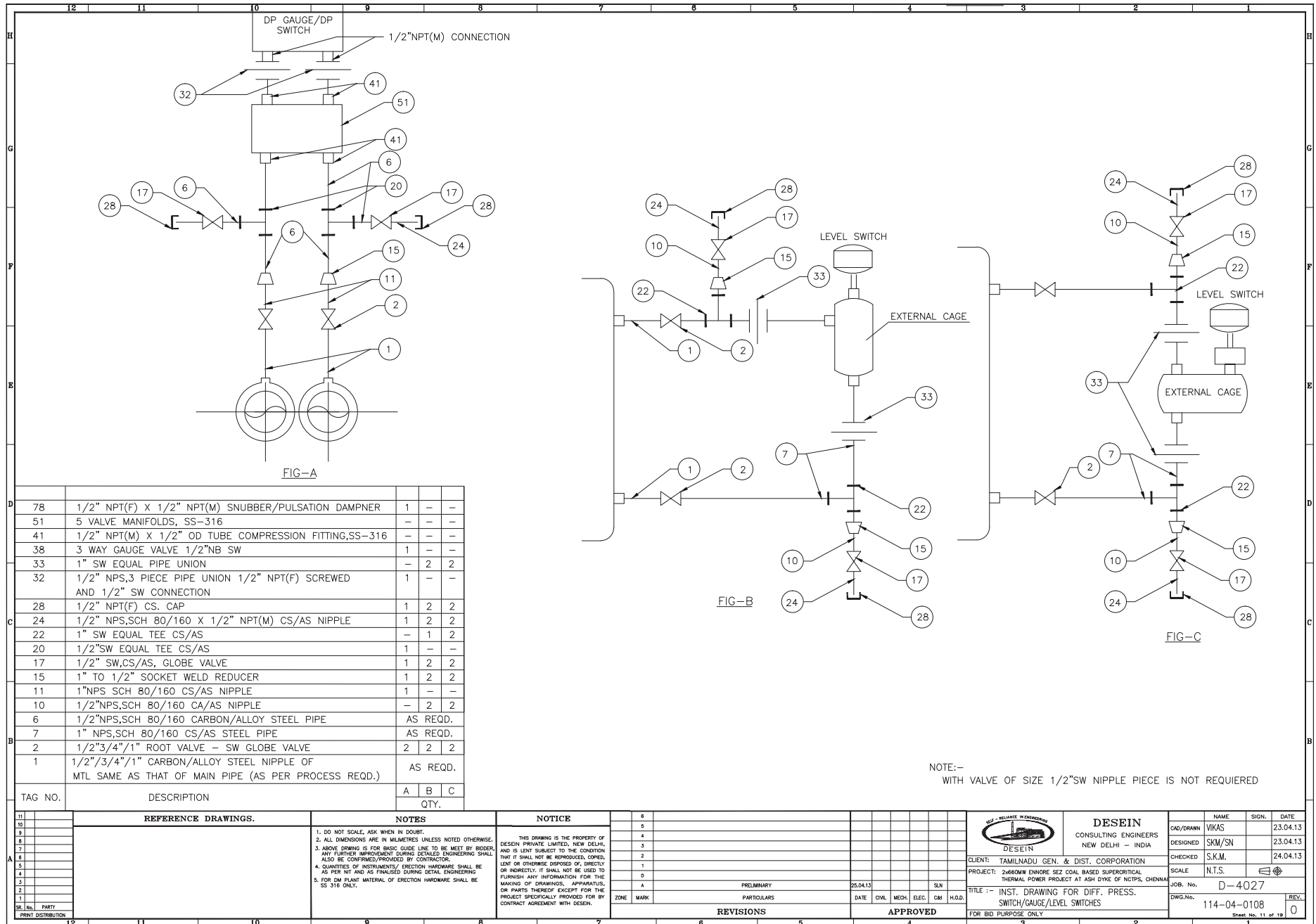
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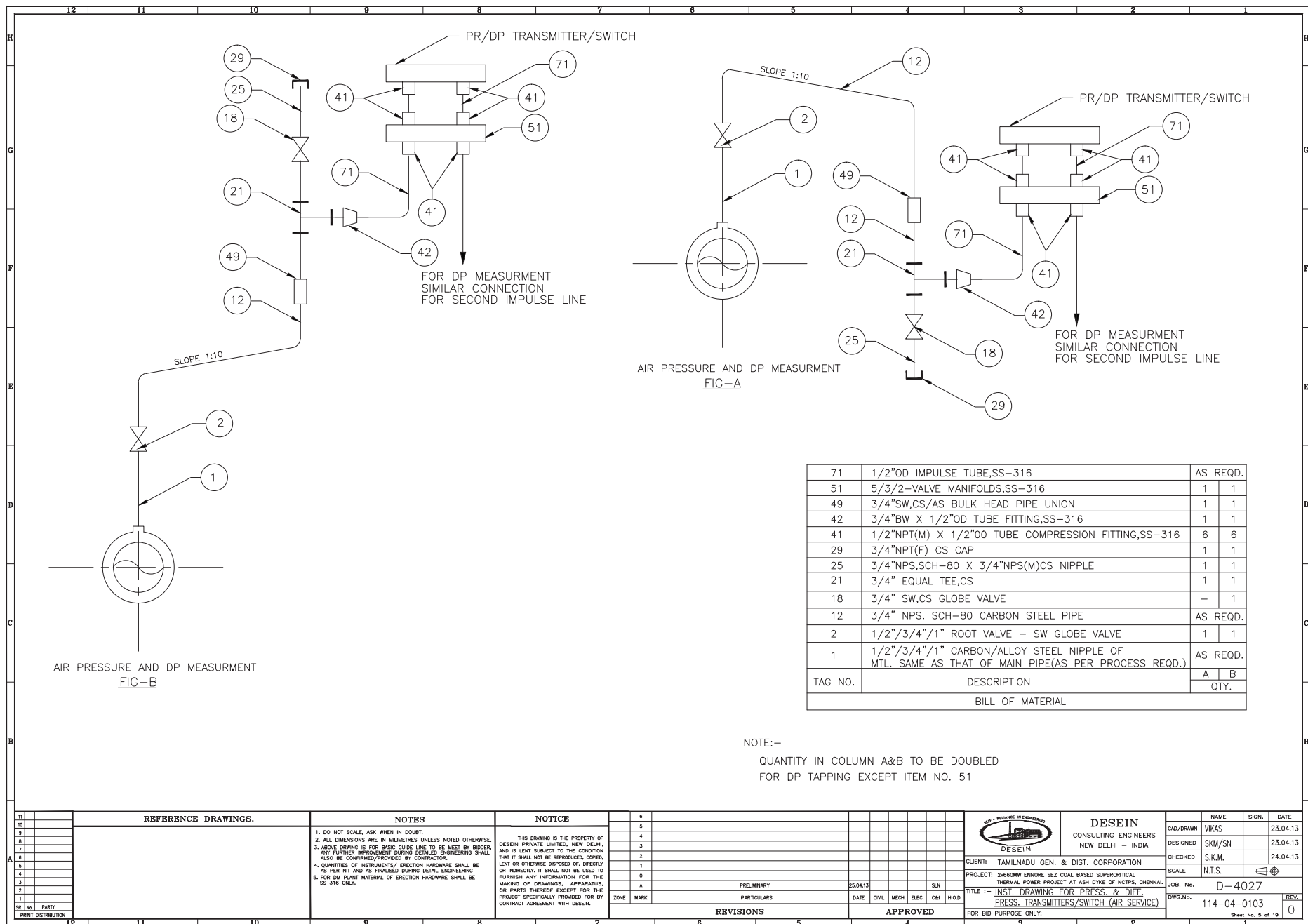
- i) IEEE - Institute of Electrical and Electronics Engineers.
- ii) ISA - Instrument, Systems and Automation Society
- iii) NEMA - National Electrical Manufacturers Association
- iv) ANSI - American National Standards Institute
- v) NFPA - National Fire Protection Association
- vi) ASME - American Society of Mechanical Engineers
- vii) IS - Indian Standards
- viii) IEC - International Electro-technical Commission
- ix) ASTM - American Society for Testing Materials
- x) EIA - Electronic Industries Association
- xi) DIN - Deutsche Institute Normale
- xii) TIA – Telecommunication Industries Association

L.DRAWINGS



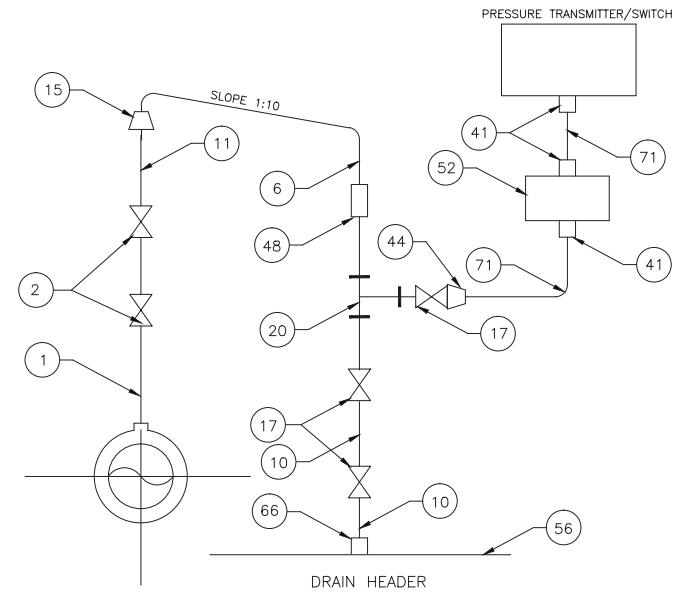
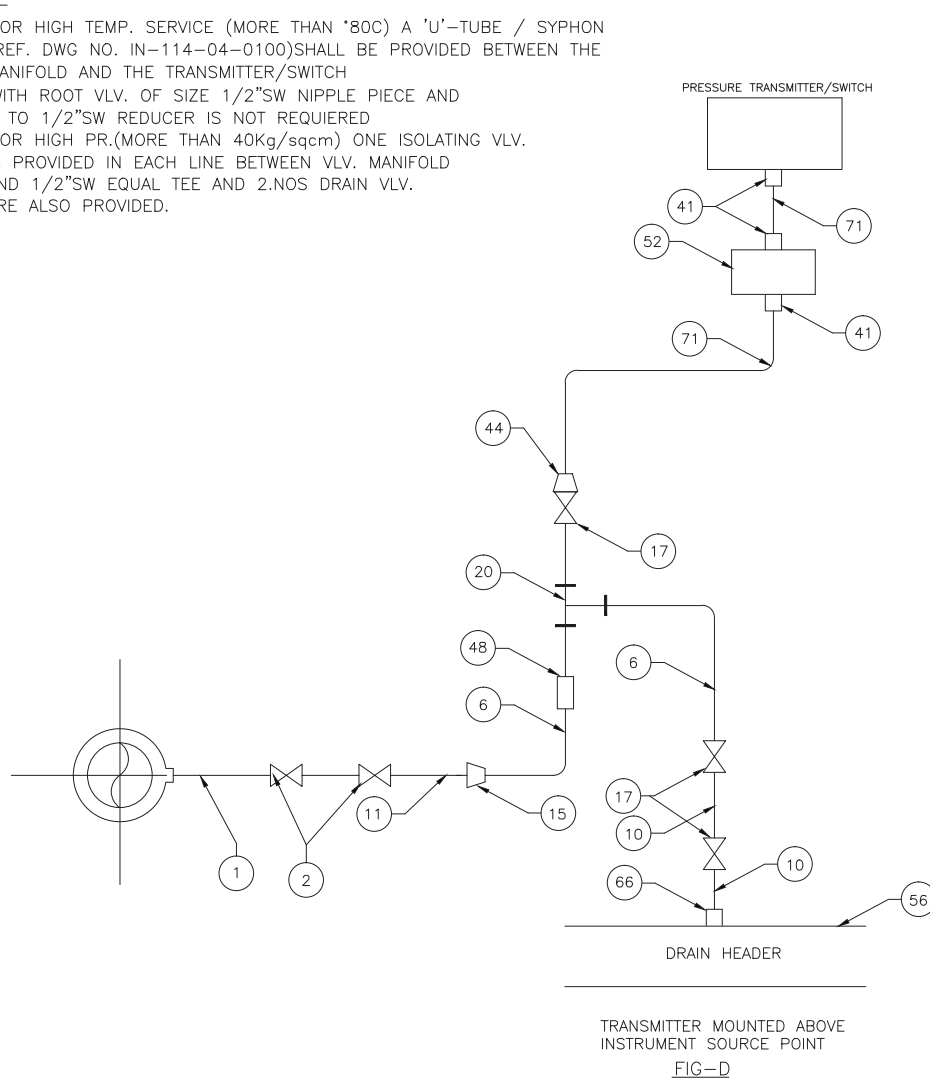






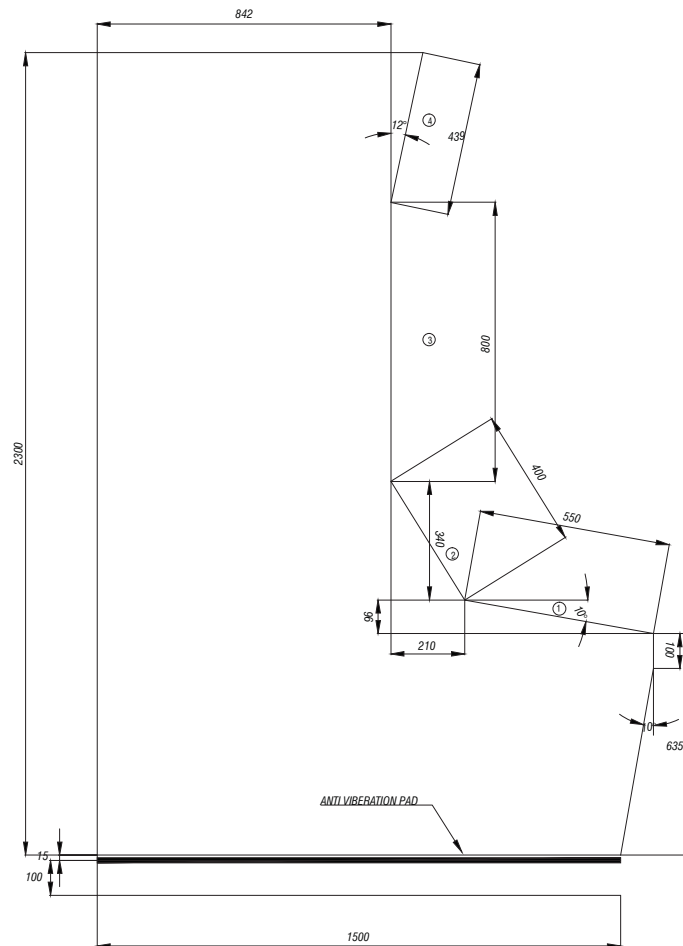
NOTE:-

1. FOR HIGH TEMP. SERVICE (MORE THAN 80°C) A 'U'-TUBE / SYPHON (REF. DWG NO. IN-114-04-0100) SHALL BE PROVIDED BETWEEN THE MANIFOLD AND THE TRANSMITTER/SWITCH
2. WITH ROOT VLV. OF SIZE 1/2" SW NIPPLE PIECE AND 1 TO 1/2" SW REDUCER IS NOT REQUIRED
3. FOR HIGH PR. (MORE THAN 40 Kg/sqcm) ONE ISOLATING VLV. IS PROVIDED IN EACH LINE BETWEEN VLV. MANIFOLD AND 1/2" SW EQUAL TEE AND 2 NOS DRAIN VLV. ARE ALSO PROVIDED.



71	1/2"OD IMPULSE TUBE,SS-316	AS REQD.
66	1/2" GI SOCKET	1 1
56	2"NB GI DRAIN HEADER	
52	5/3/2-VALVE MANIFOLDS,SS-316	1 1
48	1/2"SW,CS/AS BULK HEAD PIPE UNION	1 1
44	1/2"BW X 1/2"OD COMPRESSION TUBE FITTING,SS-316	1 1
41	1/2"NPT(M) X 1/2"OD TUBE COMPRESSION FITTING,SS-316	3 3
20	1/2"SW EQUAL TEE,CS	1 1
17	1/2" SW,CS GLOBE VALVE / NEEDLE VALVE	3 3
15	1" TO 1/2" SW REDUCER	1 1
11	1" NPS SCH-80 CS/AS NIPPLE	1 1
10	1/2" NPS,SCH 80/160, CS/AS NIPPLE	2 2
6	1/2" NPS. SCH-80/160 CS/ AS PIPE	AS REQD.
2	1/2"/3/4"/1" ROOT VALVE	2 2
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	AS REQD.
TAG NO.	DESCRIPTION	C D QTY.

BILL OF MATERIAL			
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REVISIONS			
APPROVED			
FOR BID PURPOSE ONLY:			
DESEIN CONSULTING ENGINEERS NEW DELHI - INDIA			
CLIENT: TAMILNADU GEN. & DIST. CORPORATION			
PROJECT: 2x600MW ENCORE SET COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DIKE OF NCTPS, CHENNAI			
TITLE :- INST. DRAWING FOR PRESS. & DIFF.PRESS. TRANSMITTERS/SWITCH (STEAM & LIQUID SERVICE)			
JOB. No. D-4027			
DWG.No. 114-04-0104			
Sheet No. 7 of 19			

**NOTE:-**

- 1 : Panel for Mounting annunciation P.B.,
Desk release PB, Emergency Trip P.B.
- 2 : Panel for Mounting ILPB for OLCS / Sequential Operation.
- 3 : Sheet metal panel for mounting MIMIC , Ammeters, Indicator,
Totalizer, recorder etc.
- 4 : Inclined Sheet metal panel for mounting Annunciation Facia windows.

NOTES		NOTICE		5								DESEIN CONSULTING ENGINEERS NEW DELHI - INDIA		DRAWN		DESIGNED		CHECKED	
1. DO NOT SCALE, ASK WHEN IN DOUBT. 2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE. 3. DETAILS OF PANELS/ DESK SHALL BE AS PER SPECIFICATION.		THIS DRAWING IS THE PROPERTY OF DESEIN CONSULTING ENGINEERS, NEW DELHI, AND IS LENT SUBJECT TO THE CONDITION THAT IT SHALL NOT BE REPRODUCED, COPIED, LENT OR OTHERWISE DISPOSED OF DIRECTLY OR INDIRECTLY. IT SHALL NOT BE USED TO FURNISH ANY INFORMATION FOR THE MAKING OF DRAWINGS, PRINTS OR APPARATUS OR PARTS THEREOF EXCEPT FOR THE PROJECT SPECIFICALLY PROVIDED FOR BY CONTRACT AGREEMENT WITH DESEIN.		4										VIKAS		SKM/SN		SKM	
				3										23.04.13		23.04.13		24.04.13	
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				A		PRELIMINARY		25.04.13		SLN								JOB NO. D-4027	
				ZONE		MARK		PARTICULARS		DATE		C/M		MECH		ELEC.		TITLE :- GEN.ARRG.OF DESK CUM PANEL (TYP) FOR BOP PACKAGES	
								REVISIONS		APPROVED		FOR BID PURPOSE		SHEET NO. 1 of 1		DRG NO. 114-05-0105		REV. 0	



DESEIN
CONSULTING ENGINEERS
NEW DELHI - INDIA

DRAWN	DESIGNED	CHECKED
VIKAS	SKM/SN	SKM
23.04.13	23.04.13	24.04.13

CLIENT:- TAMILNADU GEN. & DIST. CORPORATION

SCALE NTS

PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF INCTPS, CHENNAI

JOB NO. D-4027

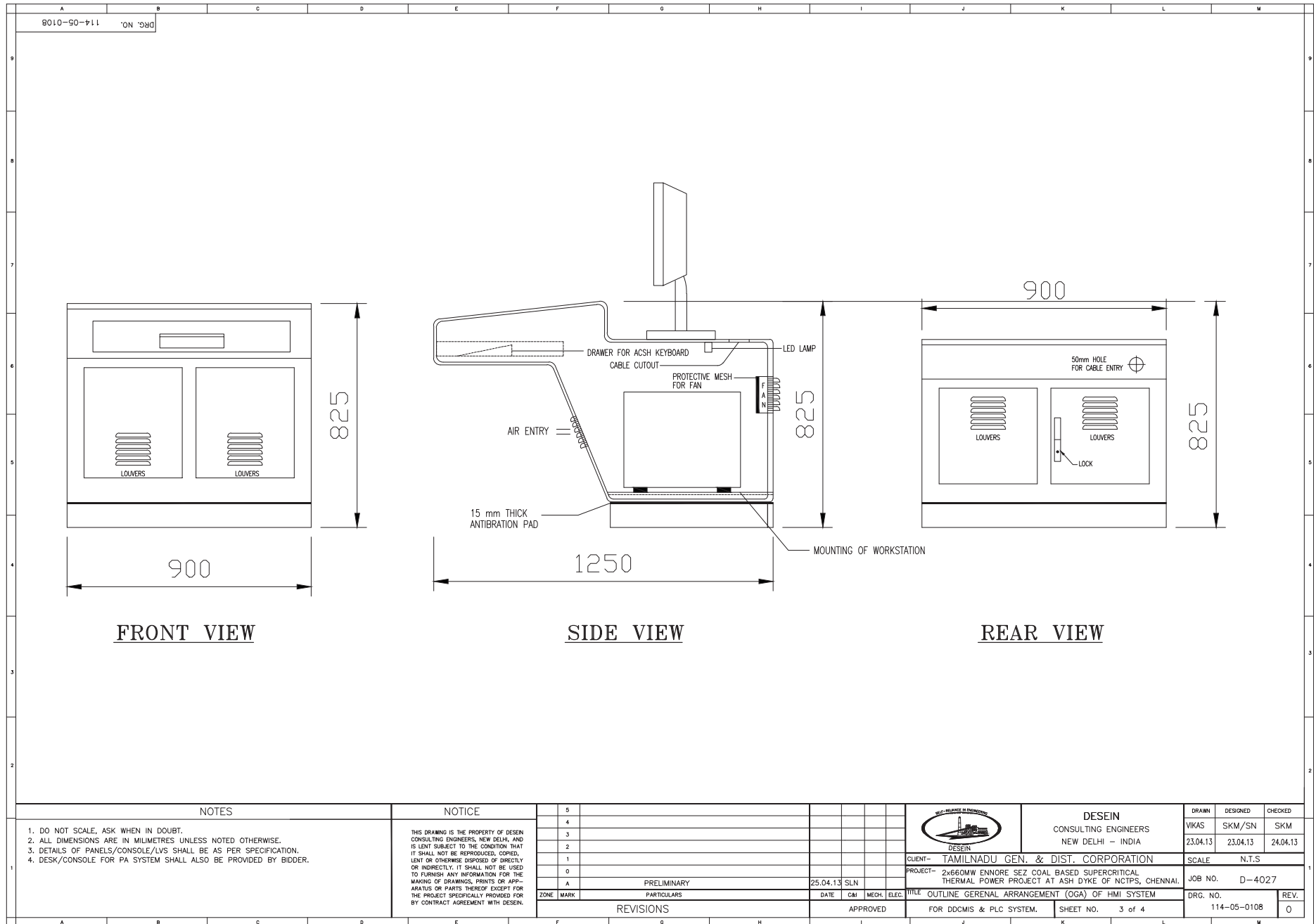
TITLE :- GEN.ARRG.OF DESK CUM PANEL (TYP) FOR BOP PACKAGES

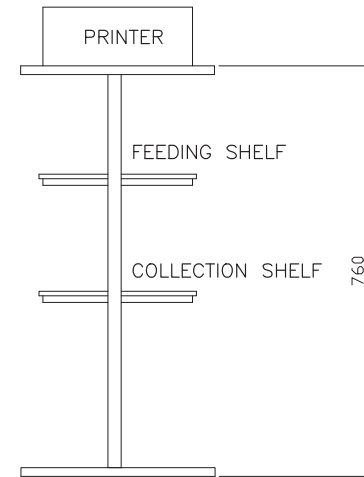
DRG NO. 114-05-0105

FOR BID PURPOSE

SHEET NO. 1 of 1

REV. 0





SIDE VIEW



NOTES			NOTICE									DESEIN CONSULTING ENGINEERS NEW DELHI – INDIA			DRAWN	DESIGNED	CHECKED
1. DO NOT SCALE, ASK WHEN IN DOUBT. 2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE. 3. DESG/CONSOLE FOR PA SYSTEM SHALL ALSO BE PROVIDED BY BIDDER.			THIS DRAWING IS THE PROPERTY OF DESIGN CONSULTING ENGINEERS, NEW DELHI, AND IS LENT SUBJECT TO THE CONDITION THAT IT SHALL NOT BE REPRODUCED, COPIED, LENT OR OTHERWISE DISPOSED OF DIRECTLY OR INDIRECTLY. IT SHALL NOT BE USED TO FURNISH ANY INFORMATION FOR THE MAKING OF DRAWINGS, PRINTS OR APPARATUS OR PARTS THEREOF EXCEPT FOR THE PROJECT SPECIFICALLY PROVIDED FOR BY CONTRACT AGREEMENT WITH DESEIN.			5 4 3 2 1 0			PRELIMINARY 25.04.13 SLN			CLIENT- TAMILNADU GEN. & DIST. CORPORATION PROJECT- 2x660MW ENMORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.			VIKAS	SKM/SN	SKM
															23.04.13	23.04.13	24.04.13
															SCALE N.T.S		
															JOB NO. D-4027		
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ZONE MARK			PARTICULARS			DATE CM MECH ELEC.			TITLE-			OGA-PRINTER TABLE FOR DDCMS AND PLC SYSTEM			DRG. NO.		
REVISIONS			APPROVED			FOR BID PURPOSE			SHEET NO.			4 of 4			114-05-0108		
															O		

M. ERECTION HARDWARE

CHAPTER-9**ERECTION HARDWARE****9.00.00 PROCESS CONNECTION AND PIPING****9.00.01 General Requirements**

This section covers the material requirement for instrument connection to process, instrument process, piping, tubing, supports, Instrumentation cables, control cables and power cables for connecting UPS, 24/48 V DC, unregulated power supply for cubicle illumination, compensating cables/Extension cables, transmitter racks and main accessories to be furnished under this specification and the requirements of installation and routing. Impulse lines, fittings and other accessories required for the erection of complete Instrumentation and Control System supplied under various packages of this specification shall be supplied on "as required" basis. Bidder shall offer all necessary items for this section based on his experience on similar plants, plant layout diagrams, installation drawings and other applicable sections of this specification. Based on the good engineering practices Bidder shall furnish installation drawings during the engineering of the system for Owner's review and approval. The installation of the drawings shall be suitable for his installation of his range of instrumentation.

The Bidder shall furnish and test all required erection hardware, which is necessary for proper installation and interconnection of the equipment/systems furnished by the Bidder and their integration with main equipment/systems as per the enclosed installation drawings and other applicable clause. The Bidder shall furnish all hardware and accessories to ensure that the equipment/systems furnished form a complete and operational system meeting the intent and requirement of this specification.

All materials, furnished shall conform to the latest editions of America National Standard Code for Pressure piping, Power piping, ANSI B311.1, ANSI B16.11, ASME Boiler and Pressure Vessel Codes, IBR and other applicable ASME, ANSI and Indian Standards. Schedule numbers, sizes and dimensions of all carbon steel, stainless steel and alloy seamless steel pipe shall confirm to ANSI B.36.10 and of stainless steel pipe shall confirm to ANSI B 36.19 unless otherwise specified.

All materials supplied under this section shall be suitable for intended service; process operating conditions and type of instruments used and shall fully conform to the requirements of this specification.

The Bidder is responsible for the performance of the equipment furnished on system basis any shortfall in erection material observed during erection stage shall be compensated by the Bidder at no extra cost. (Installation drawings # 114-04-0000, 0100 to 0113 shall also be referred by bidder).

9.01.00 GUIDLINE FOR INSTALLATION AND ROUTING OF INSTRUMENT PIPING**9.01.01 General Requirements**

The following general erection guidelines have been enumerated here to enable the Bidder to estimate the requirement of instrument piping in plant:-



- i) All instrument piping shall be in accordance with good engineering practice. It shall be finalized during engineering stage. Instrument piping shall be complete with fittings, valves and other required accessories.
- ii) Instrument piping shall not be routed:-
 - a) Across equipment removal areas
 - b) Below mono-rails and cranes
 - c) Above or below removable gratings
 - d) Above or below cable trays.
- iii) Primary Impulse Piping System:
 - a) The primary impulse piping system shall include the instrument piping and all required accessories from process tap off point (root valves onwards) up to the respective instruments. From the same source, Tee off for instruments are not allowed. Separate tapping shall be provided for each instrument. The Bidder shall provide the necessary fittings and accessories along with impulse pipes for completeness and arrangements as per the finalized Instrument Installation Diagrams. Special accessories such as reservoirs and other devices shall be installed as required for flow primary element connection as required by the design of instruments, in accordance with the instructions of the instrument manufacturer.
 - b) The Bidder shall prepare impulse pipe routing drawings.
 - c) Impulse piping shall include a blow-down line and shut-off valve adequate for the duty requirements and for withstanding continuous design pressure and temperature of process medium. For process pressure above 40 Kg/Cm²g, double valves shall be used before connecting to the blow-down header (This arrangement shall be provided for installation for the new transmitter if the existing transmitter has the same arrangement.)
 - d) To assure a constant static head the connections from low pressure steam and low pressure liquid filled lines should preferably slope downward continuously towards the instrument as the instrument is mounted below the source point. If downward slope is not feasible or the instrument is mounted above the source point, the line should slope upward continuously and a "pigtail" installed at the instrument to assure a water seal for temperature protection. Upward sloping liquid lines should be used only if the process pressure is sufficient to assure a head of liquid at the instrument. Horizontal runs should have a slope of not less than 40 mm per meter and must be adequately supported to maintain a constant slope. Vacuum connections to the condenser should always slope upward to the instrument.
 - e) Primary process piping for steam flow, liquid flow and manometric level measurement systems should preferably slope downward from the primary element connections to the instrument. Primary piping for flue gas and air flow measurement systems should preferably slope upward from



the primary element connections to the instrument. If these requirements cannot be met, special venting or drain provisions will be required. Horizontal runs must have a slope of not less than 40 millimeters per meter and must be adequately supported to maintain a constant slope.

- f) Primary process piping from the field which enters the instrument enclosure from the bottom shall extend into the enclosure approximately 150 millimeters and be equipped with a socket weld to flare less tubing coupling of stainless steel. This coupling shall be used to connect the field primary process line to the enclosure process line. The field primary process line shall be anchored to the enclosure angle with U-bolts. Holes for supporting U-bolts shall be field or drilled.
- g) All impulse piping shall be supported rigidly at an interval not exceeding 1.5 meters so as to prevent excessive sag in piping. Process piping shall not be used for supporting impulse piping.
- h) Impulse lines subject to severe sonic pulsations such as boiler feed pump discharge, shall be of sufficient length and of suitable configuration to scatter harmful sonic wave energy before it reaches the instrument.
- i) Impulse piping shall be installed to permit thermal expansion without placing excessive stress on the piping and without affecting the gradient of slope. Long continuous straight runs of piping shall always be avoided. If required, expansion loops shall be provided at least every 2.5 meters to break the continuity.
- j) All welded and screwed fittings shall conform to ANSI B16.11. Threads of piping components shall be taper pipe thread in accordance with ANSI B2.1. All threads shall be clean machine cut with all burrs and chips removed. Lubricants shall be of dry film type. Any one of the following compounds may be used as a pipe thread sealer. Bidder shall supply adequate amount of his preferred sealer for erection purpose.
 - a) Permatex
 - b) Molycote
 - c) Neolube(Teflon tape shall not be used as a pipe thread sealer).

9.01.02 Impulse Piping System

Impulse piping system consists of primary impulse pipes/tubes, valves, fittings, valve manifolds and other accessories between the source connection point (source shut-off valve on wards) and all instruments/devices. Impulse pipe span for supporting clamp shall be 1.5 mtr. This will also include all piping and valves etc. required for instrument drain and vent connections. The Bidder shall furnish and test all items required for completeness of this specification.

9.01.03 AIR SUPPLY PIPING



The piping for air supply shall be as specified below (However the Bidder shall supply the materials as required basis to complete the system in all respect)

i) Individual Supply Lines and Control Signal Lines:-

Air lines shall be ¼ inch size, connected by brass/SS316 flare less tubing fittings. Copper/SS316 tubing shall be light drawn tempered tubing conforming to ASTM B75 except copper tubing in tubing cables shall be annealed soft temper tubing conforming to ASTM B68 or B75. Fittings on the branch line to facilitate connections to the individual supply line shall be cast brass screwed type.

ii) Flexible Hoses:-

Flexible hoses shall be ¼ inch SS flexible hose pipe and with Buna-N liner steel wire braid reinforcement complete with ¼ inch brass/SS316 fittings and shall have swivel male pipe threads. Each hose shall be done meter in length.

iii) Pipe Material Specification:-

The piping material shall be carbon steel hot-dipped galvanized inside and outside as per IS-1239 or the equivalent of these standard heavy quality with screwed ends. The piping threads shall be as per ASA B.2.1.

iv) Isolating Valves:-

Gate valves as per ASTM B62 inside screw rising stem screwed female ends as per ASA B.2.1 valve bonnet shall be union type and trim shall be stainless steel body rating 150 pounds ASA. Valves sizes shall be ½ inch to 2 inch.

v) Fittings:-

Forged cast steel A234 Gr. WPM galvanized inside and outside; screwed as per ASA B2.1 dimensions as per ASA B16.11, rating 2000 pounds, elbows and soft seats. The size of the fittings shall be ½ inch through 2 inch.

vi) Air Filter Regulator Set:-

An instrument Air Filter Regulator Set with mounting assemblies shall be provided for each pneumatic device requiring air supply.

vii) Instrument Air Piping System:-

a) Instrument Air shall be made available by the bidder at 3.5 to 7.0 Kg/cm² pressure. The instrument air may be arranged as under:-

11. For the control valves and power cylinders in owner's scope but controlled by bidder's control system, the instrument air requirement for E/P converter shall be tapped from the nearest instrument air header laid by bidder / already laid existing piping with accessories available near the control valves or damper.



Complete hardware required for interfacing with Owner system shall be in bidder scope.

- b) Air supply piping shall be installed at site always with a slope of over 1/100 to prevent accumulation of condensed water within the pipe.
 - c) All joints in the instrument air sub-header shall be of screwed type.
 - d) Instrument air line shall be separate for each individual instrument, equipment & drive with own isolation valve and other required hardware. Tee off of instrument line for two or more same/similar services instrument, equipment & drive are not acceptable.
 - e) Instrument air flushing/purging lines shall be provided for Bowl Mill DP, secondary air flow measurement instrument and other all flue gas services instruments etc.
- viii) Signal / Control Air Tubing System:-

Necessary tubes with fittings and accessories for output signal from pneumatic instruments mounted in the field and control signals to final control elements shall be covered under this tubing system.

9.02.00 **SPECIFICATION FOR ERECTION HARDWARE**

The erection hardware shall meet the following specifications:-

	<u>Item</u>	<u>Specification</u>
9.02.01	Impulse Piping	
i)	High pressure and high temperature services (Medium: Steam & Water and furnace region)	Seamless Alloy Steel piping to ASTM A335 GR.P91/22 (schedule XXS/160 for high pressure & high temperature)
ii)	Low pressure and low temperature services (Medium: Steam & Water)	Seamless carbon steel piping to STM A106, Gr.C
iii)	Low pressure and low temperature services (Air, Flue gas)	ERW carbon steel piping to IS 1239:1973 Heavy class System)
iv)	Steam and water analysis system	Seamless stainless steel piping to ASTM A312 GR. TP-321
v)	Seamless copper tubing	ASTM B-75



9.02.02 Fittings Double compression type

i)	Material for socket weld fittings	ASTM A105 ASTM A182, Gr. F22 6000/3000 lbs
ii)	Dimensions of fittings	ANSI B16.11
iii)	Fittings for steam and water analysis.	Gr. F-321

9.02.03 Valves

i)	3 – way valves	SS body/forged CS body stellited internals and SW ends as per requirement for 2500 lb/800 lb ASA ratings.
ii)	5- valve manifolds	FAS body/FCS body 316SS stellited internals with NPT(F) SCRD ends for 3000/2500 lb/1500 lb/800 lb ASA ratings. Construction – Single block (Bar stock)
iii)	3-valve manifolds	FAS body/FCS body 316SS stellited internals with NPT(F) SCRD ends for 3000/ 2500 lb/1500 lb/800 lb ASA ratings. Construction – Single block (Bar stock)
iv)	2-valve manifolds	FCS body, 316SS stellited in ternals, NP T(F) S CRD ends. C onstruction – Single bl ock (Bar stock)
v)	Isolation and drain valves	Globe valves with FAS body/FCS body, 316SS stellited internals SW ends for 3000/2500 lb/1500 lb/800 ASA ratings.

9.02.04	Condensation vessels	FAS/FCS body with NPT (F) SCR D connection and vent plugs for 3000/2500/1500/800 lb ASA ratings.

9.02.05	Racks and Associated Equipment	ANSI C83.9-1972

9.02.06	Code for pressure piping, welding and Hydrostatic testing	ANSI B-31.1



- 9.02.07** Flexible conduits with fittings Lead coated, paper insulated, heat resistant flexible metallic conduits with necessary fittings.
- 9.02.08 3 Valve manifold shall be used, wherever Diff Pressure transmitter/switch have been used for pressure measurement.
- 9.02.09 5 Valve manifold shall be used for Diff. Pressure & Flow measurement Transmitters/Switches.
- 9.02.10 In addition to above, table # 9.1 shall also be followed for selection of specific erection hardware as per process requirements.

9.03.00 TRANSMITTER & SWITCHES ENCLOSURES

In general, BTG process transmitters & switches installed at outdoor location and in areas where they are subjected to splashing oil, water, steam etc., shall be mounted in closed type transmitter rack. For other areas (indoor), open type racks may be used for installation of transmitters and process switches. However the actual requirement shall be finalized during detailed Engineering considering following:-

- i) Transmitter/Switches enclosures shall be free standing, enclosed type of ferrous protection against dust, moisture and vermin. Enclosures shall be suitable for outdoor installations, in thermal power plants.
- ii) The enclosures shall comprise of Galvanized Sheet mounting plate internally. Also external-mounting brackets in Polyamide or Stainless Steel shall be available. Alternatively transmitter enclosures can be glass Fiber Reinforced Polyester (GRP) compression moulded and shall be weather proof.
- iii) Instrument piping inside the enclosure shall conform to the specification and in line with typical installation drawings enclosed with the specification.
- iv) Blow down header shall be provided inside the enclosure as called for.
- v) Bulk head connection shall be provided to receive and terminate the impulse pipes from root valves.
- vi) Instrument tubing, fittings and isolation, drain valves shall be to ANSI code for pressure piping. Piping/tubing shall be subject to hydrostatic tests at 1.5 times maximum system pressure.
- vii) Support angles shall be provided for valve manifolds, wiring trays etc. Enclosures shall be complete with necessary bulk head fittings, junction boxes, drain header and other accessories as needed on the basis of approved hook up drawings.
- viii) Sufficient spacing among adjacent transmitters shall be maintained to offer easy accessibility and operational convenience. The enclosure shall be designed with sizes to suit the grouping and to completely include all the hardware for hooking up



the transmitters to the process on the basis of approved installation diagrams. A maximum of five (5) transmitters are envisaged to be grouped in one enclosure.

- x) A minimum of twenty (20) per cent spare terminals shall be provided. Only one wire per terminal shall be used on the outgoing side of these blocks (for cable panel). Any common connections required shall be provided on the panel side of the block. All incoming power terminals are to be clearly identified in a manner distinctly different from all other terminals and grouped in a logical pattern.
- xi) Chapter no. 6 of this volume shall also be referred for designing of Transmitter/Switches enclosures.

9.04.00**LOCAL INSTRUMENTS, LOCAL BOARDS AND TAPPING POINTS**

- i) All local gauges as well as sensors, Transmitters and switches any other instruments for parameters like pressure, temperature, level, flow etc for safe and efficient operation of equipment under the scope of specification, shall be provided by bidder as approved by Owner. Such equipment shall be listed by the Bidder detailing the items with their respective functions in service. All field mounted instruments shall be mounted in such a way as not to be affected by vibration & environmental conditions. Racks to mount these instruments shall be furnished by bidder complete with requisite erection hardware, tubings and junction boxes with all terminals of the instruments duly wired complete with cable glands. Groupings of instruments, actual number of racks for instruments and its construction shall be to Owners approval.
- ii) Transmitters & Switches provided shall be mounted in transmitter/Switches enclosures to owner's approval. The junction box for electrical connections shall be outside the transmitter enclosures.
- iii) All erection hardware required for complete installation/ implementation of entire instrumentation specified is included in bidders scope. Any change in size, type, rating or in quantity deemed necessary during engineering shall be supplied within package price with no additional financial implication to owner.
- iv) Bidders scope includes providing counter flanges on pipe lines/ vessels to suit owner arranged flanged devices. Counter flanges shall be complete with gaskets, nuts, bolts and other requisite accessories for proper installation.
- v) Separate and independent tapping on equipment/associated piping shall be provided to suit the philosophy of redundant primary sensors. Separate sensors for control and monitoring etc are as decided by Owner. This shall include application such as first stage pressure. Wherever the process value being measured needs to be compensated for temp, pressure variations, the tapping points for such compensating elements shall be provided in requisite number along with the tapping for the process value.
- vi) Wherever transmitters & switches are provided, in addition Local gauges shall also be provided by bidder for local field monitoring.



- vii) Local instruments and remote sensors & transmitters to be furnished with the equipment shall generally be as indicated herein and as per redundancy criteria indicated elsewhere but not be limited to the following: -

1. Pressure Measurement

i. **Pressure Gauge** for:

- a) Shell pressures of all Deaerator, HP and LP heaters and other vessels.
- b) Mercury manometers shall be provided during air outlet flows measurement.
- c) Bleed steam pressure at extraction point for all turbine extractions and for pressure on drain lines.
- d) Pressure gauges at inlets and outlets of condensate extraction pumps, main oil pump, each auxiliary oil pump, ACS standby oil pump, DC Emergency oil pump, jacking oil pumps, DM makeup pumps, DMCW pumps, BFP, or any other pumps etc.
Pressure Gauge at outlet of each type of Fan.
- e) Lube oil pressure before and after oil coolers, HPT & IPT front seal chamber leak off pressure.
- f) MS pressure downstream of ESV, after HPT control valves and after HPT first stage, HRH steam pressure after IV, Gland steam header pressure, HPT exhaust etc.
- g) Condensate pressure in condensate pump discharge header, and feed water pressure at inlet and outlet of each LP & HP heaters.
- h) LP turbine exhaust pressure and condenser pressure
- i) Relay/Lube/Control oil pressure, Drain oil lines pressure.
- j) Pressure gauges for vacuum pumps and each pump discharge.
- k) Pressure gauge at Instrument and service air header in compressor room and in the field at the main location of instrument/service air header, the pressure gauges shall be provided.
- l) Pressure gauges at inlet and outlet of each heat exchanger and cooler.
- m) Frame mounted Pressure Gauges (FMG) shall be provided for Main steam Pressure, Feed water pressure to economizer, CRH Steam Pressure, HRH Steam Pressure etc.
- n) For condensate storage tank the pressure gauge in terms of 0-10000 mm wc or suitable range having **dial size of 300 mm or bigger size** shall be provided.
- o) **U tube manometer with Hg filled for direct measurement of condenser vacuum** shall be provided in the fixed with isolation valve for local indications.
- p) Above are the minimum requirements, actual quantities shall be as decided during detailed engineering by owner.
- q) Pressure gauge for all IBOP packages as decided during detailed engineering by owner.

ii. **Pressure Switches**

- a) Pressure switches at condensate Extraction Pump Discharge header, Boiler feed pump, seal water line or any other pumps for alarm (high & low) and interlock purpose.



- b) Pressure switches for steam supply to LP/HP heaters.
- c) Pressure switches for initiation of turning gear.
- d) Pressure switches for control oil, jacking oil and lube oil pressure for all required alarms and interlocks.
- e) Steam pressure downstream of ESV, steam pressure after first stage of HPT, gland steam header pressure and suction line from turbine glands to Gland cooler.
- f) Pressure switches for condenser vacuum low, very low alarms & interlocks.
- g) Condenser water box pressure for alarm interlocks.
- h) Pressure switches (low & high) for individual pumps/blowers suction/discharge and discharge header – alarms, interlocks and protection
- i) At the main location of instrument air header the pressure low switches shall be provided for alarms in DDCMIS
- j) Pressure switches/any other process switch etc. for OLCS / Alarms / Interlocks / Protection. Pressure switches at inlet, outlet of individual pumps and discharge header of pumps for protection and auto start / stop & alarms.
- k) Above are the minimum requirements, actual quantities shall be as decided during detailed engineering as per redundancy criteria by owner.
- l) Pressure switches for all BoP packages as decided during detailed engineering by owner.

iii. **Differential Pressure Transmitters, Diff Pressure Switches & Diff. Pressure Gauges**

- a) Pressure across strainers and filters.
- b) Diff. Pressure Transmitters/switches/Gauges for all BoP packages as decided during detailed engineering by owner.
- c) Diff. Pressure Transmitter across condenser on CW lines, Air pre heaters on air & flue gas lines, on PA lines, CEP suction strainers, Feed control station etc.
- d) Above are the minimum requirements, actual quantities shall be as decided during detailed engineering as per redundancy criteria by owner.

iv. **Pressure Transmitters**

- a) For all services as mentioned for Pressure gauges & Pressure Switches.
- b) Pressure Transmitters at condensate Extraction Pump individual Discharge and discharge header, Boiler feed pump individual Discharge and discharge header, seal water line or any other pumps/fans/HT/LT unidirectional drive for alarm (high & low) and interlock purpose.
- c) Pressure transmitter for wind box (Left/Right) & pulverizer seal air fans discharge pressure.
- d) Pressure Transmitters as on required basis for monitoring, interlocks & controls as per redundancy criteria and approved by owner.
- e) Above are the minimum requirements, actual quantities shall be as decided during detailed engineering as per redundancy criteria and approved by owner.
- f) Pressure Transmitters for all BoP packages as decided during detailed engineering by owner.



2. Temperature Measurements:-

The Bidder shall furnish all temperature sensing elements to be installed in their piping. The scope of supply shall include, but not limited to the following: -

- i) Duplex RTDs for all bearing, drain oil from bearings, LPT exhaust steam, 3 no's of duplex RTDs each on left and right CW outlet of condenser etc.
- ii) 6 no. duplex or 12 no. simplex Embedded temperature detectors for various motor stator windings and duplex RTDs for Motor/Pump bearing temp.
- iii) Chromel-alumel surface/other thermocouples for turbine casings, ESV, IV bodies, superheated steam, hot reheat steam piping, steam of first stage HPT, inlet bowl of IPT, steam exhaust of HPT, down stream of ESV and IV, steam in ESVs and IVs, steam admission pipes metal temperatures, HPC, IPC flange metal temperature etc.
- iv) For all HP heaters remote monitoring with redundant independent sensors of inlet/outlet temperatures of feed water and extraction steam shall be provided in addition to local gauges.
- v) For all LP heaters remote monitoring with redundant independent sensors of inlet/outlet temperatures of feed water and extraction steam shall be provided in addition to local gauges.
- iv) Temperature sensors for HP-LP bypass system for measurement as well as for control.
- v) Adequate number of temperature Elements shall be furnished to provide initiating contacts for temperature interlocking and trip circuits. The temperature elements shall be provided, but not limited to the following: -

Steam temperature of HPT exhaust, steam temperature after ESV (L&R), IV (L&R), LPT exhaust hood steam, drain oil temperature of all journal bearings and thrust bearing & lube oil heater temperatures, thrust bearing of each condensate extraction pump and vacuum pump protection, interlocks.

- vi) Metal Temp measurement and steam temp measurement at each super heater & Reheater location.
- vii) Temp. Element & Temp gauges at Feed water line to economizer inlet, economizer to steam separator, spray water lines to desuperheaters, Soot blower steam, Soot blower steam drain lines, steam drain lines, Flue gas & air lines etc
- viii) Temp. Measurements (Local & remote) for all BOP packages as decided during detailed engineering.
- ix) Thermocouples for Temp. above 200 deg C shall be provided by bidder.
- x) For plate heat exchangers, spare thermowell provision shall be made at inlet & outlet of ACW & DMCW lines in addition to local & remote temperature monitoring points.
- xi) Each ESP Hopper shall be provided with RTDs to control the temperature of ash through Hopper heater.

xii) Temperature gauges.

- a) For bearing temperatures AC and DC lube oil pumps, LPT exhaust hood etc.
- b) For condensate and feed water at inlet and outlet of HP heaters, Vacuum pumps, LP heaters etc.



- c) Steam & water inlet/outlet of LP and HP heaters, steam and air mixture inlet to vacuum pumps, and drain lines etc.
 - d) Journal/thrust bearing drain oil, lube oil at inlet/outlet of oil coolers, cooling water at inlet and outlet of oil coolers etc.
 - e) Thrust bearing of each condensate extraction pump.
 - f) Temp. Gauges at inlet and outlet of each heat exchanger and cooler.
 - g) Frame mounted Temperature Gauges (FMG) shall be provided for Main steam Temperature, Feed water Temperature to economizer, CRH Steam Temperature, HRH Steam Temperature etc
- xiii) Above are the minimum requirements, actual quantities shall be as decided during detailed engineering by owner.

3. Level Measurement

- i) Level gauges - level gauges for boiler separator, HP heaters, LP heaters, deaerator, drain cooler, gland steam cooler, vacuum tanks, condenser hot well CBD tank, storage water tank, Storage water expansion tank and other pressure vessels, main oil tank and all oil tanks in BTG & BOP package. The level gauges shall be mica shielded steel armoured transparent glass type. Level gauges for condenser hot well shall be provided on both sides.
- ii) Level switches for HP/LP heaters, drain cooler, gland steam cooler, condenser hot well, deaerator, main oil tank and other pressure vessels, tanks, sumps etc. The separate switches for high, very high and low levels shall be provided as per interlocks and protection requirements.

External cage mounted magnetic level switches/ displacer type shall be employed for low pressure & low temp. services.

However conductivity type level switches shall be provided for high pressure & high temp services like HP heaters, CRH/HRH drain Pot, Turbine Drains etc.

- iii) Level Transmitters (Type as per Owner approval) for open sump/tank/bunker/vessel/heaters.
- iv) Level measurement for all BoP packages as decided during detailed engineering.
- v) Level switches for OLCS / Alarms / Interlocks / Protection. Level switches for sump/tank level high/normal/ low/very low interlocks.
- vi) Each ESP hopper must be provided with 3 nos. level switch (switches 2 nos. for high level and One no. for low level.)
- vii) Above are the minimum requirements, actual quantities shall be as decided during detailed engineering by owner.

4. Flow Measurements:-

- a) Primary Elements: Flow nozzles shall be used for feed water flow and other critical measurements where weld-in construction is required. Flow nozzles shall be made of stainless steel, with three sets of pressure taps installed in the pipe wall where required. One no. spare set of pressure tap shall also be provided on flow nozzle,



wherever required. Installation of flow nozzles and pressure taps shall be made in the pipe fabricator's shop and shall be witnessed by a representative from the flow nozzle manufacturer.

- b) Paddle type orifice plates shall be used for other flow measurements where flanged construction and higher pressure loss are acceptable. Orifice plates shall be made of stainless steel. Orifice flanges shall be of the raised face weld neck type with dual sets of taps.
- c) Construction and installation of flow nozzles and orifices shall conform to the requirements of ASME Performance Test Code PTC-19.5, and discharge coefficients shall be predicted in accordance with data published in ASME Research Report on Fluid Meters.
- d) Airfoil or venturi flow sections, shall be used for measuring boiler combustion airflow.
- e) A special high accuracy flow nozzle pipe shall be provided to determine feed water flow to the economizer. This nozzle shall be hydraulically calibrated and utilized for feed water flow control and for turbine testing as described in ASME PTC 6 (latest revision).
- f) Orifice plates shall be supplied with carrier rings as per process requirement.
- g) Doppler effect type flow meters shall be used for sludge applications.
- h) For Raw water, water treatment plant and effluent treatment plant, ultrasonic type flow meters to be used.
- i) Secondary Elements: Secondary elements for differential type flow sensors shall be strain gauge or capacitance type differential pressure transmitters. Square root extraction required for the DP transmitters shall be performed electronically in the transmitter itself.
- j) HFO/LDO flow meters shall be based on coriolis mass flow technology. Fuel Oil meters shall be provided for fuel oil unloading system and near boiler after day oil tank (at main supply & return line).
- k) Flow nozzles shall be provided for following services in main plant:-
 - i) Steam flow measurement for BFP Turbines.
 - ii) Feed water flow measurement
 - iii) Auxiliary steam flow measurements
 - iv) HP bypass flow measurements
 - v) BFP suction flow.
 - vi) Deaerator water flow measurement
 - vii) HP heaters drain Flow measurements.

Orifices shall be provided for following services:-

- i) Spray water flow measurement



- ii) Condensate flow measurements
 - iii) DM/hotwell makeup to condenser.
 - iv.) Condensate dump flow to CST
 - v) Gland Steam Condensate flow measurements
- l) For DM water flow & Ash Slurry flows measurements online electromagnetic flow meter shall be used.
- m) At CW & ACW pump discharge headers flow transmitters shall be provided (Non Contact ultrasonic Type are preferable). In addition flow measurement shall also be provided for CW water used any where except condenser service.
- n) Instrument and Service Air - Vortex/Swirl type Flow meter
- o) Flow transmitters for general applications shall be of the differential pressure type
- p) Flow switches for OLCS / Alarms / Interlocks / Protection.
- q) Lubricating oil Flow transmitter/meter with switch shall be provided for Bearing systems of APH, FD, PA, etc.,
- r) Sight glasses flapper indication type shall be provided on lube oil cooling water piping as required to ensure indication of fluid flow.
- s) On line Fuel flow & velocity measurement facility in each Pulverized Fuel (PF) pipe for each coal pulveriser shall be provided by bidder for accurate, absolute and simultaneous measurement of coal velocity, coal density, coal mass flow rate and air-to-fuel ratio. The equipments shall comprise of sensors working on micro wave technology.
- t) In addition to the **conventional triple DP measurement techniques** involving venturi/Airfoil or secondary air flow measurement, One number **Flow measurement** system each on Left side and Right side shall be provided as **redundant/checking measurement for secondary air flow** which could be used in the optimization package.
- On line secondary air flow & velocity measurement facility in each on Left side & right side shall be provided by bidder for accurate, absolute and simultaneous measurement of air velocity & flow rate. The equipments shall comprise of sensors working on tribo-electric (Correlation technique) technology.
- u) Any other flow element/meter required for system shall be finalised as per system requirement and as per approved drawings/documents by owner.

9.05.00

Process Connections

The type of instrument source connection shall depend upon the process parameters and the tapping size. The source connection drawings shall be finalised during the engineering stage.



2 x 660 MW ENnore SEZ Supercritical Thermal Power
Project at Ash Dyke of NCTPS
Spec. No. CE/C/P&E/EE/E/OT.No.03/2013-14

Vol. V /Sheet - 326



Size of tapping point stub, number and size of root valves for different types of measurements are as follows:

Sl. No.	Quantity of root valves	Size of stub and root valve	Service Condition
Pressure and Differential Pressure Measurement			
(i)	2	25NB	≥ 40 bar(g) OR 425°C
(ii)	1	15NB	< 40 bar(g) AND 425°C .
Level Measurement			
(a) Level Gauge & Switch			
(i)	2	25NB	≥ 40 bar(g) OR 425°C
(ii)	1	25NB	< 40 bar(g) AND 425°C
(b) Level transmitter (displacement type)			
(i)	2	40NB	≥ 40 bar(g) OR 425°C
(ii)	1	40NB	< 40 bar(g) AND 425°C
(c) Stand pipe for level measuring instrument			
(i)	2	80 NB	≥ 40 bar(g) OR 425°C
(ii)	1	80 NB	< 40 bar(g) AND 425°C
<i>Flow Measurement</i>			
(i)	2	25NB	≥ 40 bar(g) OR 425°C
(ii)	1	25NB	< 40 bar(g) AND 425°C
<u>Sampling system measurement (Steam and Water Service)</u>			
(i)	2	25 NB	≥ 40 bar(g) OR 425°C
(ii)	1	25 NB	< 40 bar(g) AND 425°C



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-IID

REV 00

SECTION – IID
GENERAL TECHNICAL REQUIREMENT (CIVIL)

1 GENERAL

1.1 Intent of Specification

Contractor shall read the parts of specification relevant to contract and shall ignore other parts of specification. In case of ambiguity between BOQ, Part C and Part D of specification, the following priority for acceptance of items may be followed:

- a) BOQ
- b) Specific technical specification (Part C)
- c) General technical specification (Part D)

1.00.00 CODES AND STANDARDS

Following is a general listing of Codes and Standards to be used in the design of the Plant. Specific applicable codes and standards will be identified in System Design Descriptions / Technical Specifications as appropriate. The latest editions / revision of following codes and standards along with addendums / amendments, if any, shall be followed:

1.01.00 General

- a) Internationally accepted design Codes and Standards where Indian Codes are not available and which are equivalent to Indian Standards.
- b) National Building Code of India.
- c) “Accepted Standards” and “good Practice” listed in the appendix to National Building Code of India.
- d) IS:1200 : Method of measurement of Building and Civil Engineering Works.
- e) IS:1256 : Code of Practice for Building Byelaws.

1.02.00 Earthwork

a)	IS-1498	:	Classification and identification of soils for General Engineering purpose
b)	IS-3764	:	Safety code for excavation work
c)	IS:7293	:	Safety code for working with construction machinery

1.03.00 Concrete

a)	IS-269	:	Ordinary and low heat Portland cement
b)	IS-383	:	Coarse and fine aggregate from natural sources for concrete
c)	IS-432	:	Mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement
d)	IS-455	:	Portland slag cement
e)	IS-456	:	Code of practice for plain and reinforced concrete
f)	IS-460	:	Test Sieves (all parts)
g)	IS-516	:	Methods of test for strength of concrete
h)	IS-1199	:	Methods of sampling and analysis of concrete

i)	IS-1566	:	Hard drawn steel wire fabric for concrete reinforcement
j)	IS-1786	:	High strength deformed steel bars and wires for concrete reinforcement
k)	IS-1834	:	Hot applied sealing compounds for joints in concrete
l)	IS-2386	:	Methods of test for aggregates for concrete (all parts)
m)	IS:2502	:	Code of practice for bending and fixing of bars for concrete reinforcement
n)	IS:3370	:	Code of practice for concrete structures for storage of liquids (all parts)
o)	IS-3414	:	Code of practice for design and installation of joints in buildings
p)	IS-4948	:	Welded steel wire fabrics for general use.
q)	IS-6452	:	High alumina cement for structural use
r)	IS-7320	:	Concrete slump test apparatus
s)	IS-7861	:	Code of practice for extreme weather concreting (all parts)
t)	IS-8041	:	Rapid hardening Portland cement
u)	IS-8112	:	High strength ordinary Portland cement
v)	IS-10262	:	Recommended guidelines for concrete mix design.
w)	IS:13290	:	Ductile detailing of RCC structure subjected to seismic loads
x)	SP:34	:	Handbook on concrete reinforcement and detailing

1.04.00**Foundations**

a)	IS-1904	:	Code of practice for structural safety of building - Shallow foundations
b)	IS-2950	:	Code of practice for design and construction of raft foundations
c)	IS-2974	:	Code of practice for design and construction of Machine foundations (all parts)



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 5



- d) IS-2911 : Code of practice for design and construction of pile foundation.
- e) IS-9716 : Lateral dynamic load test on pile
- f) IS-6313 (Part-1 & Part-2) : Code of Practice for anti-termite measures and treatment.

1.05.00**Loading**

- a) IS-875 : Code of practice for design loads for buildings and structures
- b) IRS : Bridge Rules of Government of India, Ministry of Railways (Railway Board)

1.06.00**Masonry**

- a) IS-712 : Building limes
- b) IS-1077 : Common burnt clay building bricks
- c) IS-1127 : Recommendations for dimensions and workmanship of natural building stones for masonry work.
- d) IS-1528 : Methods of sampling and physical tests for refractory materials
- e) IS-1597 : Code of practice for construction of stone masonry (all parts)
- f) IS-2212 : Code of practice for brickwork
- g) IS-2116 : Sand for masonry mortars
- h) IS-2185 : Concrete masonry units. (all parts – Hollow and Solid concrete blocks)
- i) IS-2250 : Code of practice for preparation and use of masonry mortars
- j) IS:2572 : Code of practice for construction of hollow concrete block masonry
- k) IS-2691 : Burnt clay facing bricks



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 6



- l) IS-3414 : Code of practice for design and installation of joints in buildings
- m) IS-3495 : Methods of tests of burnt clay building bricks
- n) IS-4441 : Code of practice for use of silicate type chemical resistant mortars
- o) IS-4860 : Acid resistant bricks

1.07.00**Doors, Windows & Ventilators**

- a) IS-399 : Classification of commercial timbers and their zonal distribution
- b) IS-883 : Code of practice for design of structural timber in buildings
- c) IS-1003 : Timber paneled and glazed shutters (all parts)
- d) IS-1038 : Steel doors, windows and ventilators
- e) IS-1081 : Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators
- f) IS-1361 : Steel windows for industrial buildings
- g) IS-2835 : Transparent sheet glass for glazing and framing purposes
- h) IS-1948 : Aluminium doors, windows and ventilators
- i) IS-1949 : Aluminium windows for industrial building
- j) IS-2191 : Wooden flush door shutters (cellular and hollow core type)
- k) IS-2202 : Wooden flush door shutters (solid core type)
- l) IS-3103 : Code of practice for industrial ventilation
- m) IS-3548 : Code of practice for glazing in buildings
- n) IS-3614 : Fire check doors
- o) IS-4021 : Timber door, windows and ventilator frames
- p) IS-4351 : Steel door frames
- q) IS-6248 : Metal rolling shutters and rolling grills



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 7



1.08.00**Roof & Flooring**

- a) IS-2204 : Code of practice for construction of reinforced concrete shell roof
- b) IS-3201 : Criteria for the design and construction of precast concrete trusses
- c) IS-2210 : Criteria for design of RC shell structures and folded plates
- d) IS-809 : Rubber flooring materials for general purposes
- e) IS-1195 : Bitumen mastic for flooring
- f) IS-1196 : Code of practice for laying bitumen mastic flooring
- g) IS-1198 : Code of practice for laying, fixing and maintenance of linoleum floors
- h) IS-1237 : Cement concrete flooring tiles
- i) IS-1443 : Code of practice for laying and finishing of cement concrete flooring tiles
- j) IS-2114 : Code of practice for laying in situ terrazzo floor finish
- k) IS-2571 : Code of practice for laying in situ cement concrete flooring
- l) IS-5491 : Code of practice for laying in situ granolithic concrete floor topping
- m) IS-5766 : Code of practice for laying burnt clay brick flooring
- n) IS-1197 : Code of practice for laying of rubber floors
- o) IS:2441 : Code of practice for fixing ceiling coverings.

1.09.00**Waterproofing**

- a) IS-1322 : Bitumen felts for waterproofing and damp proofing
- b) IS-1346 : Code of practice for waterproofing of roofs with bitumen felts



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 8



- c) IS-1609 : Code of practice for laying damp proof treatment using bituminous felts.
- d) IS-3036 : Code of practice for laying lime concrete for a water proofed roof finish
- e) IS-3037 : Bitumen mastic for use in waterproofing of roofs.
- f) IS-3067 : Code of practice for general design, details and preparatory work for damp proofing and water proofing of buildings
- g) IS-3384 : Bitumen primer for use in water proofing and damp proofing
- h) IS-4365 : Code of practice for application of bitumen mastic for waterproofing of roofs.

1.10.00**Soil Engineering**

- a) IS-1498 : Classification and identification of soils for general engineering purposes
- b) IS-1892 : Code of practice for sub-structure investigation for foundations
- c) IS-2131 : Method for standard penetration test for soils
- d) IS-2720 : Methods of test for soils (all parts)

1.11.00**Water Supply, Drainage & Sewerage**

- a) IS-404 : Lead pipes
- b) IS-458 : Concrete pipes
- c) IS:651 : Salt glazed stoneware pipes and fittings
- d) IS-771 : Glazed fire-clay sanitary appliances (all parts)
- e) IS-774 : Flushing cisterns for water closets and urinals other than plastic cisterns
- f) IS-783 : Code of practice for laying of concrete pipes
- g) IS-1172 : Code of basic requirements for water supply, drainage and sanitation
- h) IS-1626 : Asbestos cement building pipes, gutters and fittings (all parts)



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 9



i)	IS-1742	:	Code of practice for building drainage
j)	IS-2064	:	Code of practice for selection, installation and maintenance of sanitary appliances
k)	IS-2065	:	Code of practice for water supply in buildings
l)	IS-2470	:	Code of practice for installation of septic tanks (all parts)
m)	IS-3114	:	Code of practice for laying of cast iron pipes
n)	IS-4127	:	Code of practice for laying of glazed stoneware pipes
o)	IS-12251	:	Code of practice for drainage of building basement
p)	IS-1200	:	Method of measurement : Laying of water and (Part-XVI) sewer lines including appurtenant items
q)	IS-1536	:	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage
r)	IS-1537	:	Vertically cast iron pressure pipe for water, gas and sewage
s)	IS-3486	:	Cast iron spigot and socket drain pipes
t)	IS-5329	:	Code of practice for sanitary pipe work above ground for buildings
u)	IS-3076	:	Low density polyethylene pipes for potable water supplies
v)	IS-1538	:	Cast iron fittings for pressure pipes for potable water supplies
w)	IS-1230	:	Cast iron rainwater pipes and fittings
x)	IS-1729	:	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories
y)	IS-784	:	Pre-stressed concrete pipes
z)	IS-1726	:	Cast iron manhole covers and frames
aa)	IS-5961	:	Cast iron grating for drainage purposes
bb)	IS-5219 [Part-I]	:	“P” and “S” traps
cc)	IS-772	:	General requirements for enameled cast iron sanitary



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 10



appliances

- dd) IS-775 : Cast iron brackets and supports for wash basins and sinks
- ee) IS-777 : Glazed earthenware wall tiles
- ff) IS-2548 : Plastic water closet seats and covers (all parts)
- gg) IS-2527 : Code of practice for fixing rainwater gutters and down pipes for roof drainage.

1.12.00 Paving & Road Works

- a) IS-73 : Paving bitumen
- b) IS-702 : Industrial bitumen
- c) IS:1201 : Method of testing tar and bituminous materials thru' 1220
- d) IRC-15 : Standard Specification and code of practice for construction of concrete roads.
- e) IRC-58 : Guidelines for the design of plain jointed rigid pavement for highways
- f) IRC-58 : Guidelines on cement fly ash concrete for rigid pavement.

1.13.00 Earthquake Resistant Design

- a) IS-1893 : Criteria for earthquake resistant design of structures
- b) IS-4326 : Code of practice for earthquake resistant design and construction of buildings

1.14.00 Chimney

- a) IS-4998 : Criteria for design of R.C. Chimneys (all parts)

1.15.00 Structural Steel Work

- a) IS-800 : Code of practice for general construction in steel
- b) IS-802 : Code of practice for use of structural steel in overhead transmission line

Part-I: Load and permissible stresses



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 11



Part-II: Fabrication, galvanizing, inspection and packing.

c)	IS-806	:	Code of practice for use of steel tubes in general building construction
d)	IS-808	:	Rolled steel beams, channels and angle sections
e)	IS-813	:	Scheme for symbols for welding
f)	IS-814	:	Covered electrodes for manual metal arc welding for carbon and carbon manganese steel
g)	IS-816	:	Code of practice for use of metal arc welding for general construction in mild steel
h)	IS-817	:	Code of practice for training and testing of metal arc welders
i)	IS-818	:	Code of practice for safety and health requirements in electric and gas welding and cutting operation
j)	IS-819	:	Code of practice for resistance spot welding for light assemblies in mild steel
k)	IS-919	:	Recommendations for limits and fits for engineering.
l)	IS-1024	:	Code of practice for use of welding in bridges and structures subjected to dynamic loading
m)	IS-1161	:	Steel tubes for structural purposes
n)	IS-1182	:	Recommended practice for radiographic examination of fusion welded butt joints in steel plates
o)	IS-1200 [Part-VIII]	:	Method of measurement of steelwork and iron work
p)	IS-1239	:	Mild steel tubes, tubulars and other wrought steel fittings (all parts)
q)	IS-1363	:	Black hexagonal bolts, nuts and locknuts (dia. 6 to 39 mm) and black hexagon screws (dia. 6 to 24 mm) [all parts].
r)	IS-1364	:	Precision and semi-precision hexagon bolts, screws, nuts and locknuts (dia. range 6 to 39 mm) [all parts]
s)	IS-1365	:	Slotted counter sunk head screws (dia range 1.6 to 20 mm)
t)	IS-1367	:	Technical supply conditions for threaded steel



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 12



			fasteners
u)	IS-1443	:	Code of practice for laying and finishing of cement concrete flooring tiles.
v)	IS-1608	:	Methods of tensile testing of steel products
w)	IS-1730	:	Dimensions for steel plate, sheet and strip for structural and general engineering purpose
x)	IS-1731	:	Dimensions for steel flats for structural and general engineering purposes
y)	IS-1852	:	Rolling and cutting tolerances for hot rolled steel products
z)	IS-1977	:	Structural steel (ordinary quality)
aa)	IS-2016	:	Plain washers
bb)	IS-2062	:	Steel for general structural purposes
cc)	IS-2074	:	Ready mixed paint, air drying, red oxide zinc-chrome, priming
dd)	IS-2633	:	Methods of testing uniformity of coating of zinc coated articles.
ee)	IS-3613	:	Acceptance test for wire-flux combinations for submerged arc welding of structural steel
ff)	IS-3664	:	Code of practice for ultrasonic pulse echo testing by contact and immersions methods
gg)	IS-3757	:	High strength structural bolts
hh)	IS-4000	:	High strength bolts in steel structures
ii)	IS-4759	:	Hot dip zinc coatings on structural steel and other allied products
jj)	IS-5334	:	Code of practice for magnetic particle flaw detection of welds
kk)	IS-7215	:	Tolerances for fabrication of steel structures
ll)	IS-7280	:	Base-wire electrodes for submerged arc welding of structural steel
mm)	IS-7318 [Part-I]	:	Approval test for welders when welding procedure approval is not required.



- nn) IS-8500 : Structural steel – micro-alloyed (medium and high strength qualities)
- oo) IS-9595 : Recommendation for metal arc welding of carbon and carbon manganese steel
- pp) AWS D.1.1 : Structural welding code.

1.16.00**Painting**

- a) IS-348 : Specification for French polish
- b) IS-427 : Specification for distemper, dry colour as required
- c) IS-428 : Specification for distemper, oil emulsion, colour as required
- d) IS-1477 (I & II) : Code of practice for painting of ferrous metal in buildings
- e) IS-2338 (I & II) : Code of practice for finishing of wood and wood based materials
- f) IS-2339 : Specification for Aluminium Paints for general purposes in dual containers
- g) IS-2395 : Code of practice for painting concrete, masonry and plaster surface
- h) IS-2932 : Specification for enamel, synthetic, exterior - (a) undercoating, (b) finishing
- i) IS-2933 : Specification for enamel, exterior – (a) undercoating, (b) finishing.
- j) IS-5410 : Specification for cement paint.

1.17.00

- a) Indian Road Congress (IRC) Bridge codes
- b) Indian Railways Standard Bridge Rules

1.18.00**Environmental Protection**

Charter on Corporate Responsibility for Environmental Protection (CREP) published in Gazette of India dated 27.08.2003.

1.19.00

Rules & Regulation of Local Authorities

1.20.00

Statutory Regulations of Tariff Regulation Commission (TAC)



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 14



2.00.00 SCOPE OF CIVIL & STRUCTURAL WORKS

2.01.00 This specification is to cover design, preparation of general arrangement, construction as well as fabrication drawings, supply of all labour as well as materials and construction of all civil, structural as well as architectural work on EPC basis.

2.02.00 The work to be performed under this specification consist of design, engineering as well as providing all labour, materials, consumables, equipment, temporary works, temporary labour, constructional plant, fuel supply, transportation and all incidental items not shown or specified but reasonably implied or necessary for the completion and proper functioning of the plant, all in strict accordance with the specifications and including revisions and amendments thereto as may be required during the execution of the work.

2.03.00 All materials including cement, reinforcement steel, structural steel etc. shall be arranged by the Contractor.

2.04.00 The scope shall also including setting up by the Contractor a complete testing laboratory in the field to carry out all relevant tests as per BIS or other international standards required for the civil works for the project.

2.05.00 The work shall be carried out according to the design/drawings to be developed by the Contractor and approved by the Purchaser. For all building and structures, foundations, etc. necessary layout and details are to be developed by the Contractor keeping in view the statutory & functional requirements of the plant & facilities and providing enough space & access for operation, use & maintenance. Certain minimum requirements are indicated in this specification for guidance purpose only. However, the Contractor's offer shall cover the complete requirements of the plant & facilities and providing enough space & access for operation, use & maintenance. Also the Contractor's offer shall cover the complete requirements as per the best prevailing practices and to the complete satisfaction of the Purchaser.

2.06.00 Description of various items of work under this specification and nature of work in detail are given hereinafter, but not limited to the items listed below. The complete work under this scope is referred to as CIVIL WORKS. List of various civil works covered under the scope is given below:

1. Turbine building foundation including Turbo-generator foundation and superstructure including service and maintenance bays.
2. Switch Gear and Control Room including Compressor house, D.G. set room and Co2 room.
3. Steam Generator Elevator supporting structure.
4. Foundation for steam generator / ESP / duct supporting structure & other equipments.
5. ESP control room.
6. Mill and bunker building including bunker structures & Mill Foundations.
7. Steel Mill reject silo and foundations to be provided for the same.



8. Foundations for various fans and fan handling system.
9. RCC chimney of 275m height with twin flues.
10. Ash pipe supporting structure both for bottom ash and fly ash (100% dry collection) from plant area upto RCC silo & wet fly ash slurry pipe & supports from silo to ash dyke.
11. Ash / mill reject handling system structures.
12. Fly ash silos.
13. Ash slurry pump house & ash compression house.
14. Buffer hopper tower.
15. Ash handling electrical/ Control room.
16. Intake pump house & channel near existing cooling water forebay of NCTPS-stage II with modification of existing forebay at intake point.
17. Pipe line to carry water from proposed pump house near existing forebay of NCTPS-stage II to proposed power plant area. Pipe line will be supported on RCC piers.
18. Cooling water (CW) pump house, sump including forebay, CW inlet and outlet conduits.
19. Cascade aerator, partial flume, clarifier, reject sump, RO Plant stage –I, RO stage-II, Permeate storage tank, Pump house.
20. RCC CW ducts from CW pump house to Turbine building, Turbine building to cooling tower and RCC channel from cooling tower to CW pump house forebay.
21. Natural draft cooling tower including basin and other apparatus.
22. Service water overhead tank, DM water storage tank, potable water tank, Condensate storage tank & Condensate polishing unit. Capacity to be provided for overhead water tank shall be 500m³ as per mechanical requirement whichever is higher.
23. Filtered Water Pumphouse/ fire water pumphouse & Filtered water reservoir/ fire water storage tank.
24. Clarified water storage tank and pump house.
25. Dual Media filters.
26. DM Plant – Eye washer & whole body shower shall be provided in DM plant area for emergency. Also a building for testing lab for coal, water, chemicals etc., in DM plant should be provided.
27. Electrochlorination Building.



28. Chemical house and bulk chemical area.
29. Neutralization pit, effluent treatment plant & sewage treatment plant.
30. **Rain water harvesting pond earthen construction.**
31. Guard pond and pump house.
32. Foundation of various water pumps.
33. Fuel oil tank (2x3000 KL) Foundation, Fuel oil pump house, fuel oil storage tank dyke area.
34. **External Coal Handling System from JTB-3** upto western side NCTPS Stage I compound wall and pipe conveyors from NCTPS Stage I to plant area with trestles and necessary transfer points.
 From JTB-3 to TH1 -open belt conveyor with all sides completely covered as indicated in layout of ICHP drawing.
 From TH1 to crusher house -pipe conveyor shall be proved by EPC contractor.
 All civil works including foundation for above items is in the scope of EPC contractor.
 - a) Rails complete with fixing accessories for stacker / reclaimer machines and travelling trippers.
 - b) Crusher house and CHP control room.
35. **IN-Plant Coal Handling System:-** Junction towers (underground and above ground) in plant area, trestles and coal Conveyor galleries, cable galleries, stacker reclaimer, emergency reclaim hoppers with RCC water tight pit, underground tunnels, coal stockyard, coal run off pit, dust suppression / extraction and ventilation system, switchgear room, pump houses, cable trays, cable supports, underground cable trenches with cover, monorails, beams for hoists etc.
36. Switchyard control building and all works for GIS switchyard.
37. Transformer yard structures including rail track foundation for transformer.
38. Transformer Maintenance Building, Mill & Boiler Maintenance Building & FGD provisions.
39. **Auxiliaries buildings**
 - Service building.
 - Administrative building
 - Air washer building and Plant air compressor building.
 - Hydrogen generation plant (H₂ Plant)
 - Workshop



- Canteen building
- Dozer shed and repair shed
- Fire station
- DG House
- Bank extension counter with ATM and Post office **200sqm**
- Field maintenance building – 3 no.(20 x 10 m²) - **RCC Buildings**
- Main gate and Time office cum security complex with two no. of dormitory (100 m² each) with toilet and change rooms for security persons in the first floor. Steel building shall be provided for CW Pump House,

Workshop (Excluding Stores and Office area), D.M Plant, Parking sheds. The Structural Steel shall be confirm to IS 2062. The side wall shall be brick cladding for a height of 1.0m above that color coated galvalume sheets of minimum thickness not less than 0.6mm shall be provided. The roof shall be covered with same sheet of adequate thickness to suit the design requirement. Transparent / Translucent sheet may be used to permit natural lighting. Sufficient number of roof extractor shall be provided for effective ventilation. Aluminum glazed windows shall be provided for natural ventilation and lighting.

All other civil items not covered above but required for completion and proper functioning of plant shall form part of scope.

40. Trenches, tunnels, channels, duct banks etc.
41. Structural steel pipe rack and cable racks for pipes and cables for clarified water, D.M. Water, steam pipes, fuel oil pipes and other areas(if required). with walkways.
42. RCC paving from Transformer Yard to chimney including Boiler area.
43. Parking sheds for four wheelers and two wheelers
 - a) Car park – Partly covered parking – total parking area 3000 Sq.M.
 - b) Covered car parking with roof only and sides open shall be provided adjacent to the administrative building for minimum 20 Cars.
 - c) Parking area indicated are net areas only (i.e.) excluding ramp, etc.
 - d) Scooter and Cycle shed shall be provided with roof cover only.(Area 1250 Sq.M).
44. RCC storm water drainage system for the entire plant.
 - a) Site shall be graded upto **+9.5m** level with available material from existing bund and the balance depth i.e up to +10.00m (+ 10.00m corresponds to RL +



10.00m) shall be filled with approved good quality murrum / gravel (Gravel Blanketing).

Site shall be graded upto **+9.2m** level by the OWNER. The EPC contractor has to carry out site grading work for the entire plant from **+9.2m** level to +9.50 m level with approved quality of murrum/gravel. The finished floor level of Plant shall be +10.00m elevation.

45. Dispensary and first aid centre. **150sqm**
46. Service water system / make up water pipelines.
47. Rain Water Harvesting for all buildings. All roofs tops shall have RWH with filter arrangement. Filtered water shall be pumped to Raw Water Reservoir for its utilization.

Rain Water Harvesting should be implemented as per the scheme / design approved, Central ground water Authority / Board or State ground water authority or MoEF authorized agency shall be consulted for finalization of appropriate rain water harvesting technology. The necessary consultancy charges for the above agency for preparing rain water Harvesting method / scheme for the project to be borne by the Bidder.

48. Site illumination work.
49. All the civil works related to arrangement for lifting of stator.
50. Clearing and removing the buried items if any in the whole proposed plant area and the same is to be deposited to the NCTPS existing stores.
51. The contractor has to fill or excavate the areas to the required formation levels as indicated in the plot plan.
52. 30 metre high lighting towers shall be provided in Coal yard area and Switchyard area.
53. Road Weigh Bridge and Control Room
These shall be RCC framed structure with RCC roof and brick cladding. Adequate windows shall be provided for ventilation & lighting. Roof shall be given liquid membrane water proofing treatment. Flush welded steel doors shall be provided for personnel movement. Toilet facilities shall be provided.
54. All underground structures such as basement, sump etc. and water retaining structures shall be water proofed as per specification.
55. For under deck insulation, Fire Resistant Under deck insulation such as Lloyd foam or equivalent PUF may considered with suitable specification.
56. Modular furniture of approved make and model with electrical wiring and network cabling shall be provided in all office/operating personnel rooms/conference hall as per owner's requirements.
57. All the building shall have one dining room of owner's requirement.
58. Necessary lift/elevators for the buildings as per standard code shall also be provided by EPC contractor apart from the specifically mentioned lifts/ elevators.
59. Outfall structure- CT blowdown water, RO stage-II reject shall be let out into the seal well of stage-I. Necessary repair work required in seal well of stage-I shall be carried out by EPC contractor.



61. The Work also Includes:

- (a) Site surveying.
- (b) Soil investigation and preparation of soil investigation report and suggestion of type of foundations including design of piles.
- (c) Implementation of ground improvement techniques and post improvement evaluation of sub surface properties up to 15.0 m below the existing Ground level.
- (d) Preparation of Architectural drawings.
- (e) Design, preparation of drawings and construction of all structures.
- (f) Preparation of as built drawings of all structures and facilities to reflect as built status of construction.
- (g) Submission of as built drawings in Autocad in CDs.
- (h) Plumbing & sanitary works.
- (i) Painting.
- (j) Anti-termite and anti-weed treatment in all areas / buildings as per IS: 6313. (Anti-weed treatment for Switchyard area)
- (k) All temporary roads and approach roads necessary for construction purpose shall be of WBM for a minimum width of 4m. All permanent min roads inside the plant, cross road to auxiliary buildings and inspection road around compound wall will be provided by bidder.
- (l) Green belt development-30% of total plant area shall be developed as green belt by the EPC contractor
- (m) Internal compound wall required based on plot plan and layout. External compound wall is in the scope of bidder. Compound wall shall be provided all around the plant boundary. The wall will be 230 thick brick infill/Rcc slab of suitable thickness. Height of wall will be 4.50 m above FGL. Over the 4.5 m high wall 1 m high of 8 string barbed wire of 6 guage with 8 strands and with anti climbing arrangement of 50x50x8 Y shaped angles placed at 2.5 c/c shall be provided.

It is not the intent to specify herein all the works in the scope of this contract. All other buildings, structures and works that are necessary which are not specifically mentioned here but required for construction, operation and maintenance of the power plant or mentioned elsewhere in the specification are deemed to be included in the scope of the Contractor.

In the event of conflict between requirement of any two clauses of this specification, or different codes / standards, the more stringent requirement as per the interpretation of Owner is to be followed by EPC contractor.

All works shall conform to the specification. The works shall conform to high standards of design, engineering and workmanship. Design and construction shall conform in every respect to all local and state regulations governing such works and to stipulations of Indian Standards unless stipulated otherwise in detail specification.



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 20



General

It is preferable to adopt Pre fabricated / Pre Engineering structures for CW Pump House, Fire Water Pump House, Workshop (Excluding Stores and Office area), D.M Plant, Parking sheds.

2.07.00

Protection of existing utilities and services

During construction, the contractor shall provide all protection for existing utilities and services as may be required by his construction operations. Permanent protection of certain items shall be as included under other sections or as instructed by the Owner.

In addition to the requirements as specified, herein the contractor shall comply with the following requirements:-

- a) Use all necessary precautionary and protective measures required to maintain existing utilities, services and appurtenances that must be kept in operation. In particular, the contractor shall take adequate measures to prevent undermining of utilities and services presently in services.
- b) Protect existing or new utilities and services where required by the contractor's operations and/or as directed by the Owner. The contractor shall be responsible for bracing and supporting utilities and services to prevent settlement, displacement or damage.
- c) If any existing structure such as Pipe line, Road drain, Culvert, Towers, Light Posts, Underground Structures, Buildings, Tanks, Rail line etc are damaged during execution of project, same shall be reconstructed by EPC Contractor at his own cost at locations wherever approved by owner.



3.00.00 INSTRUCTION TO BIDDERS**3.01.00 Data to be furnished by Bidder at the time of Bid**

3.01.01 A write-up on survey to be undertaken indicating grid, intervals for taking spot levels, contour intervals, precision of surveying instruments proposed to be used, drawings that will be prepared, details to be covered by survey etc.

3.01.02 Detail general arrangements / architectural drawings of all buildings and structures showing dimensions, levels, plans, sections, elevations, loadings, materials proposed, types of framings, wall / cladding, floors, roofs, types of finishes etc.

3.01.03 Detail design criteria proposed to be adopted for each building, structures, foundations, facilities etc.

3.01.04 A write-up with schematic drawings of cooling water (CW) system indicating size and details of cooling tower, CW conduits, channels and forebay along with method of construction etc.

3.01.05 Organisation chart with no of Engineers to be furnished by EPC Contractor.

3.01.06 A write up on size and construction details of 275m high RCC chimney with steel twin flue and along with appurtenances shall be furnished.

3.01.07 Details of thermal insulation for ceiling and detail of false ceiling assumed with manufactures catalogue and areas where they propose.

3.01.08 All deviations from bid document shall be furnished by the Bidder.

3.01.09 List of equipment to be deployed and rates of labour assumed by the bidder and by other sub-contractors to be associated with him-in is to be furnished.

3.01.10 List of softwares proposed to be used against various areas for analysis, design, drafting and project monitoring along with their source and validation report for the softwares.

3.01.11 The list of documents indicated elsewhere of this section to be submitted by the contractor to the Owner for his approval and manner in which the same need to be submitted. No construction shall commence at site without obtaining approval from the Owner on these documents. Therefore, it is necessary that bar charts for buildings / structures / area wise shall be submitted for design / drawing activity indicating.

- a) A Level-1 pert chart showing the starting and completion date of all civil construction activities.
- b) A Level-2 pert chart showing the time required for preparation of design criteria, for approval of design criteria by Owner, time required for detailed design and drawing preparation and time required for approval of design and drawing by Owner. This part shall taken into account the construction schedule (Level – 1 part).



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 22



- c) A Level-3 pert chart for all civil works shall be submitted to Owner for monitoring of progress of works at site.

- 3.01.12** A detail note on quality plan both for design and construction activity proposed to be adopted for obtaining quality works.
- 3.01.13** List of all sub-contractors/Consultants/Architects that the bidder proposes to employ, in case the contract is awarded to him, indicating their addresses with telephone number, experience on similar jobs, name, qualification and experience of persons who shall be involved in the job on behalf of the contractor etc. shall be submitted to Owner. Only the sub-contractor approved by Owner shall be engaged by the contractor on the job.
- 3.01.14** Write-up on proposed storm water drainage system furnishing layout of the drains, types of drains and suggested disposal system.
- 3.01.15** A write-up on dewatering system proposed at the time of construction where deep construction such as for reclaim hoppers pit/track hopper pit, conveyor tunnels, CW forebay and pump house etc. are to be executed.
- 3.01.16** Tentative plot plan showing location of all buildings, structures, roads, site office, storage etc. with plan dimensions.
- 3.02.00** **Inspection of Site by Bidder**
- 3.02.01** Bidder shall inspect the site, examine and obtain all information required and satisfy himself regarding matters and things such as access to site, communications, transport, right of way, the type and number of equipment and facilities required for the work, availability of local labour, materials and their rates, local working conditions, weather, sub-soil conditions, natural drainage etc. Ignorance of the site conditions shall not be accepted by the Owner as basis for any claim for compensation or extension of time.
- 3.02.02** The submission of a bid by the Bidder will be considered as an evidence that such an examination was made and any later claims / disputes in regards to rates quoted shall not be entertained or considered by the Owner.
- The contractor shall organize his own arrangement to transport his equipment, men and materials so as to match the construction schedule.
- 3.03.00** **Construction Tools & Materials Supplied by Contractor**
- 3.03.01** Contractor shall provide and maintain at the site necessary number and type of machinery and equipment including survey instruments in good working condition for proper setting out and timely completion of the various works cover under this specification. All arrangements for transporting the equipment to and from the site shall be done by the Contractor at his own expenses. No claim shall be entertained for mobilizing additional equipment and/or personnel to complete the work within the stipulated time.
- 3.03.02** Contractor shall provide all fuels and lubricants required for the operation and maintenance of construction machinery and equipment as well as his transport vehicles at his own cost.



- 3.03.03** The contractor shall ensure that the work shall proceed uninterrupted even in the event of power failure. As such, adequate number of diesel operated equipment shall be provided by the contractor at his own cost as an alternative arrangement, in case electrically operated equipment are proposed to be brought to site.
- 3.03.04** The contractor shall maintain sufficient stock of material so that there is no interruption of works at any point of time during the contract period & extended period if any.
- 3.03.05** All materials supplied by the contractor shall be original, new and of the best quality and shall conform to the given specifications. Approval in writing shall be obtained from the Owner before any alternative or equivalent material is used other than what is specifically mentioned in the drawings.
- 3.03.06** Contractor shall furnish manufacturer's test certificate for all the manufactured items supplied by him. Representative specimens of the material shall also be submitted to the Owner and shall be tested at a recognized testing laboratory at Contractor's cost in case Owner so desire.
- 3.03.07** The Owner reserves the right to test any construction material supplied by the Contractor in an established testing laboratory at Contractor's cost and to instruct the Contractor to remove all materials, which do not meet the specification requirements.
- 3.03.08** EPC Contractor to arrange third party quality inspection & audit of all construction material at site.
- 3.03.09** Contractor has to set-up a testing laboratory equipped with the following minimum apparatus, materials and competent trained staff required for carrying out field tests:
- Slump cone apparatus to measure slump.
 - Concrete cube testing machine with adequate number of moulds of (15cmx15cmx15cm) to measure compressive strength of concrete.
 - Vicat apparatus to find initial and final setting time of cement.
 - IS sieves with vibrating machine to determine fineness modulus of coarse and fine aggregate.
 - Abrasion & impact testing equipment for testing coarse aggregate and apparatus to determine flakiness index of aggregates.
 - Complete apparatus for the test of air content of concrete by pressure method as per IS:1199.
 - Density bottle to determine sand bulkage.
 - Hydrometer for testing pH value of water
 - Thermometer for checking temperature



- j) Apparatus for measuring proctor density, water content of compacted soil determining CBR values.
- k) All apparatus for determining dry density and water content of sand/soil and aggregates. Any other equipment felt appropriate by the Owner for measurement of paint thickness, testing of structural members, welding etc. The testing machines shall be recalibrated periodically and as directed by Owner to detect errors. The moulds for cubes shall be checked frequently and made to conform to specifications contained in IS-516.

3.04.00 Work Execution and Supervision

- 3.04.01** Contractor shall have at the site accredited and qualified engineers and foremen / supervisors with adequate number of years of experience in execution of similar works and also operators of machinery and equipment, for satisfactory progress and timely completion of the work.
- 3.04.02** Contractor's Engineer-in-charge of the work at site shall be capable of interpreting the specification and drawings and make adequate site decisions as and when required. He shall also take instructions from the Owner and be responsible for carrying out the instructions.
- 3.04.03** Contractor shall be fully responsible for the correctness and accuracy of the tests performed, results obtained / tabulated, interpretation of test results and recommendations made. The work shall be executed in a professional manner, with fully understanding of the importance of work for a project of this magnitude.
- 3.04.04** In the event of occurrence of any accidents at / near the site of the work or in connection with execution of the work, a report shall be made immediately to the Owner, giving full details of the accidents. He shall also report such accidents to all the competent authorities wherever such reports are required by them.
- 3.04.05** All temporary electrical installation shall be supervised by a qualified electrical supervisor of the Contractor.
- 3.04.06** Owner reserves the right to order in writing, from time to time, during the progress of the work, removal and re-execution of any work which in the opinion of the Owner, is not in accordance with the specification.
- 3.04.07** During inclement weather, rains etc. contractor shall suspend all works for such time as the Owner may direct and shall protect from damage all works already in progress or completed just then. All such temporary protective measures shall be at contractor's cost and any damage to works shall be made good by the contractor at his own expense.
- 3.04.08** Should the work be suspended by reasons of strikes / riots by Contractor's own employees or any other causes whatsoever save and except the force majeure condition, Contractor shall take all precautions necessary for the protection of works and make good, at his own expenses, any damage arising from any of these causes.
- 3.04.09** During the course of contractor's works, other works either by the Owner or by the Contractors or by both simultaneously will be in progress within the project area.



Contractor shall make his best effort to work in harmony with others in the best overall interest of the project and towards its speedy completion.

3.04.10

The Contractor shall be responsible for maintaining cleanliness of the site. The site shall be free of unwanted rubbish or filth, which is hazardous & detrimental to health, and affect safety of the work place. Proper watering to be done for dust suppression.

3.04.11

All material supplied shall conform to the specification. Entry of unwanted materials shall be prohibited.



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 26



4.00.00**SUBMISSION**

The following documents are to be submitted for the approval of the OWNER, prior to commencement of fabrication & erection / construction. All drawings shall be of standard sizes (metric system) and shall be made on AUTOCAD. Software used for design shall be validated and established ones like STAAD Pro, NISA, and ANSYS. Hard and soft copies of all the drawings / document shall be submitted to the OWNER. The following list is not exhaustive but indicative only.

- 1) The analysis of TG building, Mill building, ESP control room, Chlorination building, Switchyard control building, CW pump house, Raw water pump house, Ash water pump houses and Service building are to be done by developing 3D mathematical model adopting response spectra method of analysis as per IS: 1893-2002 & 2005, in addition to wind load analysis as per IS: 875 Part-3.
- 2) Preparation of design drawings with maximum detailing possible and developing all possible connection / joint details for all the buildings within the scope of civil / structural works.
- 3) General plant layout drawing with coordinates of roads, boundary wall and facilities, piping / cable corridors, pipe and cable trestles, provision of landscaping and green belt development, diversion roads and drains, equipment lay down areas etc.
- 4) Drawing showing underground facilities with coordinates like buried pipes, buried cables, trenches, ducts, sewer, drains, sumps pits, culverts, foundations etc.
- 5) Soil investigation report based on additional geo-technical investigation carried out by CONTRACTOR along with foundation recommendation for various buildings / structures / facilities.
- 6) Site Grading and storm water drainage study furnishing levels of various terraces arrangement and details of drains, culverts etc for storm water drainage system.
- 7) Study note on disposal of sewage and other effluent from the plant to satisfy the statutory requirement.
- 8) Design basis memorandum for all buildings, facilities, services and structures.
- 9) Drawing showing loading data at various levels for all buildings and structures.
- 10) Architectural floor plans, elevations, cross sections and perspective view in colour scheme of all buildings. For main plant building CONTRACTOR shall submit two different schemes along with a report elaborating the underlying philosophy of the proposed architectural concepts.
- 11) Design calculations and drawings for foundations / substructure and superstructure of all buildings including pump houses and other structures.



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 27



- 12) Design calculations including dynamic analysis and drawings for all foundations subjected to dynamic loads like foundations for TG, BFP, Mill, Fans (PA, FD, ID), Crushers etc.
- 13) Design calculations and drawings for all facilities and services like roads, culverts, bridges, pavings, road / rail crossings, drainage pump house (if required), drains, sewers, sewage pump house, sewage treatment plant, water supply, water tank, sumps, tunnels, trenches, ducts etc.
The contractor shall resubmit the design document and drawings within a maximum period of 3week from the date of receipt of comments by the contractor. Timely submission of design/drawings to the owner for review/approval is the sole responsibility of the contractor and postal or other delays as reasons for late/non submission shall not be entertained by the owner.
- 14) Drawings of all architectural works including finishing schedule, colour schemes (both internal and external), doors & windows, flooring and false ceiling shall be submitted by EPC Contractor to owner along with or before releasing of construction drawings.
- 15) Design calculations and drawings for plumbing and building drainage.
- 16) Design calculations and drawings for switchyard structures, transformer yard, etc.
- 17) Design calculations and drawings for structures pertaining to condenser Cooling water system.
- 18) Design calculation and drawings / document for the sea water system structures is covered within the scope of the Contractor.
- 19) Design calculations and drawings for civil structures / works associated with fuel oil handling system, ash handling system, coal handling system, Ash disposal system, etc.
- 20) All other designs, details / drawings or any other submissions as indicated elsewhere in this specification and as required by the Owner.
- 21) Details of corrosion protection measures for all structures.
- 22) All design and drawings for the natural draught Cooling towers.
- 23) All design and drawings for RCC Twin flue chimney.
- 24) All design calculations and drawings for foundation of Boiler and ESP area structures.
- 25) Preparation & Review of structural steel fabrication drawings is entirely of the responsibility of contractor & will not be approved by the owner. However, all fabrication drawings shall be submitted by the contractor for owner's reference & records prior to the commencement of fabrication.



- 26) Construction and erection procedure for all major structure with specific reference to main plant building, bunker structures, transfer towers, conveyor galleries, TG foundation and other machine foundations.
- 27) Write up on various statutory requirements and their compliance for various buildings and facilities.
- 28) Quality assurance and Quality Control procedures. Third party quality audit is required.
- 29) Copies of all reports on investigation and studies carried out by the CONTRACTOR as per the scope.
- 30) Soft copies of all design calculation and drawings shall be submitted for records after approval of the OWNER.
- 31) EPC Contractor to ensure that photograph of progress of work at site with required album is being submitted to owner once in every month in soft & hard copy.
- 32) EPC Contractor to ensure that Bar Bending Schedule & Bill of quantities has been furnished in various construction drawings.
- 33) All drawings are approval category except fabrication drawings which are information category.



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 29



5.00.00 GEO-TECHNICAL INVESTIGATION

5.01.00 M/s TANGEDCO, owner of this project has carried out preliminary soil investigation work in power block area i.e. from power house to chimney. Few boreholes and static cone penetration tests were performed. The borelog datas are enclosed in soil report attached along with specification.

As per the soil consultant's report for main plant building structures, TG foundation, boiler foundation, ESP foundation, mill building foundation, mill foundation, ID, FD & PA fan foundation, chimney foundation, conveyor gallery trestle foundation, junction tower foundation, crusher house foundation, stacker reclaimer foundation, fly ash silo foundation etc. pile foundation is recommended. Piles will be bored cast-in-situ.

5.02.00 Recommended safe load carrying capacity of Bored Piles will be as follows:

S.No.	Location	Length of Pile below E.G.L (m)	Length of Pile below Cut off (m)	Dia. of Pile (mm)	Safe Load Carrying Capacities (kN)		
					Vertical	Pull Out	*Horizontal
1	Main Plant (Ash Pond Area)	30	27	500	1000	260	50
2				600	1100	340	55
3				700	1500	400	75
4				800	1600	420	80
5				900	1900	500	95
6	Balance Plant Area	30	27	500	1000	260	50
7				600	1100	340	55
8				700	1500	400	75
9				800	1600	420	80
10				900	1900	500	95
11	Coal Conveyor Belt Area	30	27	500	1000	260	50
12				600	1100	340	55
13				700	1500	400	75
14				800	1600	420	80
15				900	1900	500	95

*Horizontal Capacity is considered 5% of Vertical Compression Capacity.

Note :- The Above load carrying capacities are valid only if ground improvement technique is adopted and post improvement properties are estimated to validate the improvement.



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 30



Above informations regarding soil investigation is only for the guidance of the bidders. Owner does not take any responsibility for the correctness and interpretation of the result. Any variation of the said information shall not constitute a valid reason in affecting the terms and condition of the bid. The bidder shall fully satisfy himself about the nature of soil expected to be encountered, including the type of foundation, bearing capacity, sub-soil water etc. prior to the submission of his bid.

5.03.00

Detailed geotechnical investigation shall be carried out by the Contractor on award of work. Based on the plot plan developed, the contractor shall identify proposed borehole locations and obtain the approval of Owner prior to commencing the investigation. In the power block bore holes shall be provided and spread judiciously to cover all major building as well as equipment foundations. Generally, a grid of 50 metres c/c both ways is recommended from Chimney to end of Switchyard. In the offsite areas also it shall be ensured that the bore holes are provided near all major structures. If the final geotechnical investigation report is found to be in variance with the assumptions / preliminary investigations made during bid stage, the contractor is not eligible for any extra claim or time extension.

Geotechnical investigation must be completed by EPC Contractor within 3 months from the date of handing over the site to the contractor & same should be wetted by IIT / Anna University before submission to the owner for review / approval.

5.04.00

Following field tests shall be conducted:

- Bore holes and standard penetration tests
- Static plate load tests
- Cyclic plate load test
- Cross hole shear velocity test
- Field permeability tests
- Field density tests
- Vane shear tests
- Static cone and dynamic cone penetration tests
- Electric resistivity tests
- Pressure meter tests
- Percolation test
- California bearing ratio tests

5.05.00

Bore holes shall be located to cover the entire area. All bore holes shall be sunk up to a depth of 40.0 m or 'N' value greater than 100 is obtained for 4 consecutive intervals.



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 31



5.06.00 Standard penetration test (SPT) and collection of undisturbed soil samples (UDS) shall be carried out alternatively at 1.0m intervals and at significant change of strata. The interval shall be increased to 1.5m below 5m depth of boring. UDS shall be replaced by SPT in cohesion less strata. Even in highly weathered / disintegrated rock, where core recovery is poor, SPT shall be conducted. The first SPT in any borehole shall be conducted at 1m depth.

5.07.00 Dynamic Cone Penetration Test (DCPT)

The test equipment and procedure shall meet the requirement of IS:4968 (Part II). The driving shall not be done for more than 30 cm at a time after which it shall be stopped for a minute or two. The tests shall be terminated when the blow counts exceed 35 for 100 mm. penetration when the cone is dry and 20 for 100 mm. penetration when the cone is penetrated by circulating slurry.

The results shall be reported in a suitable tabular form giving blow counts for every 30 cm. penetration supplemented by a graphical plot of blow count versus depth.

5.08.00 In rock strata, core recovery, Rock Quality Designation (RQD) and Room Mass Rating (RMR) shall be noted carefully for each run, immediately after cores are taken out of barrel.

5.09.00 During boring, the level at which ground water is struck shall be carefully noted. Ground water samples shall be collected for chemical analysis. Boring shall be carried out without the use of water or drilling mud up to the depth of ground water table.

5.10.00 Following laboratory tests shall be conducted: (preferably on Undisturbed soil samples and if UDS is not possible, on remoulded soil samples)

- i) Grain size analysis
 - a) Hydrometer analysis
 - b) Sieve analysis
- ii) Field density and moisture content.
- iii) Specific gravity.
- iv) Chemical analysis of soil and ground water including sulphates, chlorides, pH value etc.
- v) Chemical analysis of 2:1, water:soil extract of the samples giving SO_3 content.
- vi) Consistency Index: Liquid limit, plastic limit, plasticity index, shrinkage ratio.
- vii) Consolidation test giving all relevant information.
- viii) Swelling pressure and free swell index for expansive soils.
- ix) Unconfined compressive strength on undisturbed soil samples
- x) Direct shear test.



- xi) Triaxial compressive strength tests:
 - a) Unconsolidated undrained test
 - b) Consolidated undrained test
 - c) Consolidated drained test
- xii) Moisture density relations for Standard Proctor and Modified Proctor tests.
- xiii) Crushing strength, specific gravity, unit weight, water absorption test of rock specimens of NX size.
- xiv) Permeability test.

5.11.00

The Geotechnical investigation report shall necessarily include but not be limited to the following information:

- a) Recommended types of foundation.
- b) Allowable safe bearing capacities and settlement values in different strata for shallow foundations indicating relevant design criteria adopted, method of analysis adopted etc.
- c) Type of piles recommended with reasons for the same, length, diameter, allowable capacity (vertical lateral and pullout) of individual and groups of piles, negative skin friction, if any, and magnitude of estimated negative skin friction.
- d) Recommendations for values for modulus of sub grade reaction for foundation design by elastic method.
- e) Type of cement to be used for concrete substructures and in stone/ brick masonry foundations with reference to the chemical nature of subsoil and ground water.
- f) Recommendations regarding excavations (shallow & deep), embankment, safe sides slopes for excavation and embankment, dewatering, site drainage etc.
- g) Recommended soil properties such as density, specific gravity, cohesion, angle of internal friction etc. for design.

5.12.00

The Bidder shall carry out the topographical survey of the area within boundary.

The survey map should identify all topographical features such as but not limited to buildings, structures, burial grounds, wells, natural drains, roads, footpaths, depressions, underground sources, overhead transmissions lines, telephone lines or any other obstruction, trees and prominent vegetation. In addition, all wet land and marshy stretches shall also be identified. CONTRACTOR shall prepare contour map to a scale of 1 in 1000 in AUTOCAD. In addition, CONTRACTOR shall prepare LS and CS of the site at suitable intervals to adequately represent actual topography. For natural drains and water courses, sections at closer intervals shall be provided.

For further detail refer section 19.0 of part B.



5.13.00**SOIL IMPROVEMENT**

Since soil is having very low bearing capacity hence Implementation of ground improvement techniques and post improvement evaluation of sub surface properties upto 15.0 m below ground level is a part of foundation design, which is in the scope of contractor. Method of stabilization / improvement of soil to be used by contractor shall be got vetted by IIT / Anna University before submission to owner / owner's consultant for approval.



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 34



6.00.00 GENERAL REQUIREMENT OF BUILDING / STRUCTURES

The CONTRACTOR shall obtain and be conversant with all laws, by-laws and regulations of local and Statutory Bodies as applicable to the project. The architectural concept evolved should also take care of these requirements. The CONTRACTOR shall provide the drawings and documents for such statutory approvals.

EPC Contractor to ensure that all building layout has been finalized in such a way so that adequate space is available all-round the equipment for operation, repair & maintenance.

6.01.00 Roof Access

All roofs shall be provided with access thorough a staircase / cage ladder. Minimum 1000 mm wide access path shall be provided with tiles to approach equipment on roof.

6.02.00 Platform and Walkways

Platforms shall be provided to all major equipment, not directly accessible from - the floors, for maintenance. Platforms and connecting walkway shall have a minimum width of 750 mm. Platforms in front of the entry shall be atleast 900 mm wide. Platforms located close to each other shall be connected with walkways.

All steel platforms above grade level shall be constructed with kick plates at edge of the platform to prevent tools or materials from falling off. It shall consists of 8 mm thick Galvanised steel plate projecting 100 mm above the platform surface. Kick plate shall be painted with the same type of coating as the material to which it is attached.

Continuous walkway with GI Hand rail at least 750 mm (Wherever occurs) wide shall be provided along the crane girder level with handrails, on both side of the building. Approach to EOT crane shall be ensured by Cage ladder and staircase.

The plinth of powerhouse and its surrounding area is to be kept RL.10.0M. Top of finish of main approach road and internal road are to be kept be 250mm above surrounding Grade lvl. at RL.9.5M level.

Finished floor level boiler area / transformer yard area shall be kept 200mm lower than the finished floor level of power house building.

Finished ground floor level of all buildings and pump houses shall be minimum 500mm above the formation level / grade level.

6.03.00 Edge Protection

All-around floor openings an RCC kerb of 100 mm wide 150 mm high shall be provided. All concrete edges, where breakage of concrete corners expected shall be provided with angles of minimum size L 50x50x6 with lugs for edge protection e.g. all-round the cut-outs I openings in floor slab, edges of drains supporting grating covers, edges of. RCC cable I pipe trenches supporting covers, edges of manholes supporting covers and supporting edges of precast covers etc.

6.04.00 Anchor Bolts and Inserts Plates



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 35



Anchor bolts shall be designed for working stress, in tension and shear, for embedded length of the anchor bolts and pipe sleeves. Shear and crushing strength of concrete shall also be checked.

Insert plates shall be designed / checked for shear and bending moment. All lugs shall be checked for tension. Bond strength of concrete shall also be checked. Lugs using steel bars shall preferably be fillet welded to the plate to transfer full strength of the lug.

Insert plates required for the equipment supplied by BTG vendor will be supplied by BTG supplier and same shall be fixed in position under this contract and supply and fixing of all the balance inserts shall be under the scope of this contract.

6.05.00**Vertical Headroom**

All accessible areas shall be provided with minimum clear headroom as follows, unless otherwise specified.

Finished floors to ceiling (buildings)	3000 mm
Doors, Walkways, Platforms, Stairs etc.	2100 mm
False ceiling of office areas	2400 mm
Above false ceiling	1000 mm
Safety cage for ladders	2500 mm
Access for fork lift trucks	2800 mm
Main roads / Railway crossings & crane access	7000 mm
Other plant roads and truck access	5000 mm
Cable & Pipe rack (except at road and rail crossings)	3000 mm

6.06.00**Anti Termite Treatment**

Pre-constructional anti termite treatment shall be given to all vulnerable areas susceptible to termite attack and shall include column pits, wall trenches, foundations filling below the floors etc., as per IS: 6313 and other relevant Indian Standards.

6.07.00**STAIRS AND LADDERS****6.07.01****Steel Stairs**

All steel staircases shall normally have minimum clear width (back to back of stringer) of 1000mm and maximum inclination with horizontal of 35.75°. However, in case of space restriction, minimum clear width upto 750mm and slope upto 45° may be provided. The vertical height between successive landings shall not exceed 5m. Channels (minimum MC200) shall be provided as stair stringers. Treads shall be minimum 250mm wide of grating, with suitable nosing, and spaced equally so as to restrict the rise to maximum 180mm.

6.07.02 Steel Ladders

Ladders shall be provided to platforms, walkways, instruments and equipments which do not require frequent access. Ladders shall preferably be vertical and its angle with vertical shall not exceed 5°. Ladders shall be of minimum 450mm clear width with 35x35x3 angle diameter MS rungs spaced at 300mm (maximum). Ladders shall be provided with a safety cage of minimum 750mm diameter clear when the top of ladder is more than 4.5m above the landing level. However safety cages shall start at 2.5m above the lower landing level.

6.07.03 RCC Stairs

All stairs shall have maximum riser of 180mm and a minimum tread of 250mm. However, for Administration & Control room building riser shall be limited to 150mm and tread width of 300mm. Minimum width of stairs shall be 1200mm generally. All stairs normally shall have not more than 15 risers in one flight. Aluminium angle nosing with minimum 50x25x3 angle shall be provided for edge protection of RCC stairs.

6.08.00 Handrails

Handrails shall be provided at appropriate places to ensure safety e.g. around all floors / roof openings, projections / balconies, walkways, platforms, steel stairs etc.

All handrails shall be of 32mm nominal bore MS pipes (medium class) as per IS:1161 galvanised using 750 gm/sq. m of zinc. Handrails for platforms, walkways and projections shall be a two-rail 450mm below the top rails. Handrail post spacing shall be limited to 1500mm as far as possible but can be proportioned to the length of the protected horizontal opening. In such a case spacing shall not exceed 1850mm center to center of posts. Handrails shall be shop fabricated for specific locations and field welded or bolted to the erected structural steel. For platforms at elevation more than 30m, three rail system with top rail at 1500mm shall be adopted.

For RCC stairs, handrails with 20mm square MS bar balustrade with suitable MS flat & Teakwood handrail shall be provided, unless specifically mentioned otherwise.

6.09.00 Expansion/Construction Joints

Expansion and construction joints shall be provided wherever required. All expansion and construction joints of water retaining structures in RCC shall be made watertight using PVC ribbed water stops with central bulb. However, kicker type (externally placed)



PVC water stops may be used for the base slabs and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stops shall be 6mm and minimum width 225mm. At other joints these shall be 150mm wide.

Two part polysulphide sealant conforming to IS:12118 shall be used for sealing of joints in contact with water. For other cases, bitumen sealing compound conforming to IS:1834 shall be used. Dura board HD100 or its equivalent shall be used as joint filler.

6.10.00**Brick / Stone Masonry And Parapet Wall**

All masonry works shall be designed in accordance with IS:1905, IS:2212, IS:4326, IS:2185 and other relevant IS codes as applicable. Structural design of load bearing and non load bearing walls constructed with fly ash bricks shall be in accordance with criteria specified by section-4 of National Building Code of India, Part-VI and codal provisions.

All walls shall be non-load bearing in filled panel walls. External walls of all buildings shall be atleast one brick thick. All internal walls shall be atleast one brick thick except for internal partition walls for office area, canteen, change room, first aid rooms and toilets, which may be half brick thick. RCC bands (transoms and mullions) shall be provided wherever necessary to curtail the unsupported length / width of the wall.

50mm thick DPC (1:1.5:3) with water proofing admixture shall be provided at plinth level before starting masonry works.

Bricks having minimum 75 kg/sq.cm compressive strength shall be used for non-load bearing superstructure brick work. Cement and sand mortar 1:5 for one brick thick wall and 1:4 for half brick thick wall shall be used. For half brick walls, RCC transoms and mullions shall be provided. Transoms shall be provided at lintel / door height. The spacing of mullions shall not exceed 2000 mm centre to centre. The size of transoms / mullions shall be minimum 115mm square with four numbers, 8 mm dia bars and 6mm stirrups 150 mm centers.

Type, thickness and height of external wall, facing the transformer yard to take care of fire accidents in transformer yard shall be according to the requirements of Tariff Advisory Committee.

Even where metal cladding is specified, for initial 3m height from the ground level, minimum one brick thick masonry wall shall be provided.

All upstands and parapet walls on roof shall be of RCC construction, minimum height of parapet walls shall be 750mm and thickness 125 mm.

6.11.00**Waterproofing Of Underground Structures**

All underground structures like water retaining structures, track hoppers, transfer house, conveyor tunnel & other deep underground structures etc., shall have plasticizer cum water proofing cement additives conforming to IS:9103. In addition, limits on permeability as given in IS:2545 shall also be met with.



All water retaining structures shall be hydro tested as per IS 3370 for leakage & in case leakage is noticed pressure grouting or any other approved method shall be used to rectify the same.

The concrete surface of these structures in contact with soil shall be provided with water proofing treatment as stated below.

- i) For base slab, a layer of PCC 1:4:8 shall be laid. Over PCC layer, 25mm thk CM 1:3 mixed with approved water proofing compound at the rate specified by the manufacturer shall be applied. Over this two coats of acrylic polymer modified cement based flexible water proofing membrane of approved make laid as per manufacture's and instruction. Over water proofing membrane, 25mm thk CM 1:3 mixed with approved water proofing compound at the rate specified by the manufacturer shall be provided over which protective layer of 15mm thk kota / cuddapa or equivalent stone with joints sealed with C1:3 shall be laid. Over this stone layer, 25mm thk CM 1:3 mixed with approved water proofing compound at the rate specified by the manufacturer shall be applied before RCC base slab shall be casted.
- ii) For side walls, two coats of acrylic polymer modified cement based flexible water proofing membrane of approved make laid as per manufacture's specification and instruction shall be applied to the sides of RCC walls. 25mm thk CM 1:3 mixed with approved water proofing compound at the rate specified by the manufacturer shall be applied over it. Protective layer of 15mm thk kota / ciddapa or equivalent stone with joints sealed with CM 1:3 shall be laid. Finally 25mm thk CM 1:3 mixed with approved water proofing compound at the rate specified by the manufacturer shall be applied.

For all other foundation & pedestal work below ground coming in contact with soil, bituminous painting of grade 85/25 conforming IS 702@ 1.7 kg/ sqm.(min)

6.12.00

Miscellaneous Requirements

Doors and windows on external walls of buildings shall be provided with RCC sunshade over the openings With 300 mm, projection on either side of the opening. Projection on sunshade from the wall shall be minimum 450 mm over window openings and 750 mm over door openings.

Doors and windows on the external walls of buildings with metal cladding shall be fixed by creating recesses in the cladding system.

No cable trenches shall be provided in TG hall, Boiler/ESP area, fuel oil pump house, Ash pump houses etc.

Duct banks consisting of MS/PVC conduits for cables shall be provided with proper sealing arrangement consisting of fire retardant sealing compound.

All floor openings for cables below electrical panel shall be sealed with fire sealing compound after cables are laid.



All openings in external walls provided for pipes, cables, duct etc. shall be effectively sealed to prevent water seepage, after the routing of the services are completed.

Natural lighting & Ventilation.

The area of windows shall be a minimum 15 % of the floor area to ensure adequate natural lighting. Fans shall be provided in general office areas as per standard norms. Sewerage system shall be provided with adequate ventilation for the pipe work as well as manhole.

6.13.00

Statutory Requirements

All the applicable statutory rules pertaining to Indian Factories act, Factory rules of State Government, Fire safety rules of Tariff Advisory committee, Water act of Pollution Control boards, Explosives act, Environmental requirements etc., and stipulations of other relevant statutory authorities shall be taken into consideration at the time of design and construction.

Provisions of safety, health and welfare according to Factories act shall be complied with at design stage. These shall include provision of continuous walkway (minimum 750 mm wide) along crane-girder at crane girder level on both sides of the building, comfortable approach to **EOT** crane. cabin, railings, fire escape locker room for workmen, pantry, toilets, rest rooms etc.

Adequate no. of fire escapes shall be provided in a building. Fire proof doors, no. of staircase, fire separation walls, lath plastering on structural steel member (in fire prone areas) shall. be made according to the recommendation of TAC.

Obtaining statutory approval clearance/ license from relevant agency will be within the scope of EPC Contractor.

For fire safety requirements of buildings IS: 1641 and IS: 1642 shall be followed in addition to TAC requirements. All masonry firewalls shall be minimum 345 thick and RCC firewall shall be minimum 200 mm thick.



7.00.00 MATERIAL**7.01.00 Structural Steel**

Steel will conform to Grade-A of IS:2062 (latest) for rolled steel members or plates upto 20 mm thickness. For plates above 20 mm thickness and welded construction steel conforming to Grade-B (killed and normalized) of IS: 2062(latest) shall be used except for crane girders where Grade-C (IS: 2062) steel shall be used. Steel shall be procured from SAIL or any other approved main producers.

Chequered plate shall conform to IS: 3502 (latest) and minimum thickness of chequered plate for floorings, covers etc shall be 8 mm O/P.

Bottom 1.0 M of cylindrical portion and entire conical portion of bunker in mill building shall be provided with lining of atleast 6mm thik SS plate grade SS 316L.

The electrodes classification as per AWS shall be as follows:-

- a) For welding of stainless steel to stainless steel : E308L
- b) For welding of stainless steel to mild steel : E309

7.02.00 Cement

Ordinary Portland Cement (OPC) shall be used for all structures except for foundations, under ground structures & structures coming in contact with sea water where in sulphate resistant cement with C3A content limited to 5% to 8% shall be used. Grade of cement shall be 43 conforming to IS: 8113.

7.03.00 Reinforcement

The reinforcement used shall be cold worked steel high strength deformed bars of grade Fe 415 / Fe 500 conforming to IS:1786 – latest.

Fusion bonded epoxy coated reinforcement steel with coating conforming to IS:13620 shall be used for the complete project.

Intermixing of different grades of rebars or rebars of different material composition in same structure shall not be allowed.

Welding of reinforcement shall not be carried out without the permission of the Owner.

Projecting reinforcement or dowel bars for future connection of the structural works shall be protected by cement paint, if they are to be left exposed for a long time.



8.00.00 LOADING**8.01.00 Dead Loads**

Dead loads shall include the weight of structure complete with finishes, fixtures & partitions and shall be taken as per IS: 875 (Part-I)

8.02.00 Imposed Loads

Imposed loads in different areas shall include live loads, erection, operation and maintenance loads. Equipment loads (which constitute all loads of equipment to be supported on the building frame) are not included in the imposed loads furnished below and shall be considered in addition to imposed loads.

For consideration of imposed loads on structures, IS:875 (Part-2) "Code of practice for design loads (other than earthquake) for buildings & structure" shall be followed. The following minimum imposed loads as indicated for some of the important areas shall however be considered for the design. If actual expected load is more than the specified minimum load, then actual load is to be considered

Sl.No.	Location	Imposed Loads (T/Sq.m)
A)	Turbine Building	
i)	Ground floor (general)	2.50
ii)	Ground floor (Heavy equipment storage area)	5.00
iii)	Mezzanine Floor	1.50
iv)	Operating Floor	
	a) Rotor Removal area Rotor removal area beams shall also be checked for ½ the rotor load at the center of beam	5.00
	b) Equipment Laydown area	3.00
v)	Gratings, chequered floors, walkways, platforms, stairs etc.	0.75
vi)	Roof (Where no equipment are located and non-accessible)	0.15
	Roof (where equipment are located and accessible)	0.50
B)	Deaerator and Heater Bay	
i)	HP / LP heater floor	2.0



	ii)	Deaerator floor	1.5
	iii)	Cable gallery	0.50 (In addition to this actual cable load shall be considered)
	iv)	MCC & Control Building floors	1.00
	v)	AHU room battery room, air washer room	1.5
C)	Mill & Bunker Bay		
	i)	Ground Floor	2.5
	ii)	Feeder Floor	2.00
	iii)	Tripper Floor	2.00 Beams however shall be checked for feeder / tripper concentrated load
	iv)	Roof	0.15 (where no equipment are located) 0.50 (where equipment are located)
	v)	Dust Load	0.1
D)	Pump Houses operating floor		1.50
E)	Underground Structures such as Channels, Sumps, Underground Pump House, Tanks, Trenches, Reservoirs, Cooling Water Ducts etc. In addition to earth pressure and ground water pressure, the surcharge load of 2T/sqm. shall also be considered for design of all underground structures.		
F)	Road Culverts / Bridges and its allied structures including RCC Pipe Crossings & Road Crossing of Trenches. Design for class 'AA' loading (wheeled & tracked both) and checked for class 'A' loading as per IRC Standard.		
G)	Covers for Channels / trenches		Trench cover at entry to building and road



		crossings shall be designed for live load of 100 kN at centre. Trench cover at other location shall be designed with a surcharge of 100 kN/m ² or a concentrated load of 100 kN at center which is worst.
H)	Railway Supporting Structures, Rail Culverts	As per railway 'Bridge Rules'
I)	Boiler / ESP Support Structures	0.50
J)	General (Unless Specified Otherwise)	
i)	Stairs, Landings and Balconies	0.50
ii)	Toilets	0.20
iii)	Chequered plates, grating floors, etc.	0.50
iv)	RCC floors (General)	0.50
v)	a) Flat roofs (where no equipment are located)	0.15
	b) Flat Roofs (where equipment are located)	0.50
vi)	Inclined Roofs	As per IS:875 (Part-II)
vii)	Walkways (General).	0.50 T/sq.m or a concentrated load of 0.3 T/m which ever is greater
viii)	Walkways of conveyor galleries.	0.50
ix)	Floor of control room of switchyard control building	1.00
x)	Cable and pipe trestles	0.20 for walkway and in addition, friction loads as applicable.



NOTE :

1. Additional load for cable, piping / ducting, shall be considered as applicable.
2. Hung load shall be based on minimum loading equivalents of 1 kN/m^2 for piping and 0.5 kN/m^2 for electrical ventilation and air conditioning.
3. Loading resulting from concentrations of facilities in specific areas shall be substituted where listed base loadings are excluded
4. Cantilever loads of not less than 2000 kg/metre at a distance of 1200 mm from the external face or the columns, on both sides of the ESP, for cable trays and walkways.
5. Cantilever loads of not less than 500 kg/metre at a distance of 1200 mm from the external face or the columns, on both sides of the boiler, for cable trays and walkways.
6. All ESP hoppers filled up with ash upto the top of the hoppers or the bottom of the electrodes (whichever is more) using a bulk density of not less than 1600 kg/cum for the ash, along with additional ash build-up from the end of the third field upto the inlet duct bottom level at a natural repose angle (not less than 30° to horizontal in any case)
7. Boiler supporting structures shall be so configured that the temperature of steel does not exceed 60°C unless specified otherwise. Brackets shall be provided on both sides of the outermost row of columns of both the boiler and ESP for supporting cable trays and walkways, at a height not exceeding 10.0m . The exact levels shall however, be decided during detail engineering. Each ESP hopper shall be supported at four corners by providing four columns from the ground.
8. In design of boiler /ESP support structures dynamic piping loads need not be considered acting simultaneously with wind or seismic loads. Increase in permissible stresses shall be allowed in load combinations where dynamic piping loads are considered and shall be as permitted under seismic load conditions.

8.03.00 Equipment, Piping and Associated Loads

Equipment loads shall be considered over and above the imposed loads. Equipment loads shall be considered as given by equipment supplier.

8.04.00 Crane Loads

For crane loads, an impact factor of 25% and lateral crane surge of 10% (of lifted weight + trolley weight) shall be considered in the analysis of frame according to the provisions of IS:875. The longitudinal crane surge shall be 5% of the static wheel load. Longitudinal surge and lateral surge shall not be considered to act simultaneously.

8.05.00 Seismic Load

2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 45



The project site is in Zone – III as per IS: 1893/Part I-2003 & IS:1893 – Part II – 2005.

Zone factor Z = 0.16

Importance factor = 1.75

Response reduction factor = 5.0 (for MRF) AND 3.0 (for OMRF)

8.06.00 Wind Load

Basic wind speed at project site is 50 m/sec. as per IS:875 -1987 Part-3

Probability factor, (k1 risk coefficient), terrain, height and structure size factor, k2 and topography factor, k3 shall be as per IS:875.

8.07.00 Damping in Structures

The damping factor to be adopted shall not be more than as indicated below:

Type of Structure	Wind Load	Seismic Load
a) Welded steel structure	1%	2%
b) Bolted steel structure	2%	2%
c) RCC structure	1.6%	5%

8.08.00 Temperature Load

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

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

Systems and system component design criteria which require ambient temperature extremes shall use the range from 22C to 40C for dry-bulb temperatures.

8.09.00 The following densities shall be considered for design of coal bunkers:

- (a) For volume calculations : 800 kg/cum
- (b) For structural design : 1200 kg/cum

The coal bunker will be designed as per criteria outlined in IS:9178 (Part I&II)



8.10.00 Loading for Switch Yard

The loading for the design of switchyard structures shall be as per IS:802 Part 1/Sec 1:1995 (latest edition). Following loads shall be considered:

- (a) Dead load due to equipment and dead load due to structure
- (b) Wind load on towers, conductors, ground wires and insulator strings calculated as per clause 8 and 9 of IS:802
- (c) Temperature effects consisting of effect of temperature variation and sag tension as per clause 10 of IS:802
- (d) Climatic loads as per clause 11.2 of IS:802
- (e) Anti concading loads as per clause 11.3.1 of IS:802
- (f) Torsional and longitudinal loads caused by breakage of conductor as per clause 11.3.2 and 16 of IS:802
- (g) Construction and maintenance loads
- (h) Seismic loads as per IS:1893
- (i) Short circuit forces including “snap effect” in the case of bundled conductors.

8.10.01 Switchyard structure shall be designed for the worst combination of above loads. The factor of safety for design of members shall be considered as 2 for normal and broken wire conditions and 1.5 for combined short circuit and broken wire conditions. Short circuit forces and wind forces shall not be considered simultaneously.

8.10.02 Foundation shall be designed for a factor of safety 2.2 for normal and broken wire condition and 1.65 for combined short circuit and broken wire conditions. Design of foundation shall be carried out as per IS:4091.



9.00.00 STEEL STRUCTURE**9.01.00 Framing**

All steel framed structures shall be either “rigid frame” or “simple space frame” or a combination of two.

Lateral forces shall be resisted by stiff jointed moment connections in rigid frame design. The column bases shall generally be fixed to concrete foundation pedestal by providing moment resistant base detail.

The power house building design shall be a combination of rigid frame in transverse direction and simple frame in longitudinal direction.

If RCC floor / roof is assumed to act as diaphragm transmitting lateral loads to braced bays, it shall be provided with shear connectors. However, whenever large / more number of cut-outs are provided in the floor slab, horizontal floor bracings shall be provided below slab to transfer horizontal force to columns without considering diaphragm action from slab.

Floors for vibrating machines of all kind together with supporting framework shall be adequately braced in both horizontal and vertical planes. Floors or structure supporting mechanical equipment shall be designed to minimise vibration, avoid resonance and maintain alignment and level.

9.02.00 Design Concepts

Individual members of the frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion, etc. Criticality of erection / maintenance loads shall also be checked separately in combination with other simultaneously occurring loads for possible design loadings.

The different load combinations shall be taken as per IS:875 (Part-5) and other relevant IS Codes.

- a. Wind and seismic forces shall not be considered to act simultaneously.
- b. For the design of main plant structures during seismic condition, the deaerator feed water tank shall be considered full upto operating level. However, for other load combinations, deaerator feed water tank in flooded condition shall also be considered.
- c. In the analysis of main plant building & bunker building, the stresses arising due to temperature shall be considered.
- d. ‘Lifted load’ of crane shall not be considered during seismic condition.
- e. In case two cranes are provided and tandem operation is not envisaged, the load shall be taken as one crane fully loaded and second crane without lifted load but standing idle adjacent to first crane.



- f. In case two cranes are provided and tandem operation is envisaged for some bays, then the load shall be taken as both the cranes fully loaded and standing side for these bays. For other bays, load shall be taken as one crane fully loaded and second crane without lifted load but standing idle adjacent to first crane.
- g. Permissible stresses for different load combinations shall be taken as per relevant IS codes.
- h. For the design of pipe / cable supporting structure, the soil weight shall be considered as backfilled upto grade level for the condition of pipe running full / cables in position.
- i. Frictional force between the pipes and supporting structure in longitudinal direction need not be considered along with seismic or wind forces.

The design of steel structures shall be done by working stress method. Design shall be as per provision of IS:800 (latest) and other relevant IS standards. For design of coal bins and loading hopper IS:9178 (Part I to III) shall be followed.

Roof decking sheets shall be designed as per IS:801 to carry the self load, dead load due to RCC slab and finishes and imposed load. The deflection of metal deck shall be limited as per BS:5950. In case composite action is considered in the design, suitable shear studs shall be provided as per BS: 5950.

Permissible stresses for different members shall be allowed to exceed upto 33.33% only under normal loads along with wind and seismic conditions. The members which are designed primarily to resist wind load such as bracing members, no increase in permissible stress will be permitted. However, permissible stresses in bolts and welds shall be allowed to exceed up to 25 % only under wind and seismic conditions.

For design which requires the use of the minimum column load (such as, uplift on anchor bolts, column axial tension, etc.) the following criteria shall be used in determining minimum load: Use 90% of the column dead load, No live load is used, Uplift forces from vertical bracing are included where applicable and Wind uplift on the roof is included where applicable.

Base plates shall be placed on foundation pedestal with grouting. For large base plates necessary grout holes shall be provided. All anchor bolts for fastening steel columns on foundation shall be embedded in foundation during concreting itself. No anchor pockets in foundation shall be allowed. Design of base plates shall be based on design pressure on foundation which shall not exceed the following:

Pedestal in concrete grade M20	5.0 N / sq.mm
Pedestal in concrete grade M25	6.25 N / sq.mm
Pedestal in concrete grade M30	7.5 N / sq.mm

The total horizontal shear force at the base of column is transferred to the column pedestals through friction between the base plate and the grout. A coefficient of



friction of 0.30 shall be used in conjunction with the minimum column load as defined above. If the horizontal shear force exceeds the frictional resistance force or if the column is subjected to a net uplift load, the total force shall then be transmitted through shear bars / shear keys welded to the base plate. Anchor bolts are not assumed to resist any horizontal shear force. Necessary recesses shall be kept in the foundation concrete for shear lugs.

Welding shall be used for fabrication and erection. Site connections shall generally be with welding. However, high Strength Structural (HSS) bolts shall be used for all important connections to be decided during detail engineering stage. In few cases, for shear connections or removable beam connections, bolted joints with MS bolts may be adopted. For HSS bolt connection, IS:4000, IS:3757, IS:6623 and IS:6649 shall be followed. IS:814, IS:816, IS:1024, IS:4353 and IS:9595 shall be followed for welding of structures.

Trestles supporting coal conveyor galleries shall be so proportioned that the transverse deflection of trestles due to wind / seismic load shall not exceed trestle height / 1000 as stipulated in IS:11592.

In the case of galleries, temperature expansion joint shall be introduced at intervals less than 90 m to divide the galleries into temperature block. In each block at least one number four legged rigid support guaranteeing stability of structure in the longitudinal direction shall be provided. This shall also take care of all longitudinal forces in the given block. Effect of wind load acting on 2-legged trestle shall also be considered while designing the 4-legged trestle.

Base plates for trestles shall be designed as gusseted bases with shear lugs to transfer horizontal forces. Anchor bolts shall be designed only for uplift forces.

Anchor fasteners shall not be used for supporting equipment imparting dynamic forces.

Pedestals supporting gravity take-up shall be designed to resist 100% impact.

For calculation of coal load on moving conveyor, a multiplication factor of 1.6 shall be used to take care of inertia force.

- a) Conveyor gallery structure & trestles shall be designed considering both conveyors operating simultaneously.
 1. Dynamic analysis of conveyor galleries and conveyor supporting system shall be carried out for spans greater than 25m.
 2. All structures close to railway line shall have clearances conforming to Railway norms.

Transverse coal pressure on Bunker/ Silo / Hopper walls shall be calculated using Walker's theory and IS:9178. The Coal Bunker / Silo / Hopper shall be designed for the following conditions.



- i) The Bunker / Silo / Hopper is full up to its full capacity with top surface nearly horizontal.
- ii) The Bunker / Silo / Hopper is partially empty with the top surface of coal at an angle of repose of 37 degrees.

Design pressure on coal bunker / hopper walls shall take into account all possible flow regimes (core flow, mass flow, etc.), and different aeration regimes (radial, diametrical, radial and core, impulsive etc.)

9.03.00 Permissible Deflections

The permissible deflections of various steel members under normal loading conditions shall be as specified below. For calculation of deflections in structures and individual members dynamic effects shall not be considered, unless specified otherwise. Also, no increase in deflection limits shall be allowed when wind or seismic load are acting concurrent with normal loading conditions.

9.04.00 Vertical Deflection

- 9.04.01**
- a) For beams supporting dynamic equipment : Span / 500
 - b) For beams supporting floors / masonry : Span / 325
 - c) For beams supporting pipes : Span / 400
 - d) For roofing and cladding components : Span / 325
 - e) For gratings and chequered plates : Span / 200 subject to a maximum of 6 mm
 - f) Coal/ Ash conveyor gallery bridges : Span / 450

9.04.02 For crane gantries or any member subjected to working loads, the maximum deflection under dead load and live load excluding impact shall not exceed the following values:

- a) For manually operated cranes & monorails : Span / 500
- b) For electric overhead cranes
 - i) Up to 50 t capacity : Span / 750
 - ii) Over 50 t capacity : Span / 1000

9.05.00 Horizontal deflections

The permissible horizontal deflections shall be as per following unless specified otherwise:

- a) Single storey building (without crane load) : Height / 325
- b) Multistoried building (without crane load) : Height / 500



c)	Pipe rack columns	:	Height / 200
d)	Crane gantry girder due to surge	:	Height/200
e)	Building main columns at crane rail level due to action of crane surge load only	:	Height / 2500 limited to maximum of 10 mm
f)	Open gantry columns at crane rail level due to action of crane surge load only	:	Height/4000 limited to maximum of 10 mm
g)	Open structures	:	Span / 2000 Limited to Maximum of 15mm
h)	Coal handling trestles	:	Height / 1000

9.06.00 Provisions of IS: 800 and relevant IS Code shall be followed for limiting deflections of structural elements not listed above.

9.07.00 MINIMUM THICKNESS OF STRUCTURAL STEEL ELEMENTS

The minimum thickness of various components of a structure and hot rolled sections shall be as follows. The minimum thickness of rolled shapes shall mean flange thickness regardless of web thickness. Structural steel members exposed to significantly corrosive environment shall be increased suitably in thickness or suitably protected otherwise as per good practice and sound engineering judgement in each instance.

a)	Trusses, purlins, girts and bracing	6mm
b)	Columns and beams	8mm
c)	Gussets	8mm
d)	Stiffeners	8mm
e)	Base plates	10mm & above
e)	Chequered plates	8 mm o/p & above
f)	Grating flats	5 mm

Minimum thickness of structural members other than gratings directly exposed to weather and inaccessible for painting and maintenance shall be 8 mm.

9.08.00 Minimum Sizes

The flange width of purlins supporting light weight concrete slab shall not be less than 65 mm and for those supporting roof sheeting and wall cladding it shall not be less than 50 mm. Width of steel rolled section connected to other member shall be at least 50 mm. The depth of beams for platform of all structures shall not be less than 125 mm.



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 52



9.09.00**Slenderness and Depth Ratio**

The slenderness ratio of main members in tension, compression or bending shall be in accordance with IS:800.

The following limiting ratios of depth to span shall be considered as a general guide.

a) Truss	1 / 10
b) Rolled beams and girders for ordinary floors and rafters	1 / 24
c) Supporting floor beams for vibrating machinery /equipment	1 / 15
d) Roof purlins and girts	1 / 45
e) Gable columns	1 / 30

9.10.00**Joints / Connections in Steel Structures:****9.10.01**

Steel structures shall be detailed and connection and joints provided as per the provisions of IS:800, IS:9595, IS:1367, IS:9178 and IS:816 and as per following requirements:

- a. Connection of vertical bracings with connection members and diagonals of truss members shall be designed for full tensile capacity of the bracings unless actual loads are indicated on the drawings.
- b. Size of fillet weld for flange to web connection for built up section shall be as follows:
 - i) For box section weld size shall be designed for 60% of full shear capacity or actual shear whichever is more. Where fillet weld is not possible, full penetration but weld shall be provided.
 - ii) For built-up I section, weld size shall be designed for 80% of full shear capacity or actual shear, (if indicated in drawings) whichever is more. However, weld size shall not be less 0.5 times the web thickness. Weld shall be double fillet.
 - iii) All welds shall be continuous unless otherwise specifically approved. The minimum size of the fillet weld shall be 6 mm.
- c. Shear connections shall be designed for 70% of section strength for rolled sections and 80% of section strength of built-up section or rolled section with cover plates. However, if actual shear load is more than above, the connection shall be designed for actual load.
- d. Moment connection between beam and column shall be designed for 100% of moment capacity of the beam section. This can be achieved either by direct butt welding of the top flange of beam with column flange or by providing top moment plate with suitable notch for additional weld length.
- e. All bolts and nuts shall have property class compatible to each other. For bolts carrying dynamic or fluctuating loads and those in direct tension



shall be provided with an additional double coil helical spring washer conforming to IS:6755. The threaded portion of the bolt shall project through the nut at least by one thread.

- f) Where a steel beam or member is to be connected on RCC structure, it shall be connected using an insert plate and preferably through shear connection.
- g) All butt welds shall be full penetration butt welds.
- h) The connection between top flange and web of crane girder shall be full penetration butt weld. Bottom flange, connection with web can be fillet weld or butt weld as directed by Purchaser. Bearing edges of crane girders shall be machine finished.
- i) Connection of base plate and associated stiffeners with the columns shall be designed considering the total load transferred through welds. However, minimum weld size (double fillet) shall not be less than 0.6 times the thickness of stiffeners.
- j) Splicing: All work shall be full strength. Field splicing shall be done with web and flange cover plates for full strength. In exceptional cases, the field splicing shall be designed for 50% of load carried by the cover plates and remaining 50% load through full penetration butt weld. Shop splicing for all sections other than rolled shall be carried out by full penetration butt welds with no cover plates. Splicing for all rolled sections shall be carried out using web and flange cover plates.

9.10.02 All bolted connections shall have bolts of minimum 16 mm dia. The connections of stairs and hand railing shall be made with 20 mm diameter threaded fasteners conforming to IS:1363. Erection bolts shall be black bolts of minimum 12 mm dia.

9.10.03 Efficiency of site welds to be considered shall be as follows:

- a) Butt weld above 25 m from ground --- 50%
- b) Others --- 80%

9.11.00 Specification for Painting of Steel Structures / Material

Refer Volume-VI, Part-B



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 54



10.00.00 REINFORCED CONCRETE STRUCTURES AND FOUNDATIONS**10.01.00 General**

All structures, building foundation, machines / equipment foundation, water retaining structure, trenches, pits, etc., shall be designed as per relevant IS codes in general. Construction in general shall follow provisions of IS :456 and IS:3370 for normal and water retaining structures respectively

10.02.00 Design Methodology

- a) The design and construction of RCC structures shall be carried out as per IS: 456-2000. Working stress method shall be adopted for the design wherever specifically mentioned in this specification.
- b) For all concrete structures, ductile detailing has to be done as per IS: 13920 and IS: 4326.
- c) For reinforcement detailing, IS: 5525 and SP34 shall be followed.
- d) Two layers of reinforcement (on both inner and outer faces) shall be provided for RCC wall sections having thickness 150mm or more.

10.03.00 Foundation and Underground structures

- a) Foundation system to be adopted for structures shall be based on loading arrangement , load intensity and soil strata.
- b) All RCC liquid retaining / conveying structure / slurry pump house / underground structures, such as conveyor tunnel, reclaimer hooper pit, etc., shall be designed in accordance with IS:3370 (Part 1 to 4) . For under ground structures not in contact with liquid on inside face may be designed as cracked sections with crack width limited to 0.1mm for both faces.
- c) All liquid retaining / carrying structures shall be tested for water tightness as per the provisions of IS:3370 and IS:6494 and in case of leakage, the same shall be rectified by chemical injection grouting through nozzles.
- d) Earth pressure for all underground structures shall be calculated using coefficient of earth pressure at rest. Co-efficient of passive earth pressure shall be used only in design of shear keys for stability against sliding.
- e) In all liquid retaining structures , pvc water bar shall be provided at each construction / expansion joint. No pressure relieving devices shall be permitted in underground structures except forebay.
- f) For design of all underground structures, including CW ducts, pump house and forebay etc. ground water table shall be assumed at the finished ground level unless specified otherwise. In addition to ground water pressure, minimum



surcharge load of 2 T/M² shall also be considered for design of all underground structures.

- g) All building sub-structures including pump houses shall be checked for sliding and overturning stability during both construction and operating conditions for various combinations of loads. Factor of safety for these cases shall be as per IS:456 and other relevant IS codes. However, following minimum factor of safety shall be followed,
 - a) Factor of safety against overturning due to wind, seismic or other lateral load shall be 1.5 minimum.
 - b) Factor of safety against sliding shall be 1.5 minimum.
 - c) Factor of safety against uplift due to hydrostatic forces shall be 1.2 and due to any other loads shall be 1.5.
- h) In cases where dead load provides the restoring forces, only 0.9 times characteristic dead load shall be considered. Imposed loads shall not be considered as restoring force.

10.04.00 Grouting

- i) Non-shrink flowable grout shall be used for under pinning work below base plate of columns. Non-shrink cum plasticiser admixture shall be added in the grout. For grouting of base of machine foundation high strength flowable ready mixed non-shrink grout shall be used.
- ii) Type and grade of grouting for structural columns and equipment bases shall be indicated. Crushing strength of the grout shall generally be one grade higher than the base concrete. Minimum grade of grout shall be M30.
- iii) Nominal thickness of grouting shall be at least 50 mm for building columns and pedestals of major equipment. For secondary posts, stair and ladder base, etc. grouting shall not be less than 25 mm thick.

10.05.00 Edge Distance For Bolts

Minimum distance from the center line of foundation / anchor bolt to edge of pedestal shall be the maximum of the following:

- i) Clear distance from the edge of base plate / base frames to the outer edge of the pedestal shall be minimum 50 mm.
- ii) Clear distance from the face of pocket to the outer edge of pedestal shall be 75 mm.
- iii) Clear distance from the face of pocket to the outer edge of pedestal shall be 75 mm.



10.06.00 Loading conditions for underground structures

Following loading conditions shall be considered in addition to the loading from super structure for the design of substructure of pump house, channels, sumps, tanks, trenches and other underground structures containing liquid.

- a. Water pressure from inside and no outside pressure, like earth pressure, ground water & surcharge pressure (applicable only to structures which are liable to be filled up with water or any other liquid.)
- b. Earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.
- c. Design shall also be checked against buoyancy due to the ground water during construction as well as after construction stages. Minimum factor of safety against buoyancy shall be ensured considering empty condition inside and ignoring the superimposed loadings. Provision of pressure relief valves / flap valves, etc. may be considered only in forebay of CW Pump House to counter the buoyancy. When pressure relief valves are used, 60% of the hydrostatic pressure shall be considered for design of the base slab.
- d. Base slab of the pump houses shall also be designed for the condition of different combination of pump sump being empty during maintenance stages with maximum ground water level.
- e. Intermediate dividing pier of pump sumps and partition wall (if applicable) in channel shall be designed considering water on one side only and other side being empty for maintenance.
- f. All pump houses and other substructures (wherever applicable) shall be checked for stability against sliding and overturning during construction as well as operating conditions for various combinations of loads.

10.07.00 Machine Foundations

The design of equipment foundation shall be as per IS: 456 and IS: 2974. The provisions of DIN 4024 shall also be followed for machine foundations.

10.07.01 All machine / equipment foundations and structures subject to vibrations shall suitably proportioned so that amplitude and frequency of the foundation / structures are within permissible limits.

10.07.02 All block foundations resting on soil shall be designed using the elastic half space theory or Barkens theory. Block foundation resting on piles shall be designed using Novak's theory or Barken's theory. The mass of the RCC block shall not be less than three times mass of the machine and the CG of the combined mass of foundation and equipment should pass through the CG of the base area with tolerance not more than 5%. Dynamic analysis shall be carried out to calculate natural frequencies in all modes including coupled modes and to calculate vibration amplitudes. Frequency and amplitude criteria as laid down by the relevant codes or



machine manufacturers shall be satisfied. Minimum reinforcement shall be governed by IS: 2974 and IS: 456.

10.07.03

For the foundations supporting minor equipment weighing less than one ton or if the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary. However, if such minor equipment is to be supported on building structures, floors, etc. suitable vibration isolation shall be provided by means of springs, neoprene pads, etc. and such vibration isolation system (VIS) shall be designed suitably.

10.07.04

- a) For the foundation of Turbo-generator, Boiler feed pumps, Fan (ID, FD and PA), Mills etc., detailed static and dynamic analysis shall be done. The static analysis shall include all operating conditions, load cases and abnormal loads like short circuit, loss of blade, unbalance and seismic forces. Unbalance loads for normal operating condition as given by machine manufacturer and / or VDI 2060 whichever is more conservative shall be used for calculating dynamic response. The dynamic analysis. Transient analysis shall be carried out for the short circuit condition with an appropriate force function. Frequency separation criteria and amplitude criteria as laid down in IS: 2974 and / or DIN 4024 and / or VDI 2056 and / or as required by the machine manufacturer, whichever is more stringent shall be satisfied. RCC design shall be done by working stress method for all machine foundations. A fatigue factor of 2.0 shall be considered for dynamic forces. Minimum reinforcement shall be governed by IS:2974 as well as IS:456. However minimum reinforcement in bottom face of the foundation raft resting on soil or pile shall not be less than 0.2% of effective cross sectional area of the raft.

The special requirements for concreting including grade, type of aggregate, use of admixture, temperature control, ultrasonic testing, etc. shall be as mentioned elsewhere in this specification.

- b) All block foundations supporting rotating equipment resting on soil or piles shall be designed using the elastic half space theory. The mass of the RCC block shall not be less than three times the mass of the machine. Dynamic analysis shall be carried out to calculate natural frequencies in all the modes including coupled modes and to calculate vibration amplitudes. Frequency and amplitude criteria as laid down in the relevant codes and / or by machine manufacturer whichever is more stringent shall be satisfied. Minimum reinforcement shall be governed by IS: 2974 and IS: 456. Minimum Reinforcement in base raft in either direction shall be as follows:-

i)	At bottom face	0.2% of gross cross-sectional area.
ii)	At top face	0.12% of gross cross-sectional area.

- c) For the foundations supporting minor rotating equipment weighing less than one tonne or if the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary. However, if such minor equipment is to be supported on building structure, floors, etc. suitable vibration



isolation shall be provided by means of springs, neoprene pads, etc. and such vibration isolation system shall be designed suitably.

- d) BFP, Mill, PA, FD & ID fan foundations shall be supported on vibration isolation system. The vibration isolation system shall consist of steel helical spring units and viscous dampers supporting the RCC deck which would support the machine. The spring units shall conform to DIN 2089 and DIN 2096.
- e) GERB or equivalent manufacturer's vibration isolation system shall be supplied for supporting machines like TG, BFP, Mill, PA, FD & ID fan.
- f) Isolation efficiency of at least 90% shall be provided for the Turbo generator, ID fan foundations.
- g) All approved drawings of equipment foundations shall be vetted by execution agency of civil works in order to match between the equipment sizing and foundation.

10.08.00 Increase in Stresses

10.08.01 Where stresses due to wind (or seismic) and temperature are combined with those due to other loads, the allowable stresses in concrete and reinforcement steel shall be increased by 33.33% in case of working stress design.

10.08.02 Bearing capacity of the soil / pile capacity shall be allowed to increase by 25% under seismic / wind load condition except for chimney where increase in bearing capacity/pile capacity is not considered.

10.09.00 Minimum thickness of structural elements:

The following minimum thickness shall be followed:

Flat roof slab	:	125 mm
Suspended floor / slab / walkways / canopy slabs etc.	:	150 mm
Ground floor slab (non-suspended)	:	200 mm
Water retaining slabs / walls	:	200 mm
Cable / pipe trenches / underground pits / Launder walls and base slab	:	125 mm
All footings (including raft foundations)	:	200 mm
Parapets	:	125 mm
Sunshades at edge	:	75 mm
Pre-cast louvers / fins	:	50 mm



Pre-cast trench cover slabs / floor slabs / louvers	:	75 mm
Paving	:	200 mm
Basement walls and base slab	:	200 mm
Silo / bin walls	:	150 mm
Underground reservoir:		
Below ground	:	200 mm
Above ground	:	150 mm

10.10.00 From fire resistance point of view minimum thickness of reinforced concrete members shall be as per fig. 1 or table 16a of IS:456.

10.11.00 MINIMUM HEIGHT FOR PEDESTALS / ENCASEMENT OF STEEL COLUMNS

10.11.01 Pedestals to steel columns for building structures

In case the top of pedestal is kept at a lower level so that the column base plate together with gussets and stiffeners remain below finished floor level (FFL) the column bases as well as the column sections shall be encased in concrete above FFL as per following:

- a. Open area : 500 mm above paved level
- b. Covered area
 - Internal Column : 1000 mm above FFL
 - Peripheral Column : 500 mm above FFL

Stair and ladder pedestal shall be kept 500 mm above the finished floor level.

Boiler structure supporting steel columns will be encased upto scarper feeder top level.

10.11.02 Pedestals to steel columns for equipment structure:

- a. Equipment in open area : As required (300 mm min.)
- b. Equipment in covered area : As required (150 mm min.)
- c. Structures and equipment : As per vendor's data subject to supplied by vendor minimum as specified above.

Dense and durable concrete with controlled water cement ratio preferably 0.45 shall be used for all underground concrete structures such as foundations, basements, pump



houses, water retaining structures, cable and pipe trenches etc. for achieving water tightness and durability.

All foundation, embedments, inserts, block-outs etc. required for equipment shall be provided by the Bidder.

Fly ash bricks shall be used for masonry work. Bidder shall ascertain himself at site regarding the availability of fly ash bricks of minimum 75kg/cm² compressive strength before submitting his offer.

Aluminium nosing shall be provided for edge protection in RCC stairs.

Wherever possible around floor openings an RCC kerb of 100 mm wide 150 mm high shall be provided. All concrete edges, where breakage of concrete corners expected shall be provided with angles of minimum size L 50x50x6 with lugs for edge protection e.g. all round the cut-outs I openings in floor slab, edges of drains supporting grating covers, edges of RCC cable I pipe trenches supporting covers, edges of manholes supporting covers and supporting edges of precast covers etc.

All cables & pipes in outlying area shall run above ground over steel trestles or other supporting structures for easy inspection & maintenance except in transformer yard area and some other localized area where the same can run in RCC trenches. However, for facilities for which buried pipe & cables are permitted by Purchaser, the same can be provided. In case of trestles, minimum 7.0 m head clearance shall be provided for road crossings. In other areas, the clear height shall be 3.0m minimum.

All cable and pipe trenches shall be of RCC of minimum M25 grade. Trenches located outside buildings shall project at least 200mm above the finished formation level so that no storm water shall enter into trench. The bottom of the trench shall be sloped suitably for draining out the collected water into sump pit. The pre-cast covers shall be of minimum M25 grade and shall not weigh more than 65kg. Lifting hooks shall be provided in the pre-cast covers. Pre-cast covers shall have edge protection angles at top and bottom on all the four sides along with lugs.

All construction drawing furnished by Bidder shall consist of total quantity of concrete (grade-wise), reinforcement steel (diameter wise) and structural steel (Section – wise).

Duct banks consisting of PVC / GI conduits for cables shall be sealed using approved fire retardant sealing compound.

All water retaining structures designed as un-cracked section shall also be tested for water tightness at full water level in accordance with IS:3370 (Part – I) and IS:6494.

10.12.00 Formwork Requirements

Refer Volume-VI, Part-B.

10.13.00 The number of construction joints in the columns of steam turbine foundation shall be restricted.

Construction joints at the following three locations shall be provided:

- a) At the meeting points of the columns and the raft.



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 61



- b) At the meeting points of the column and the top deck.

Additional reinforcement and shear keys shall be provided at the construction joints.

The base raft for steam turbine and GT foundation and table top for steam turbine shall be cast in single pour.

Mild steel bars required for earthing / grounding mat shall also be supplied and installed.

All cable vaults shall be located above ground level i.e. cable vaults shall not be provided as basements in the buildings. Minimum clear height below beam bottom shall be 2200mm in all cable vaults.

Connection work at terminal points is included in the scope of the Bidder.

All transformer / shunt reactor foundations shall be designed as per relevant IS Codes. This will include collection of oil, drainage of oil along with rainwater collected in such foundation.

Ground floor slab of all the building and RCC paving shall be of minimum 200mm thick of M-20 grade laid over minimum 75mm thick PCC and 230mm soling (minimum) course unless specifically mentioned otherwise. The reinforcement shall consist of minimum 8mm diameter bars at 200 mm c/c of grade Fe 415 at top and bottom in both directions.

10.14.00

Concrete Mix

The following minimum grades of concrete as per IS:456 shall generally be used for the type of structures noted against each grade.

a.	Grade M15	:	Fill concrete
b.	Mix (1:4:8)	:	Foundation below brick wall, blinding layer below foundations, trenches and underground structures, minimum thickness of the layer shall be 75 mm.
c.	Grade M20	:	Base plate encasement, pavement around building including plinth protection work, encasement of structural steel work, grade slab & grade beams etc.
d.	Grade M25 & M30	:	Chimney raft and all RCC members, e.g. foundation and superstructure, pedestals, roof slabs, cable and pipe trenches, water retaining structures, cooling water channel, CWPB forebay, raft & sump etc.



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 62



- e. Grade M35 : TG foundation, TG top deck, chimney shell etc. and for structures coming in contact with sea water.

For superstructure of RCC chimney and natural draft cooling towers richer mix may be used as per design requirement. However, requirement of Table-4 & 5 of IS:456 shall be satisfied as per the exposure condition. As per IS:456, exposure condition will be “severe” for all structures under the civil scope of work except for sea water intake well and pump house, cooling tower, CWPH forebay & sump etc. coming in contact with sea water, where in exposure condition shall be “very severe”.

Washing and screening of coarse and fine aggregates to remove fines, dirt or other deleterious materials shall be carried out by approved means, if desired by the Engineer-in-charge.

The water cement ratio by weight shall be 0.45 maximum including free moisture in the aggregate and slump should be suitably decided to provide good quality concrete work.

10.15.00 Special Painting For Sea Water Structures

All concrete surface coming in contact with sea water will be painted with 1.5 mm thick polyurea coating meeting ASTM D-16, Type V (two component, chemical cure). This will be applicable for pump house, Natural draught cooling tower and CW pump house forebay and sump, Clarified Water reservoir, Guard pond, Fire water sump, RO stage I Permeate Tank etc.

For NDCT inside surface special painting shall be provided upto 2.0m above drift eliminator level.

10.16.00 Allowable Settlement

The total permissible settlement and differential settlement of the foundations will be governed by IS:1904, IS:13063 and from functional requirements whichever is more stringent.

Maximum allowable total settlement should be restricted to 25 mm for foundations of all plant structures like cooling towers, CW pump house, DM plant, crusher house, transfer house etc.,

Maximum allowable total settlement should be restricted to 40 mm for all other foundations.

All foundations shall be so designed that the settlements are within permissible limits as per relevant Indian Standard or from consideration of safe equipment / machine operation whichever is critical. In case of open foundations without piles, Ground improvement methods opted by contractor, like sand drains / stone columns etc. to reduce settlement and increase the rate of settlement, detail methodology of such installation supported by calculation based on relevant field data shall be furnished for approval of Owner / Consultants before execution. In the event, the contractor adopts any patented method of ground improvement or retain any specialized agency for such purpose, the same can be done subject to prior approval of owner.



Boiler and ESP support structures shall be checked for differential settlement of foundations which shall be restricted to 1 in 1000 of span or 8 mm whichever is less.



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 64



11.00.00 DESCRIPTION OF BUILDINGS, STRUCTURES AND OTHER FACILITIES.

11.01.00 TEMPORARY STRUCTURES FOR EXECUTION

11.01.01 Construction water:

The OWNER shall provide water at one point within the plant boundary or a limited purpose such as for construction. The Contractor may avail this facility. Necessary charges for drawing the water shall be borne by the CONTRACTOR.

11.01.02 Construction Power

Construction power will be made available at a single point, metered and supplied on chargeable base by the owner. Further extension of power line to the various locations required shall be executed by Contractor at his cost. Contractor has to make provision of D.G sets as standby power source. This is especially in the case of structure involving deep dewatering as well as where uninterrupted concreting has to be resorted to. The bidder along with his bid shall indicate his average and peak power demand.

11.01.03 Temporary site buildings

The Contractor shall provide for at his cost the following building facilities for proper execution and quality control of the job, while meeting the provision stipulated by Factory Rules regarding staff welfare facilities. All these buildings shall have brick cladding, Steel / AC sheet roofing over steel roof truss with cement concrete flooring and false ceiling with A/C as required.

a) Site office for Owner

The site office shall make a provision of about 700 sqm of office area with A/C and false ceiling for the use of Owner / Owner's representative in addition to the Contractor's requirement. Additionally an A/C Conference room to accommodate about 70 people shall also be provided in the site office complex for the Owner's use. In addition to these, basic facilities like toilet for gents and ladies, potable water tanks, soak pit and septic tank for sewage disposal shall also be provided. Covered parking area for parking 10 cars shall also be provided for Owner's use. EPC Contractor to ensure that finished site office is handed over to owner within 3 months from the date of taken over the site by Contractor

b) Stores

A covered store shall be provided with brick cladding and G.I./colour coated sheeting to store at least one month requirement of cement. Cement in bags shall be stored on a raised floor well away from outer walls and insulated from the floor to avoid moisture. Not more than 15 bags shall be stacked in any tier. Each consignment of cement shall be stored separately and consumed in its order of receipt.

Covered storage area may also be provided to store other construction material which will be affected on exposure to wind, sun and rain.



Reinforcement shall be stacked on top of timber sleepers to avoid contact with ground / water.

Storage yard paved or unpaved shall be provided with in the stores complex for storage of other material.

Proper fencing and security arrangement shall be provided for the stores complex.

Contractor may consider using the existing building in the site with necessary repairs and restoration for use of this facility, provided the same does not interfere with construction of Permanent works.

11.01.04 Fabrication yard

Depending on the extent of fabrication envisaged at site, the CONTRACTOR shall establish a full fledged structural fabrication yard with adequate handling facility during and after the fabrication. A fully equipped testing laboratory providing radiography, ultrasonic, dye penetration, magnetic particle test facilities shall be ensured adjacent to the fabrication yard to enforce strict quality control. Portion of the yard shall have covered shed with H.O.T / E.O.T cranes so that fabrication work can proceed even during inclement weather.

11.01.05 Quality control laboratory

A fully equipped quality control laboratory shall be established at site with qualified personnel to conduct acceptance test on all construction material, weldments, concrete cubes etc. This laboratory shall be housed in a covered building with A/C facility as required by the testing facility. All testing equipment shall be periodically calibrated to the satisfaction of the OWNER. All testing shall be carried out in presence of OWNER. Finally the laboratory shall be handed over to OWNER in good condition after completion of project.

11.01.06 Fuel storage area

CONTRACTOR shall obtain necessary permission from competent authorities and establish and operate a POL outlet with proper storage, dispensing and adequate fire fighting facility.

11.01.07 Staff Welfare facility

CONTRACTOR shall provide adequate facility for his staff inside the plant boundary such as Toilets for both gents and ladies, Canteens, drinking water facility, rest places, creches etc.

Necessary approach roads to the construction facility complex and internal roads within the complex as well as proper drainage of the area shall be the CONTRACTOR's responsibility.

CONTRACTOR shall also provide for proper disposal of sewage and other wastewater to



meet with the requirement of Pollution Board.

CONTRACTOR shall identify sufficient area outside the plant boundary to locate his staff and labour colony. Construction and maintenance of the staff and labour colony to satisfy all statutory requirement is the sole responsibility of CONTRACTOR.

11.02.00 TURBINE GENERATOR BUILDING

Turbine building (TG bay and heater bay) framing shall be of structural steel with moment connected framing in the transverse direction and bracing in the longitudinal direction.

Service and maintenance bays shall not have any intermediate floors, however a 1500 mm wide observation gallery with handrails shall be given along the wall at the operating floor level to observe the TG erection operation. Intermediate floors shall preferably be provided at 8.50 m and operating floor at 17.0m. Floor at 8.50m and operating level shall be RCC floors over steel framing, where as the floor at any other level if required may have chequered plate supported on structural steel frame work.

Crane capacity and crane rail level shall be fixed based on the equipment to be lifted and the method of lifting generator stator. At crane girder top flange level a crane walkway shall be provided in line with factory rules. Access shall be provided to crane walkway through staircase from operating floor in addition to cage ladder at two ends. Bottom level of roof framing shall be decided by the crane clearance requirement duly taking into account clearance required for mounting light fixtures. Roofing shall consist of in-situ RCC slab of minimum 150 mm thickness laid to a slope of 1 in 100, constructed over permanently colour coated galvanized MS troughed metal sheet of approved profile supported on steel purlins and trusses. TG bay roof shall be provided with exhaust system.

Permanent colour coated sandwiched insulated metal cladding system from 3m (approx) above ground floor up to roof shall be provided on gable end and A row. Brickwork shall generally be provided from ground floor to 3m (approx) height. On other rows brickwork shall be provided upto roof level. Wall in front of transformers shall be of adequate thickness to satisfy "fire rating" as per TAC regulations. On the heater bay side the brick wall shall be provided upto 1m above deaerator floor level. Cladding beyond the above level shall of permanent colour coated sandwiched insulated metal cladding system.

Windows shall be side-hung steel glazed using 6mm thick wired glass generally. However in areas where cladding is of sheeting fixed glazing in anodized aluminium framework and in accessible areas sliding windows in anodized aluminium framework using 6mm thick wired glass shall be provided. All the doors on external walls shall be of double plate flush steel doors. For equipment entry into the service bay specially designed steel sliding cum / folding / rolling shutters shall be provided with appropriate operating mechanism. Rolling shutter shall also be provided in front of condenser to facilitate tube removal.

Staircase protected on all sides with fireproof enclosure shall be provided to satisfy LPA regulations. All the doors leading to the inside of the power house from staircase shall be automatically closing fire proof door satisfying LPA regulations. Access staircase shall be provided to TG building roof.



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 67



A roof shall be provided with roof water proofing treatment using high solid content liquid applied elastomeric water proofing membrane with separate wearing course as per ASTM-C-836 & 898. Thickness of the membrane shall be 1.5mm (min.). This treatment shall include application of polymerized mastic over the roof to achieve smooth surface and primer coat. Wearing course on the top of membrane shall consist of 25 mm thick PCC (1:2:4) cast in panels of maximum 1.2x1.2m size and reinforced with 0.56mm dia galvanized chicken wire mesh and sealing of joints using sealing compound/ elastomeric water proofing membrane. However, chequered concrete tile flooring 22mm (min.) thick of approved colour and shade conforming to IS:13801 shall be provided for path way of 1m width for access of personnel and handling of equipment and for the entire area of the roof where equipment like A/C ventilation plant, cooling towers, etc. are provided in place of PCC wearing course. Equipment shall be installed on raised pedestal of minimum 30 cm height from the finished roof to facilitate maintenance of roof treatment in future. HDPE rain water pipe of min. 150 dia OD conforming to IS:4984 shall be provided to drain off the rainwater from roof. They shall be suitably concealed from the façade.

Adequate no of roof extractors shall be provided As/mech layout details.

Thickness of structural RCC floor shall be minimum 150 mm above the steel floor beams for the intermediate floors with an additional 50 mm floor finish, which shall be provided later.

All the intermediate floors shall be provided with proper drainage. Catch pit with CI grills shall be provided near the internal column in a regular pattern and the floor shall be sloped towards the catch pit by varying the thickness of the bedding concrete for the floor finish. Catch pits shall be at the same co-ordinate for all floor levels. 80 NB galvanized MS pipes conforming to IS:1239 shall be provided to carry the drainage down. The pipes shall be clamped on to the intermediate column. Sumps shall be provided in ground floor to receive the water. Proper drainage arrangement shall be provided in the ground floor by means of RCC gravity channels with MS grills on top. The drainage shall be led to sumps from where the water shall be pumped to plant drainage, concrete kerb shall be provided to isolate the area and water shall be led through sump and channels to the floor drainage system. Oil water separator should be provided as required to isolate oil from the drainage water where the water is mixed with oil.

In operating floor the design live load shall be painted on the floors prominently showing the extent of the area where such loading is permitted.

Wherever openings are provided in the floor for handling of equipment using EOT cranes such openings shall be covered with gratings provided over removable steel beams.

Expansion joint shall be provided in the building to satisfy the requirements of IS:800 and IS:3414.

Suitable provision for future expansion shall be made by BIDDER while designing / executing the foundation system for last grid of main plant building.

In any case auxiliary columns shall not be supported on TG foundation. Preferably auxiliary columns shall be fabricated box section.



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 68



Separate Maintenance room for Turbine and Generator are to be provided.

11.03.00**CONTROL ROOM / ELECTRICAL BAY STRUCTURE**

The building framing shall be structural steel with moment connection in the transverse direction and bracing in longitudinal direction located by the side of turbine building. It shall be ensured that in front of control room no cross bracing is provided.

A minimum headroom of 3000 mm below beam bottom shall be given in the cable vaults. In control room false ceiling level shall be kept 4000 mm above furnished floor level

All floors shall be of deck RCC slab provided over structural steel beams with colour coated permanently laid deck sheet shuttering. Minimum uniform thickness of structural concrete above deck corrugation shall be 150 mm with an additional 50 mm provided for finish. Roof shall also be of in-situ concrete with colour coated permanently laid deck sheet shuttering. The concrete shall be given a slope of minimum 1 in 100 to effect proper drainage. No openings will be permitted on the roof of control room except possible opening for A/C duct to exercise proper control on air conditioning.

Cladding shall be of brick walls. Windows from switchgear room and control room / electronic cubicle room will not normally be allowed on the Boiler side to avoid coal dust nuisance. Walls shall normally be supported on wall/floor beams.

All the wall beams shall be provided with 50mm gunniting using Lugs and steel mesh.

Portion of the structural steel column projecting into the room shall be encased with brick masonry to shield it from fire hazards.

Cable vault in ground and second floor shall be provided with minimum 2 doors per unit. The doors shall be flush steel doors. No windows shall be provided on the turbine bay side

Switchgear room shall be provided with minimum two steel doors to satisfy statutory requirement. In addition a two leaf sliding doors of slush welded steel construction shall be provided to move the switchgears into the room making use of equipment lifting hatch provided in turbine building.

Main entrance to control room shall be provided with air locked lobby with automatic closing sliding glass doors. Lobby shall be formed of anodized aluminium framing with toughened sheet glass 6 mm thick. Partition between control room and adjoining rooms shall be of glazed aluminium partition with 300 mm high brick wall at bottom for toe protection. All the doors shall be single leaf glazed aluminium doors for all cabins. For movements of panels suitably sized double leaf aluminium glazed doors shall be provided. Control room wall upto the false ceiling level shall be of aluminium glazed partition on either side of air lock. In other area cladding shall be of brick wall. UPS room shall be provided with brick cladding all-round to reduce sound nuisance.

Battery room shall be provided with metal door. For Air washer room steel doors shall be used which shall be airtight. No window shall be provided in air washer room.



Necessary separation walls for the UPS charger, panels and the batteries in the battery room shall be provided.

Staircase properly enclosed to satisfy LPA regulations shall be provided at either ends of each unit. All doors leading to staircase shall be automatic closing fireproof door. Staircase shall not be provided around the passenger lift. Staircase shall extend upto roof. Toilets shall be provided at the switchgear room level and control room level. Toilet floors shall be sunk by 50mm and shaft shall be provided to route the soil pipe. Sunken floor shall be provided with damp proofing treatment.

Control room and electronic cubicle room is to be provided with false ceiling. False ceiling shall be designed aesthetically properly arranging, supply air diffuser, return air grill, fire protection sprinklers and light fittings. Aluminium ceiling system shall be provided. Under deck insulation shall be provided on the ceiling, on the walls and beams above false ceiling. Under deck insulation shall be provided for air washer room also.

Floor above control room where APRDS and other pipes are located as well as floor below the deaerator area shall be provided with proper drains to prevent any accumulation of water. This is very important to prevent seepage of water into the control room.

All openings in floor for switchgear and other panels shall be sealed with fireproof material after cables are connected. Adequately designed RCC storm water drains shall be provided to lead the roof drainage on to the plant drainage system. These drains shall have pre-cast RCC slotted cover. Plinth protection shall be given on the side of the drain up to the brick wall.

Provision of central control room shall be satisfied the requirement of vol. V also.

11.04.00

MILL AND BUNKER BAY BUILDING

The framing shall be of structural steel. This shall be designed as a moment connected framing in the transverse direction and braced in the longitudinal direction. These structures primarily support coalbunkers, coal feeders and tripper arrangement to feed the coal into coal bunker.

The bunker shall be circular in plan and shall have the capacity as per the requirement of steam generator.

A mill maintenance platform shall be provided at appropriate elevation to attend to routine maintenance. This platform shall be of chequered plate over steel framing with handrail all around. Above this floor a framing shall be provided to support under slung crane used for handling mill maintenance work. The crane runway girders shall extend to the full length of mill bay to enable approach to the service bay also.

Framework for supporting the circular bunker are provided above the feeder floor based on geometry of the hopper. Preferably bunker shall be supported on equally spaced (min.) 8 supports.

Bunker shall be provided with a top steel cover with slit openings for entry of coal. On sides of the bunker necessary openings shall have to be provided for bunker ventilation / dust extraction.



Tripper floor is immediately above the bunker. This floor is of RCC supported on structural steel framework.

Tripper roof shall be of RCC supported on structural steel framework. A fall of about 300 mm is given for the roof framing to effect proper drainage. Tripper roof supports bunker ventilation / dust supporting structure. An RCC parapet shall be provided for the tripper roof. Access stair/ladder shall be provided from tripper floor to roof in each unit.

In addition to the above, framing arrangement for structural steel platform at various levels around the bunker shall be provided with proper access ladder, for poking, striking and attending to air canons

Tripper floor and roof shall be given access through boiler staircase / elevators.

Bunker supporting structure is normally left uncladded up to the bottom of tripper floor. For tripper floor upto 3000 mm above finished tripper floor level, brick wall shall be provided. Above this level permanent colour coated galvanized trough sheet cladding shall be provided. Fixed steel windows with 6mm thick wired glass shall be provided in the tripper house as per requirements for conveyor gallery

Roof slab will be sloped to one side to permit easy drainage. Liquid membrane water proofing treatment is to be provided. As the roof is accessible and maintenance crew is likely to work on this floor, the entire roof shall be provided with min. 50 thick screed over the water proofing treatment.

Rainwater down take pipes shall be UPVC pipe of class-3 conforming to IS:4985.

One number goods cum passenger elevator, and two nos. of staircase shall provide access to all floor/platforms extending upto the roof level. These structures primarily support coal bunkers, coal feeders and tripper arrangement to feed the coal into coal bunker. Requisite nos. of corridor as per operational requirements shall be provided to access steam generator building from Mill building. The Mill building and steam generator building shall have expansion gap and corridor shall be connected with sliding supports.

Stainless steel liners shall be provided in bunkers for the conical / hyperbolic as well as vertical portion of Bunker. The grade SS liner shall be SS316L.

Colour coated metal deck sheet will be used below RCC floors, it shall be treated as shuttering material only. Uniform thickness of slab, excluding corrugations shall be min. 150mm. In this case, top of steel of beam shall be decided carefully.

11.05.00

STEAM GENERATOR AREA PAVING

Entire steam generator area upto the end of chimney shall be provided with RCC paving over rubble stone soling (for the details of RCC paving refer clause 10.13 of Volume-VI, Part-A).

Paving shall be carefully planned such that maintenance access roads of minimum 4m wide to all major equipment are available. This area shall be designed for heavy loads similar to design of roads. Such approach road shall be provided to the SG elevator also



to enable handling of equipment at higher level during maintenance. Such roadways shall be clearly identified with kerbs / painting. All drain / trench covers in these areas shall be designed to withstand truck loading.

The drainage of the entire SG area shall be properly planned. Network of RCC drains with RCC cover with slotted holes or MS grills shall be provided covering the entire area which lead the storm as well as process leakage water to the peripheral drains, which in turn will lead to plant drainage system. Where open drains are not permitted under ground pipes may be provided in which case at all junctions and ends proper manholes shall be provided to permit periodic cleaning of the pipes. All structural steel columns in the area shall be provided with encasing to a height of minimum 1000 mm above paving level and in addition the bases also need encasing if base plates are below paving level. For periodical cleaning of manholes suitable screens or baskets shall be provided for easy cleaning from time to time.

11.06.00 TRANSFORMER YARD

Generator transformer, station transformer, unit auxiliary transformer and service transformer are located in front of the turbine building. Transformers shall be installed on RCC foundations with rails on the top and oil soak pits filled with hard stone aggregate. Burnt oil pits are provided to collect leaked oil from the soak pit through salt glazed, pipes laid to slope. RCC blast wall / RCC frame with brick wall of adequate thickness and height to satisfy TAC regulations shall be provided in between transformers as fire barrier wall. Common oil sump & emergency oil sump with RCC roof shall also be provided with man hole arrangements.

RCC foundations shall be provided with rail to transport transformers out of transformer yard during maintenance. Entire area shall be surrounded with 3m high chain link fencing with gates. Where rails cross the fencing, fencing shall be made of removable type to facilitate transport of transformer. Floors shall be paved with plain cement concrete and shall be sloped towards peripheral drains, which shall lead to a sump from which the drainage is led through an oil water separator. The clear water shall be led to plant drainage. All oil sumps shall be covered with RCC cover slab with manhole arrangement.

11.07.00 ESP Control Room

ESP panel control room buildings shall be RCC framed building with brick walls plastered on both faces, complete with drains, space conditioning, and building lighting. The building shall have a separate air-conditioned area; and a separate non air-conditioned area except as required for the contained equipment. The contractor shall ascertain the building size according to the design requirements. ESP Transformer yard, firewalls & fencing shall also be provided as per requirement.

One RCC maintenance room of size 20X10 m² shall be provided.

11.08.00 SWITCHYARD STRUCTURES & CONTROL BUILDING

Extent of GIS switchyard and number of towers and gantries and the size of switchyard control room will be as per the layout of the switchyard which has been outlined in Vol. IV of the specification.



Switchyard control building will be of concrete frame structure having brick wall cladding. A crane of suitable capacity will be housed in switchyard building.

The building shall be complete with toilets, drains, plumbing, sanitary drainage and treatment piping, space conditioning for a non-air-conditioned area, building lighting, station combinations and fire protection etc. An adequately sized dedicated air conditioning plant shall be provided for the control room. For switchyard Civil Work refer Section-28 of Part-B, Volume-VI. Epoxy flooring shall be provided in all switchyard control room buildings and GIS buildings.

Maintenance room, Mini conference hall, Pantry room, battery room and EPBAX room shall be provided in these area.

Necessary covered pathways shall be made for GIS and other adjacent buildings.

11.09.00

INTAKE WATER PUMP HOUSE (AT EXISTING COOLING WATER FOREBAY OF NCTPS STAGE-II)

Near existing cooling water forebay of NCTPS-stage II, a pump house is proposed for makeup water with necessary modification of existing forebay at intake point. Raw water would be conveyed through steel conduits / pipe to the plant area.

The pump house structures shall be designed in accordance with IS-3370 (Part -1 to 4) . Cladding shall be of brick work. Crane girder shall be of steel. Cage ladder shall be provided for access to crane platform. Side of the pump house up to motor floor level on the pump discharge side shall be of RCC. Maintenance bay of the pump house shall have RCC grade slab with granolithic finish and non-metallic floor hardener. Motor floor shall also have similar finish.

Pump sump shall be designed as water retaining structure. Each sump shall be provided with stainless steel (SS 316L) groove for inserting coarse screen, fine screen and stop logs. Grooves for stop log shall be provided before and after the screens. Number of pump sumps shall be minimum of 3. Stop logs, coarse screen and fine screen shall be of material as mentioned in mechanical part of the specification. Top of the sump floor shall be kept same as of the top of forebay. This floor shall have openings for lowering the lifting of stop logs and screens. These openings shall be covered with galvanized mild steel gratings when the screens are placed in position. Provision for handling of the screens and stoplogs shall be made. Sufficient paved space shall be provided to keep the stop log when not in use and also for maintenance of screens. Galvanized MS handrails shall be provided on 3 sides of the pump floor (sump roof). Each individual pump sump shall also be provided with a drain sump to empty the sump for attending maintenance of pump.

Vertical wet pit type of pumps are envisaged in the pump house.

Dimension of the pump sump shall be decided as per mechanical requirements.

EOT crane of adequate capacity shall be provided for maintenance of the pumps and other auxiliary equipments.

An annex to sea water pump house shall be provided in RCC framed structure to accommodate switchgear and control room with cable vault below, chlorinator room and toilet block. Side cladding shall be of brickwork. All floors and roofs shall be RCC. Roof shall have proper slope and Elastomeric Membrane water proofing treatment shall



be provided and rain water down fall pipe shall be provided. Control room shall have false ceiling / false flooring and shall be air-conditioned.

Necessary office rooms 200m² and store room with adequate space shall be provided on the first floor of proposed pump house building annex as approved by Owner.

All doors shall be of aluminium for control room. For switchgear room, the main entrance door shall be of adequate size to facilitate movement of panels. All windows shall be aluminium glazed side hung.

Additional corrosion protection measures for steel, and concrete required if any due to the presence of sea water shall be submitted by BIDDER along with the bid.

11.10.00 CIRCULATING WATER SYSTEM

The circulating water system envisaged for the plant is sea water. From intake water pump house near the existing forebay of NCTPS STAGE-II, sea water will be pumped to CW forebay of proposed plant area. From CW pump house, water will be drawn by volute casing type CW pumps for condenser cooling.

From Intake water pump house to proposed CW forebay sea water will be conveyed through GRP pipes. The pipes shall be designed for worst possible combination of loads.

11.11.00 CW PUMP HOUSE, FOREBAY & COOLING WATER CHANNEL

The pump house and forebay structures shall be of RCC. Cladding shall be of brick work. Crane girder shall be of steel. Cage ladder shall be provided for access to crane platform. Side of the pump house up to motor floor level on the pump discharge side shall be of RCC. Maintenance bay of the pump house shall have RCC grade slab with granolithic finish with non-metallic floor hardener. Motor floor shall also have similar finish.

Pump sump, CW channel and forebay structure shall be designed in accordance with IS-3370 (Part 1 to 4). Each sump shall be provided with stainless steel (SS 316L) groove for inserting coarse screen, fine screen and stop logs. Grooves for stop log shall be provided before and after the screens. The stop log shall be epoxy painted and coarse / fine screens shall have stainless steel mesh over galvanized MS frame. Number and size of pump sump and stop log shall be as per the requirement of mechanical design. Top of the sump floor shall be kept same as of the top of forebay. This floor shall have openings for lowering the lifting of stop logs and screens. These openings shall be covered with galvanized mild steel gratings when the screens are placed in position. Provision for handling of the screens and stoplogs shall be made. Sufficient paved space shall be provided to keep the stop log when not in use and also for maintenance of screens. Galvanized MS handrails shall be provided on 3 sides of the pump floor (sump roof). Each individual pump sump shall also be provided with a drain sump to empty the sump for attending to maintenance of pump.



Since concrete volute pumps are envisaged separate pump floor, motor floor & valve floor shall be built in the pump house with proper access arrangements. Suitable staircase, ladders & cross-over platforms shall be provided.

An annex to the CW pump house shall be provided in RCC framed structure to accommodate switchgear room and control room and engine room with cable vault below, chlorinator room, Chlorine cylinder storage room and toilet block. Side cladding shall be of brickwork. All floor and roof shall be of RCC. Roof shall be given proper slope and heavy duty water proofing. Rain water down comers shall be of UPVC pipe of class-3 conforming to IS:4985. Roofs shall be made accessible by MS galvanized cage ladder. Staircase shall be provided from pump floor to operating floor.

Provision shall be made for installing three Nos. C.T blow down pumps at CW pump house to drain the C.T blow down water to sea.

All doors shall be of flush welded steel construction. For switch gear room, the main entrance door shall be of adequate size to transport the panels. All windows shall be steel glazed side hung. Wall in front of transformer yard shall be designed to satisfy fire rating as per TAC regulations with fencing.

An auxiliary transformer yard may be required in front of the switchgear room. Civil work similar to the transformer yard in front of ESP control room shall be included in the scope of work.

Outside the pump house support blocks for butterfly valves along with proper handling facility shall be provided.

Since soil is very soft in nature, piles shall be provided as a foundation system for CW pump house structures. PVC, PRV can be used to relieve uplift water pressure on the base slab of CW forebay. In this case, base slab of the CW forebay shall be designed for 60% of water uplift pressure.

Suitable thrust block to hold CW pipe line at various locations as per mechanical requirement is also in the scope of BIDDER.

RCC cooling water channel shall be rectangular shape and designed as a water retaining structure. Depth of channel and width of channel shall match with the width and depth of the cooling water channel from cooling tower. These branch channels shall join together and form common channel leading to the forebay of the pump house. Dimension of the channel to be decided on the basis of the quantity of water to be carried by the channel. Floor of the channel shall be given a mild slope to ensure necessary velocity of flow. The top of the channel shall be kept at least 500 mm above formation level with suitable galvanized MS pipe hand railing on either side. Expansion joint shall be provided at a spacing of about 30 m. Pedestrian cross over shall be provided across the channel at approximately 300 m centres. The channel shall smoothly diverge and form the forebay in front of the pump house.

Depth of the fore bay shall generally match with C.W. pump sump level, which shall be decided based on submergence requirement of the C.W. pumps at the lowest water level in the sump. Forebay shall be provided with cage ladder at four corners constructed with galvanized steel. Top of the fore bay shall be kept 500 mm above grade level and handrail of galvanized M.S. pipes shall be provided for the entire length on either sides.



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 75



Water level indicators (float type) shall be provided in the forebay close to the pump sump on either side to observe the depth of water.

11.12.00 CW Inlet and Outlet conduits

RCC Cooling water closed conduits of adequate size shall be provided from C.W pumps to condenser and hot water conduits from condenser to cooling tower. The inside of conduits shall be given special painting as per cl10.15 of this spec. conduits shall be checked for uplift considering water at FFL/FGL considering inside empty. Further it has to be designed for traffic load at road crossing.. The conduits shall be tested before commissioning of the system . RCC Duct shall be designed in accordance with IS-3370 (Part 1 to 4). Stress in r/f shall be limited to 130N/mm^2 as / IS 3370. Expansion joints shall be provided at spacing of about 30 meter. Following design requirements shall also be met:

- a) Provide a minimum clear distance of 1.5 m between ground level and the top of RCC.

Suitable protection devices such as air release valves shall be provided to ensure that design vacuum pressures are not exceeded.

- b) Internal Pressure Condition:

The design of CW ducts shall be done for the following conditions:

- i) Maximum design water pressure
- ii) Surge or water hammer pressure
- iii) Pressure, under testing condition.

- c) External Pressure Condition:

- i) It shall be designed for external pressure due to soil overburden, surcharge loading, ground water, applicable vacuum pressure etc. taken together.
- ii) Additional traffic load at road crossings.

- d) General Requirements:

It shall be designed as a RCC closed conduit water retaining structure subject to

- i) Maximum external pressure when inside empty
- ii) Maximum internal pressure in absence of outside soil
- iii) Uplift when inside empty and ground water level upto finished ground level.

- e) Maximum velocity of water in the duct shall not exceed 2.0 m/sec.

- e) The conduit shall be designed for surcharge of 2 t/m^2

- f) Manholes shall be provided at a maximum spacing of 150 m in



straight reach of conduit. One manhole shall be provided at all horizontal bends and one at the lowest stretch between two vertical bends. Manhole size shall be provided of 1.0m diameter.

- g) Thrust block/anchor blocks shall be provided at bends and other locations, if required, as per design.

11.13.00 FILTERED WATER/ FIRE WATER PUMP HOUSE AND TANK FOUNDATIONS

Dedicated Fire water storage shall be provided in the filtered water storage tank (RO Stage I Permeate) and the fire water pumps shall be installed in the filtered water pumphouse having two compartments with covered RCC roof. It will be over ground. Vent pipes shall be provided at the roof. The Filtered Water/ fire Water pump house shall be single storied flat roofed RCC building with brick as side cladding. Crane shall be provided for handling pumps in line with Vol III.

The building shall be complete with doors, windows and rolling shutter. Capacity shall be as per Vol. III and Composite Water Scheme.

The pump house shall include operator room, dinning room, maintenance room & toilet also.

11.14.00 NON PLANT BUILDING

11.14.01 Service building

The service building shall be a reinforced concrete framed building. The building shall be directly connected to the main plant building at operating floor. The floor area shall not be less than 1500 sqm in each floor. Number of floors shall be described by the Contractor depending upon the space requirements of various facilities. A minimum number of floors shall be 4 (four). The building shall generally be air conditioned with false ceiling. Elevators as indicated in Vol III shall be provided. Hence, clear head room below beams shall be designed to run AC ducts above false ceiling of these air conditioning areas. Level of false ceiling may be kept at 2700 mm in the ground floor and 2400 mm in upper floors in these air conditioned areas. For elevators, necessary civil works to be executed including foundation, roofing etc. based on Mechanical Specification. A grid of concrete beams and columns shall support the reinforced concrete roof (minimum 1% slope) and the floor slabs. The walls shall be of masonry construction, plastered internally and rendered externally. The service building shall have the following provisions:

- a. Seating accommodation for senior O&M executive along with supporting staff including modular furniture of latest style. For the accommodation of all Executives permanent brick wall not to be provided, instead wooden partition wall of cubicle type is to be provided.
- b. Safety and Welfare Cell, First aid room
- c. Reception, drawing hall, library, printer rooms and records room/ archives.



- d. Conference hall with all amenities like latest style modular furniture, loud speaker systems, Projector equipments, service room etc.
- e. Mini conference hall with furniture.
- f. Relay testing lab, electrical lab, C&I repair lab and transmitter lab.
- g. Pantry in each floor.
- h. Toilets – Ladies & Gents in each floor as per specification.
- i. Switch yard control room.
- j. Server room
- k. Battery room
- l. Simulator training room
- m. Connecting platform between TG building and Service building
- n. Electrical and LAN points at each seat in the cubicle, cabins & conference rooms with wiring and fittings.
- o. Minimum clear width of staircase in service building shall be 1.5m.
- p. Cabins for senior officers and conference rooms shall have attached Toilet. The cabins shall be provided wherever required as directed by the owner.
- q. Entrance to the building shall have glazed aluminium door swing type with double leaf. Glazed aluminium partition shall be provided on either side of entrance door. Internal partition in the building shall be provided with a combination of pre-laminated particle board and frosted glass in anodized aluminium framework. All doors to the cabins shall be teak veneered flush plywood door. In other utility areas, aluminium glazed or steel flush doors shall be used. Toilet shall be provided with PVC doors. All windows shall be of glazed aluminium sliding types. For windows located in the ground floor, aluminium grills shall be provided for security.
- r. The service building fascia shall have pleasing aesthetic. Landscaping shall be done around the area by developing garden with flowering plants and fountains etc.
- s. Polished teakwood handrail with stainless steel post shall be provided. At least one staircase shall lead to the roof.

11.14.02 Administrative Building

The Administrative building shall be a reinforced concrete Framed building with two floors having a minimum area of 1000 sqm in each floor. The floor area shall be as per the specification. The building shall generally be air conditioned with false ceiling. Elevators as indicated in Vol III shall be provided. A grid of concrete beams and columns shall support the reinforced concrete roof (minimum 3% slope) and the floor slabs. The walls shall be of masonry construction, plastered internally and rendered externally. The Administrative building shall have the following provisions:

- a. Safety and Welfare Cell, First aid room
- b. Reception, drawing hall, library, printer rooms and records room/ archives.



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 78



- c. Conference hall with all amenities like latest style furnitures, loud speaker systems, Projector equipments, service room etc.
- d. Mini conference hall with furnitures.
- e. Pantry
- f. Toilets – Ladies & Gents in each floor as per specification.
- g. Telephone Exchange of 500 lines
- h. Electrical and LAN points at each seat in the cubicle, cabins & conference rooms with wiring and fittings.
- i. Minimum clear width of staircase in administrative building shall be 1.5m.
- j. Ceiling fans

11.14.03 MAINTENANCE OFFICE CUM STORES

Maintenance office cum stores with provision for tool room of adequate shall be provided in the following area. This can either be fully independent building or can be part of Pump house / MCC / other buildings nearby.

- Minimum size shall be 5m x 5m
- Mill area – may be accommodated in GF of bunker bay or power house building
- Boiler area – may be accommodated in GF of ESP control building
- ESP area – may be accommodated in GF of ESP control building
- Ash handling area
- Coal handling area
- Cooling water pump house / Fore bay area – may be accommodated in GF of CW pump house or MCC building
- Sea water intake pump house area
- Sea water outfall pump house area
- Common for transformer area and Switch area – may be accommodated in GF of Switch yard control building
- Common for desalination plant / DM plant / Water treatment plant – may be accommodated in GF of DM plant
- Fuel oil tank area – may be accommodated in GF of fuel oil pump house.

11.14.04 Storage Yard

A storage yard of 7000 sqm shall be provided with a provision 4000 sqm covered area. The storage yard shall have compound wall of 3m height with anti climbing devise. Covered area shall be of RC construction with RCC roof and brick wall for side cladding. Office space and toilets shall also be provided. Entry & exit of trucks shall be thru rolling shutters of adequate size. In addition a 2 single leaf steel flesh door shall be provided for entry of the staff. Adequate windows shall be provided. The covered sheds shall be connected with bituminous roads in side storage yards. The storage yard shall be provided with 150mm thick gravel paving along with suitable drainage arrangement connected to plant drainage system.

It is preferable to adopt Pre fabricated / Pre Engineering structures for covered area of storage yard. The Structural Steel shall be confirm to IS 2062. The side wall shall be



brick cladding for a height of 1.0m above that color coated galvalume sheets of minimum thickness not less than 0.6mm shall be provided. The roof shall be covered with same sheet of adequate thickness to suit the design requirement. Transparent / Translucent sheet may be used to permit natural lighting. Sufficient number of roof extractor shall be provided for effective ventilation. Aluminum glazed windows shall be provided for natural ventilation and lighting.

EOT crane of suitable capacity shall be provided in storage yard at appropriate locations.

11.04.05 **Parking Sheds**

Parking sheds shall be provided at service building, security complex, at CW pump house area etc., at all locations for operating staff. Parking shed shall be steel framed structure.

The bidder has to furnish the three dimensional architectural plans along with the colour codes for the above buildings for approval of the Purchaser for adopting one among the alternatives proposed.

11.14.06 **Workshop**

The building shall house electrical , mechanical workshops and shall comprise the following facilities as a minimum requirement.

Mechanical workshop – consisting of carpentry, Machine shop (for lathes, drilling machines, grinding machines etc.) ,Fabrication / welding and store.

- b) Electrical room
- c) Offices, rest room and toilet
- d) Heavy vehicle shed
- e) Dozer shed

The workshop building area shall be based on the equipment layout during detail engineering. Minimum area of workshop shall not be less than 1000m². The building must have provision of EOT crane for handling. The building shall be of RCC/ steel framed structures with brick masonry side cladding. For other detail and finishes refer to Architectural specification.

11.14.07 **Fire Station**

Fire station shall be single storey RCC framed building with brick walls in office area. Provision for parking of 2 fire tenders including 1 bay for maintenance with pit, office, duty room, stores, recreating room, record room and toilet blocks shall also be made. In addition adequate space shall be provided for hose drying and drill ground. The arrangement shall satisfy the requirement of local fire brigade. Minimum area for this facility shall be 150sq.m.

11.14.08 **Canteen**

Canteen building shall be provided at 2(two) locations as indicated below for all personnel working in the power plant area.



1. Near the Admin Building with dining arrangement for 50 people at one time. This shall have a dormitory facility in the upper floor for 50 personnel (four separate halls for accommodating 5, 10, 10 and 25 personnel). Separate dining area for ladies with capacity of 20 personnel shall be provided.
One hall shall be provided with furniture for conducting meetings, retirement functions, etc.
2. Near the Service Building - The Canteen Building will be able to cater for minimum 300 persons with staggered meal times in four group with an interval of 30 minutes. Seating arrangement of at least 100 persons shall be made. In the upper floor a conference hall shall be provided with A.C. and other facilities as provided for the conference hall elsewhere in this specification. Separate dining area for ladies with capacity of 30 personnel shall be provided.

Both these Canteen buildings shall have the following facilities provided as a minimum requirement

- a) Kitchen
- b) Pantry
- c) Stores
- d) Space for Plate , pot wash and hand wash.
- e) Area for freezer / refrigerators
- f) Staff rooms and toilets
- g) General gents and ladies toilets
- h) Administrator / caretaker room
- i) Dining Hall and service counter
- j) Parking area.

Tables and chairs in the dining hall shall be fixed to the floor and shall have heavy duty stainless steel topping.

Sinks and wash basins shall be of heavy duty stainless steel.

An Air-conditioned VIP Dining room shall be provided for 15 people. General Dining room shall be with Desert Coolers

The building shall be of RCC framed structure and flat roof with brick masonry as side cladding. Architectural details shall be as per specification.

11.15.00 MISCELLANEOUS PLANT BUILDING

11.15.01 Air Washer Room & Compressor House

This shall be a single/double storied steel framed building adjoining to the Turbo generator bay. Roof shall be of RCC supported on colour coated trough shaped permanent decking supported on steel beams. Side cladding shall be by brick supported on concrete encased steel beams. Internal wall surfaces shall receive cement mortar plastering mixed with water proofing compound. Water tank and RCC supporting structures for louvers, filter and foundation for equipment such as fans and pumps are also included in the scope. Proper drainage of the floor has to be provided for. Doors shall be of flush welded steel and they shall be made airtight. Rolling shutter of adequate size should be provided for taking the equipment inside and truck with compressor. The



roof framing shall support an underslung crane of adequate capacity. Compressor foundation shall be isolated from the grade slab. Air receiver and Air drier can be supported from RCC grade slab. All trenches shall be sloped towards drain sumps. Trenches shall be provided with chequered plate cover. Steel glazed windows shall be provided for ventilation and natural lighting. A minimum of 2 flush type steel door shall be provided for movement of personnel. Dimension of the building shall be decided by the CONTRACTOR to suit the dimension of the equipment he is supplying duly taking into account maintenance requirements.

11.15.02 Diesel Generator House

This shall be a single storied RCC framed structure with electric hoist. The dimension of the building shall be decided by the CONTRACTOR to suit equipment supplied. D.G set foundation shall be isolated from the floor.

All trenches shall be of RCC and shall be designed as water retaining structure. There shall be no entry of cables / pipes to these trenches below grade level from outside. All these trenches shall be covered with chequered plate over steel framing. Adequate number of sumps shall be provided to drain these trenches.

11.15.03 Pipe racks and cable racks

All cable and pipe routing in out lying area shall be clubbed and shall run over ground on structural steel 'pipe / cable' racks at a height not less than 4000 mm clear above grade level. Where the pipes cross roads / railway clear headroom shall be 8500 mm. The racks can be multi-tiered. Cable shall normally be laid above the pipes.

Pipe racks/cable racks shall be of structural steel frame and longitudinally braced and shall be designed for worst combination of loadings. Expansion provision shall be provided wherever there is a change in direction or where length of the rack exceeds 100 metres.

Pipe racks for all connections from the existing station, existing pipe racks is to be used with necessary modification (or) new rack is to be erected.

All pipe & cable racks shall be provided with minimum 750mm wide walkway.

Necessary access ladders and platforms to be provided for maintenance. Where so required chequered plate platforms shall be provided for maintenance purpose. Pipe rack columns shall be supported on RCC foundation with bottom of base plate 300mm above adjoining ground level.

11.1600 FUEL OIL HANDLING SYSTEM

Unloading pump house to unload oil from road tankers shall be of single storey structural steel frame structure with GI sheet roofing and Brick walls. A paved platform shall be provided between the pump house and the road tanker parking area with plain cement concrete over rubble soling, sloped towards a peripheral drain. The drain will be led to a sump with oil water separator. No cable trenches will be permitted in the pump house.



Road level of fuel oil handling area shall be decided carefully so that oil from tanker can flow to unloading house under gravity flow only.

Fuel oil pressurisation pump house will house fuel oil pumps, heaters, operator room, toilet and MCC's. This is a single storeyed RCC framed structure with RCC roofing. The pumps will be located in an R.C.C basement. Protective hand rail shall be provided all round the basement. MCC shall be located at plinth level. Proper access shall be given to the basement. Basement shall be given proper drainage facility. The oil / water mixture collected in the sump will be led to an oil water separator. The basement shall be designed as a water retaining structure. Electric hoist crane or monorail facilities will have to be provided in all the pump houses as specified in the Mechanical section of the specification.

Fuel oil tanks shall be of structural steel designed as per IS:803. Foundation of the fuel oil storage tank shall be provided with bitumen sand mixture laid over confined river sand bedding formed with RCC ring beam. The type of foundation to be adopted will depend on the soil condition. Where soil is very poor, tank may have to be founded on concrete pad resting on piles or the bearing capacity will be improved using ground improvement technique.

The storage tanks shall be surrounded by RCC wall to prevent the spread of fire or leakage of oil from a leaking tank to other areas. The 750 mm wide walkway shall be provided on the dyke wall all-round. The height of the wall, c/c spacing of tanks as well as area provided within the concrete wall are to be decided based on the statutory requirements for the type of oil stored and the quantity of oil stored. The entire area outside the tank foundation and within the tank farm shall be paved with concrete. The paving shall slope towards RCC peripheral drains which shall lead to an oil water separator. RCC crossovers shall be provided at appropriate locations for entry of personal to the tank farm. Fuel oil storage area shall be protected by chain link fencing as in the case of Transformer yard. Extent of fencing shall be to satisfy statutory requirement. Foundations for trestles and pedestals for supporting the pipes, anchor blocks etc shall provided in RCC at appropriate locations.



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 83



12.00.00 REINFORCED CONCRETE CHIMNEY**12.01.00 Scope**

This specification covers the general requirements for design and construction of reinforced concrete twin flue chimney of circular cross section including RCC shell, steel flue, internal platforms, staircase, appurtenances, fixtures, fittings, conduit and other embedment, lift (inside windshield), natural ventilation etc. complete.

12.02.00 Codes and Standards

a)	IS:456-2000	:	Code of practice and reinforced concrete
b)	IS:4998	:	Criteria for design of reinforced concrete chimneys – Part 1 Design Criteria -1975
c)	IS:4998	:	Criteria for design of reinforced concrete Part 1 Assessment of loads - 1992
d)	IS:875 (All Parts)	:	Code of Practice for Design loads for buildings & Structures
e)	IS:1893-2002 (Part-1) Fifth revision	:	Criteria for earthquake resistant design of structures
f)	IS:1893-2002 (Part-4)	:	Criteria for earthquake resistant design of structures: Part 4- Industrial structures including Stack like structures
g)	IS:432 (Part 1)	:	Mild steel and tensile medium steel bars
h)	IS:1786	:	Cold twisted steel bars for concrete reinforcement
i)	IS:800	:	Code of Practice for general building construction steel.
j)	IS:158	:	Ready mixed paint, brushing, bituminous, black. lead free, acid, alkali, water and heat resisting for general purposes.
k)	IS:1239	:	Mild steel tubes, tubulars and other wrought steel fittings, Part-1 – Mild steel tubes
l)	IS:1904	:	Code of practice for design and construction of foundations in soils : General requirements
m)	IS:2062	:	Hot Rolled low, medium & high tensile structural steel.
n)	IS:3043	:	Code of practice for earthing



- o) IS:3346 : Method for the determination of thermal conductivity of thermal insulation materials (two slab guarded hot plate method)
- p) IS:3677 : Un-bonded rock and slag wool for thermal insulation.
- q) IS:8183 : Bonded mineral wool.
- r) ASCE-1975 : Design and construction of steel chimney liners. Task committee on steel chimney liners, Fossil Power Committee, Power Division, ASCE.
- s) IS: 6533 : Design construction of steel chimney- code of Practice
(Part1 &2)
- t) Vickery, B.J “Wind Induced Loads on Reinforced Concrete Chimneys” Paper presented at National Seminar on Tall Reinforced Concrete Chimneys, 25-27 April, 1985, New Delhi.
- u) Vickery, B.J. and Basu, “The response of reinforced concrete chimneys to vortex shedding”, R I Journal of Engineering Structures, 1984, Volume-6.
- v) Manohar, S.N. “Tall Chimneys – Design and Construction”, Tata McGraw Hill Publishing Company limited, New Delhi.
- w) Pinfold, G.M, “Reinforced Concrete Chimneys and Towers”, View Point Publication, cement and concrete association, U.K.
- x) The requirements of department of Civil Aviation, Government of India.
- y) Reference may also be made to ACI:307-1979 “ Specification for design and construction of RC Chimney”, if some items are not covered in India Codes.

12.03.00 Design Parameters and Requirements

12.03.01 General

- a) General parameters of the chimney:
 - 1) Total height of the chimney above grade level : 275 M
 - 2) Number of flues : 2
 - 3) No. of boilers : 2
 - 4) Exit velocity of gas at top :
 - 5) Density of gases :



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 85



6)	Volume of gases	:	
7)	Temperature of flue gases	:	
8)	Inlet duct center line elevation	:	As per Boiler manufacturer's drg.
9)	Inlet duct opening dimensions	:	As per Boiler manufacturer's drg.
10)	Internal diameter of flue	:	As per design.
11)	Maximum ambient temperature	:	
12)	Minimum ambient temperature	:	
13)	External diameter of windshield : at top of raft (min.)	:	
14)	Minimum top shell thickness	:	400 mm
15)	Minimum bottom shell thickness:	:	As per design requirement, but not less than 950mm.
16)	Chimney foundation type	:	
17)	Flue gas pressure at chimney entry level	:	

12.04.00 Grades of concrete and steel

Concrete grade to be used for foundation and shell shall be M30 (minimum). Cement content in concrete shall not be less than 400kg/m^3 .

Cement to be used for pile cap and below grade level shall be sulphate resistant cement with C_3A content 5 to 8%. For above grade level 43 grade ordinary port land cement shall be used. Only one grade of cement shall be used throughout the height of shell.

HYSD bars of grade Fe 415/ Fe 500 bars conforming to IS 1786 shall be used as reinforcement. All the reinforcement bars to be used for below grade and above grade structure shall be fusion bonded epoxy coated only.

Structural steel sections to be used for flue shall be corrosion resistant steel type "COR-TEN-B" having an yield stress 250MPa conforming to IS 2062 (E250) of minimum thickness 10mm unless noted.

12.05.00 Design Criteria

12.05.01 Dead Load



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 86



All permanent loads due to the weight of chimney shell, internal platforms and lining supported on them, ladders, flue ducts, staircases, other accessories etc.

12.05.02 Imposed Load

- i) Imposed load on service platform around Chimney shall, shall be taken as 500 Kg/m². Design live load during construction / erection shall be considered as 1000 Kg/m².
- ii) Imposed loads from duct joining the Chimney shall be considered.

12.05.03 Wind Load

Wind load calculation will be done as per IS:4998 (Part-1) and IS:875 (Part-3) Dynamic analysis will be carried out and stability ensured under such condition.

Wind parameters to be considered for calculating design wind speed and pressure shall be as follows.

Basic wind speed = 50 m/s (upto 10m above normal ground level) as per IS:875 (Part-3) : 1987.

K1	=	1.08
K2	=	(Table 2 & Table 33, Category = 1, Class-B)
K3	=	1.0

A provision of 10% increase in the wind load forces (due to dynamic interference effect) as calculated based on relevant codes, shall be considered in the initial designs. However, for final designs, the increase can be as per the recommendations of the agency carrying out wind tunnel studies.

12.05.04 Seismic / Earthquake Load

Earthquake forces acting on the Chimney and analysis for the same shall be carried out as per IS: 1893-2005 using the Response Spectrum Method and 5% damping shall be considered for the analysis. The analysis shall be furnished for a combination of five modes.

12.05.05 Thermal Effect

Due to the effect of temperature gradient ΔT , vertical and circumferential stresses are developed. These stresses induced in the concrete shall not exceed values given in IS:4998.

Flue gas temperature at inlet / exit 127⁰C (approx.)

The temperature gradient ΔT across the shell thickness of windshield shall be calculated as per IS: 4998 (Part-I) – 1975 but subject to a minimum of 20⁰C. Temperature stresses will be calculated according to the procedures given in ACI-307 and IS: 4998.

12.05.06 Local Loads

Effect of local loads such as moment produced by corbels, platforms, ovaling, oscillation and thermal gradient in addition to other if any shall also be considered.



12.05.07 Load Combination

Various load combination for calculation of stresses shall be as under.

- a) Dead load.
- b) Dead load + Wind Load
- c) Dead load + Earthquake forces.
- d) Dead load + Temperature effect.
- e) Dead load + Wind load + Temperature effect.
- f) Dead load + Earthquake force + Temperature effect.
- g) Circumferential stresses due to temperature effect.
- h) Circumferential tensile stresses due to wind inducing ring moment.
- i) Circumferential compressive stress due to wind induced ring moment combined with temperature.

In Load combinations (a) to (f) above, dead load considered shall be with or without the weight of steel lining for flues & platforms, whichever condition is more critical shall be adopted for design. Across wind loads shall be combined with co-exiting along wind loads. The combined design moment at any section shall be taken as SRSS of the moments due to across wind loads and co-exiting along wind loads.

12.06.00 Permissible Stresses for Chimney Shell

The Stress in Steel reinforcement and concrete shall not exceed the limits as prescribed in clause 7.0 of IS:4998 (Part-1) – 1975 for various combination of loads. Except for case of (dead load + wind load), the maximum permissible stress in concrete in this case shall not exceed $0.275 F_{ck}$.

Where F_{ck} – Characteristic compressive strength of concrete

12.07.00 Analysis**12.07.01 Wind Analysis**

2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 88



The “gust factor” will be calculated according to the method given in IS:4998 (Part-I) – 1992. Dynamic modulus of Elasticity of concrete as recommended in IS:4998 (Part-1) – 1992 will be used for calculating the natural frequencies of the chimney.

C_d will be taken as 0.8 for the concrete shell in general. It will be increased to 0.96 as per IS:4998 over the portion covered with strakes, if required.

Along wind response of chimney shall be calculated both by gust factor method in A-5.1 and simplified method in A-4.1 of IS:4998 Part-1, 1992. For design, higher of the along wind loads shall be used.

The across wind response of the Chimney will be evaluated as per IS:4998 (Part-1)/ACI307-98. Whether strakes will be provided or not will be decided only after wind tunnel test results.

12.07.02 Ring Moments Due to Wind

The circumferential ring moment due to wind will be calculated in accordance with clause 5.4 of IS:4998 (Part-I) – 1992. The wind induced stresses in concrete and steel shall be calculated in accordance with Cl. No. D-2.2.7, D-2.2.8 and D-2.2.9 of IS:4998 (Part-I) – 1975.

12.07.03 Seismic Analysis

The Seismic Analysis will be carried out using the Response Spectrum Method according to IS: 1893-2002 taking the first 5 modes of vibration in the account.

12.08.00 Component Design Criteria

12.08.01 Shell

The design conditions for the concrete shell shall be as follows:

- 1) The concrete shall be designed for natural phenomena and loads and loads combinations as specified in CL-18.5.7. Working stress method shall be used for design of shell. The modular ratio shall be calculated as per Annexure – B of IS-456 – 2000.
- 2) The permissible stress in concrete and steel reinforcement shall not exceed the specified in CL-7.0 of IS:4998-1975 for various load combinations. Permissible stresses in concrete shall be taken as .275F_{ck} for the load case (dead load + wind load) against the value specified in CL-7.1.1(a), IS:4998 (Part-1)-1975. The stress in concrete at the junction of shell and foundation will be limited to 0.275F_{ck} where F_{ck} is the characteristic compressive strength of the weaker concrete between shell and foundation.
- 3) The thickness of RCC shell shall be provided as required by stress calculations. However, the thickness of the shell has also to be determined on the basis of wind tunnel model studies and any increase, in the thickness of shell or quantities required to be made as per report shall be followed without any extra cost.



- 4) Stresses in the shell shall be checked at 10metre intervals along the height of the shell or at every corbel location or whichever distance is less these stresses shall be within permissible limits.
- 5) The maximum deflection at the top of the chimney for both static and dynamic cases shall not be more than $H/500$ where H is the total height of the windshield above top of the pile cap.
- 6) The dynamic modulus or elasticity of concrete for various concrete grades shall be taken as lower values in the range of values specified in IS:4998 (Part-I) – 1992.
- 7) The static modulus of elasticity of concrete shall be taken as under.
 $5000\sqrt{f_{ck}}$ for instantaneous loadings. Where f_{ck} is the characteristic compressive strength of concrete as per clause 6.2.3 of IS: 456-2000.
- 8) Minimum thickness of the shell at top shall be 400mm.
- 9) Reinforcement in the shell shall be provided as per IS:4998 (Part-I) – 1975. Minimum 0.125% reinforcement shall be provided on either face and on either side of foundation. However, the maximum spacing of reinforcement shall not be more than 250mm both ways in the shell and 300mm for foundation pile cap.

While providing vertical reinforcement steel in the shell, the total number of vertical bars shall be continued till such height when alternative bars can be discontinued. However, reduction of bar diameter along the height is permissible. At any section of the shell vertical bars shall be uniformly spaced. Non uniform spacing of vertical bars is not acceptable.

One third of the vertical bars can only be lapped at one section.

However, for a height from the top equal to half the shell outer diameter or 3 metres whichever is more, the quantity of circumferential reinforcement shall be twice that arrived at as stated above due to design considerations.

Circumferential reinforcement shall be placed around the exterior of and securely wired or welded to the vertical bars at an interval of not more than 600mm.

- 10) Openings in the shell shall be provided for ductworks, access doors, ash channel and ventilation system etc. The maximum width of opening shall be limited to an angle of not more than 30° subtended at the centre of the concrete shell.

The total plan area of the openings at a particular section shall not be more than 15% of the plan area of concrete shell at that location. The opening size for the purpose of stress calculations shall be taken as 1.1 times the actual width of the opening. The extra reinforcement around opening shall satisfy the requirements given in the following documents and the highest shall be provided.

- a) IS:4998 (Part-I)
- b) ACI 307.



- c) Reinforced concrete chimney and tower by M.G. Pinfold. The value of K1 as given in the book by M.G. Pinfold on page no. 186 shall be taken as 0.11.
- d) Minimum half number of extra horizontal bars in shell around the openings to continue for complete circle all round for both faces and both sides.
- 11) Embedments to support the stair case shall be provided in the shell
- 12) Expansion anchors shall be used to attach conduit, lightning and protection equipments, lighting fixtures and other lightweight appurtenances.

12.08.02**Foundation**

The chimney foundation will be resting on piles. A circular pile cap preferably annular shall be provided. The pile cap (min. M-30) shall be designed as rigid member with uniform thickness and no tapering of thickness shall be allowed. Minimum thickness of pile cap shall neither be less 0.09 times the diameter of pile cap or 0.4 times the overhang of the foundation beyond shell whichever is greater. Foundation diameter to depth ratio shall not exceed 12. Minimum reinforcement shall not be less than 0.12% in either face and in each direction. Wind and earthquake shall be treated as normal load and no enhancement of stress is permitted on this account in soil, concrete and steel. No tension will be allowed under the pile cap during earthquake and wind. Working stress method shall be adopted for design of foundation. Foundation will be designed for SRSS of moments of along wind response and across wind response.

12.08.03**Steel Liner (Flue)****1. General**

Liners shall essentially be constructed from structural steel and shall be of the hung type (i.e. of tension type). The liners shall be provided with externally wrapped thermal insulation. The portion of the liners projecting above the chimney roof shall be constructed of stainless steel. Stainless steel liner shall commence immediately above the flue supporting platform but below the roof supporting platform.

The liner shall be of corrosion resistant steel type "COR-TEN B" of minimum 10 mm thick. Top 10m length or length equal to 2 times flue diameter whichever is larger shall be provided using material confirming to AISI:316L or BS:1449. The liner shall be supported atleast at five different levels, and restrained laterally at several levels, with a small length at the bottom near breach elevation supported from the bottom with a suitable expansion compensator in between.

The structural steel transition inlet ducting shall be bottom supported. The transition ducting shall be suitably profiled from a rectangular shape at the chimney inlet to a circular shape up inside the chimney where it shall be connected to the suspended circular steel liners through suitable (non-metallic) fluoroelastomeric fabric expansion compensator.

2. Design of Steel Liners

Steel liners shall, in general, be designed meeting the requirements of the document, "Design and construction of steel chimney liners", prepared by Task committee on steel chimney liners, Fossil power committee, Power division published by ASCE-1975.

The flue diameter shall be so sized to ensure that the flue gas exit velocity is of the order of 20 to 25 meters/second at the normal continuous operating load. It should be ensured that the flue gas exit velocity at the lowest continuous unit load is high enough (of the order of 15 meters/second) to enable adequate dispersion of the flue gases. For this purpose, 100% turbine MCR condition with design coal firing shall be considered as normal continuous operating condition, and 60% turbine MCR condition with design coal / worst coal firing (whichever yields lesser flue gas quantity) shall be considered as the lowest continuous load condition.

The supporting / restraining arrangement of the liners should be such that expansion of the liners longitudinally or circumferentially is not restrained.

Clear space between flues in multi-flue stake shall be 1000mm after insulation is installed.

3. Insulation

(a) On exterior surface of flue.

The flue shall be insulated externally. The insulation shall be semi-rigid, resin bonded type, in the form of slabs and shall conform to IS:8183. Blanket type insulation shall not be used. The density of insulation shall not be less than 64 kg/cum for resin bonded rock wool. Maximum coefficient of thermal conductivity shall be 0.062 Kcal/m/hr/ $^{\circ}$ C at a mean temperature of 150 $^{\circ}$ C.

The insulation thickness shall be determined based on the maximum ambient temperature, surface air velocity worked out based on the draught of ventilation air in the annular space between the flue liner and chimney shell, insulation surface emissivity of 0.3 and the insulation cold face maximum temperature not exceeding 60 $^{\circ}$ C. The draught of air in the annular space shall be the natural draught by the heating of air by the flue liner and the air being vented out through the openings in the chimney shell. The increase in the annular air temperature due to the rising heated air shall be taken into account while calculating the insulation thickness. However, a minimum of 50 mm thick (2 layers of 25 mm) insulation shall be provided on the external face of flue.

The insulation shall be tightly secured to the exterior surface of the liner by impaling them on studs welded to the surface at 450mm c/c both horizontally and vertically. The studs shall be galvanized plated and be of a minimum thickness of 10 gauge and 75 mm wide. The studs shall extend a minimum of 25 mm beyond the thickness of insulation. Circular or square metal plate speed washers of standard thickness shall be placed on the extended portion of the studs to hold the impaled insulation material well in place. Further, 20 gauge galvanized wire mesh with a 25 mm hexagonal pattern conforming to IS:3150 shall be wrapped around. Where the wire mesh is jointed, a minimum 150 mm overlap shall be provided. The mesh shall be bound and tied in place with a 16 gauge GI wire at 300 mm centers. Any form of lacing the mesh fibres together will not be permitted.



Insulation for the exposed portion of flue at the top shall consist of 6 layers of insulation material each of a minimum thickness of 25 mm and all joints shall be staggered. The material shall have a minimum density of 200 kg/cum. This shall be protected from the elements by means of a stainless steel cladding, flashing and hood of grade 316 L stainless steel.

Testing of insulation material to satisfy the specific requirements and properties as outlined in this specification IS: 8183 and in the relevant drawings by the contractor shall be carried out.

Insulation materials shall be added to walls where necessary to reduce cooling loads. Also, insulation shall be used for sound absorption on walls which enclose equipment that has been determined as generating excessive noise. This sound insulation shall be provided in interior concrete block, sound block, or insulated metal wall panel liners as appropriate. The liner panels shall be as described above, except they shall include perforations and insulation enclosed in plastic bags. The overall noise Reduction Coefficient shall be 0.80 or better.

(b) Load Bearing and Side Restraints of Flues

Load bearing insulation assembly to have (i) a properly machined mild steel plate with recess at its top for seating PTFE (Poly Tetra Fluoro Ethylene) sheets conforming to BS:5400 (ii) saddle plate (MS) in the middle having stainless steel plate fixed at its bottom surface and lead / elastomeric sheet at top, and (iii) top plate formed of two numbers insulation blocks each made of minimum 50 mm thick rigid, non-combustible asbestos fibre reinforced lime-silica board (SINDANYO BLOCKS NATURAL GRADE CS-51) or equivalent bonded to mild steel plates at top and bottom. For side restraints assembly of insulation blocks of SINDANYO Natural Grade CS-51 or equivalent and stainless steel plate shall be used. All stainless steel in these assemblies shall conform to AISI-316L and mild steel to IS:2062. SINDANYO BLOCKS or equivalent shall be suitable for operation at 320°C and shall primarily satisfy the following physical properties:

- i) Minimum compressive stress prior to onset of compression yield of not less than 12 N/sq.mm.
- ii) Minimum shear strength of 30 N/sq.mm when tested in accordance with BS:3497-1979.
- iii) Thermal conductivity shall not exceed 0.67 W/m Deg.C at a mean temperature of 200°C and its coeff. of linear expansion not to exceed 1.2×10^{-5} per Deg.C.
- iv) Adhesive used for bonding purposes shall be of material with equivalent high temperature properties as approved Foundation Engineer. It may be of "Fortafix Fiborclad Adhesive" as manufactured by Fortafix Ltd., England or equivalent.

The insulation thickness shall be determined based on the maximum ambient temperature, surface air velocity worked out based on the draught of ventilation air in the



annular space between the flue liner and chimney shell, insulation surface emissivity of 0.3 and the insulation cold face maximum temperature not exceeding 55°C. The draught of air in the annular space shall be the natural draught created by the heating of air by the flue liner and the air being vented out through the openings in the chimney shell. The increase in the annulus air temperature due to the rising heated air shall be taken into account while calculating the insulation thickness. The insulation thickness shall not be less than 100 mm, in any case, and shall be provided in two layers with the second layer of insulation covering the joints of the first layer. The insulation shall be wrapped on the outer most surface with galvanized wire mesh.

4. Liner Hood:

The liner hood provided at top of flue shall be fabricated from 6mm thick (minimum) stainless steel sheets of grade 316L. The hood shall completely cover the annular area packed with insulation material between the stainless steel flue and cladding. All sections of the hood shall be anchored in places with stainless steel bolts / nuts. Slot holes shall be provided to make allowances for differential expansions / movements.

12.08.04 Internal Platforms

Internal platforms shall be provided (minimum 5 numbers excluding roof platform) unless indicated otherwise in Data Sheet-A.

The platform shall be supported on a grid work of structural steel beams supported from the wind shield. Topmost grid work shall support RCC roof slab, where as other grid work shall support M.S. gratings as required from functional requirement. Corrosion allowance of 2 mm (minimum) shall be kept in the design of girders. Live load for the design of platform shall be 5 kN/sqm.

The members of the beam grid shall be assembled by high precision bolted connections only. The member dimensions shall be made to suit the as built dimension within the wind shield. The beams shall be painted with 2 coats of zinc silicate primer and 2 coats of heat & acid resistant epoxy paint of approved brand and shade after surface preparation as per IS:1477.

The support of the beams on the R.C.C. shell shall be so designed that only vertical load is transferred to the wind shield without any temperature effect and local torsional / local bending moment.

After fabricating, the members of the individual platforms shall be pre-assembled at ground level and checked for trueness with respect to dimensions and orientation.

The gratings shall be fabricated from M.S. flats comprising of 40x5 thick bracing bars spaced at 40 c/c and 25x4 thick space bar. The grating shall be hot dip galvanized.

Handrails shall be provided with kick plates 65x8 mm along the platform edges. Openings for the elevator shall also be surrounded by a handrail as above, with a hinged gate section on the elevator door side only. The same arrangements shall be provided at all stair case landing/ladder access points, stopper plates shall be provided to prevent gates from swinging outwards. 32mm galvanized steel pipe posts at not more than 1500mm spacing shall be provided for handrail. Height of hand railing shall not be less



than 1250mm. There shall be minimum of three handrails at 450mm, 850mm, & 1250mm above platform level. 32mm dia G.I. drainage spouts shall be provided in the platform for drainage of water.

Maximum deflection of main plate girders supporting flues and gratings shall be restricted to L/600, however maximum deflection for secondary beams supported on main girder shall be L/325. The beams shall be provided with heat and acid resistant epoxy paint and as such no corrosion allowance will be considered.

12.08.05 External Platform

External platform if required, shall be provided as per directorate of air routes and aerodromes (DARA) circular for locating aviation warning lights. The platforms shall be equally spaced at a spacing of 40m (maximum)

The minimum clear width of platform shall be 1200mm and a minimum live load of 500 kg per m² shall be considered for design in addition to dead loads and incidental loads.

Hand railing shall be provided all around external platforms including hood platforms using 32 NP GI pipes. The spacing of railing of posts shall not be more than 1500mm center to centre. Height shall be 1250mm. There shall be 3 hand rails at about 450mm, 850mm & 1250mm respectively above platform level.

32mm GI drainage spouts shall be provided in platforms for drainage of rain water.

12.08.06 Design of Transition Ducting

The number, size and location of flue opening in the shell shall be as per the requirement of boiler supplier. The Contractor shall make arrangement for the proper support of ducting on the shell and provision of restraint / support arrangement as required.

The CONTRACTOR shall be responsible for furnishing, fabricating, shop painting and delivery of ducting which shall run from the chimney liner to the flange of the boiler vendor's duct including all necessary auxiliary ducting as well as soot collecting hoppers located outside the chimney shell. Soot hoppers shall be lined with SS grade AISI 304. Suitable flange connection shall be provided at the exit of the hopper to provide SS / CI pipe connection to drain ash / condensed acid mixed water.

The duct work profile and the guide vanes shall be so configured and sized to achieve the desired flue gas flow characteristic and to minimize flue gas pressure losses.

The plate thickness of the ducts shall be arrived at from minimum (i.e. codal) requirements, structural considerations and corrosion allowances. Material of construction shall be COR-TEN steel conforming to IS:2062. Minimum thickness shall be 10 mm.

The duct work shall be insulated with 75 mm thick insulation (3 layers of 25 thick sheets) as per requirements of clause 18.11 and protected with aluminium foil of minimum 1mm thickness. Access doors shall be provided for the ducting where required for inspection and cleaning.



The duct work and its supporting structures shall be designed for the most onerous of the possible combinations of gravity loading (accounting for ash accumulation), seismic loading, wind loading, flue gas pressure loading and thermal loading.

12.08.07 Expansion Compensator

The suspended portion of the liner shall be connected to the bottom supported portion of the liner by an expansion joint. The joint shall be able to compensate for the large thermal movements of the steel flue, gas tight, acid resistant, heat resistant and provide an adequate insulating medium to avoid excessive overheating in the access void.

The materials used for the fabrication of the expansion joints shall be suitable for the flue gas conditions specified herein, and shall not deteriorate during transit, site handling, storage and installation.

The expansion joint shall be manufactured by a specialist for similar type of joints. The BIDDER shall furnish outline proposals for the expansion joint during the bid stage along with the manufacturer's qualifications and experience for the EMPLOYER's review. On award of contract, full details of materials to be supplied along with fabrication drawings shall be supplied by the CONTRACTOR for the EMPLOYER'S approval. The CONTRACTOR shall procure the units only after obtaining the EMPLOYER'S approval.

The expansion joints shall be made of flexible fibre. They should be air tight and impermeable and should withstand the maximum serviceable temperatures of the flue gas.

The CONTRACTOR shall furnish in complete an installation, dismantling and maintenance user handbook. A draft of the handbook shall be submitted to the EMPLOYER for his approval well before the installation commences.

The CONTRACTOR shall also supply spare expansion joints complete with instructions for storage, fitting, instructions, spare accessories, tools for installation, etc., to replace faulty / used expansion joints at a later date. The spares should withstand a storage period of not less than 10 years.

The fabric for expansion compensator shall comprise several layers of materials given below in order from the gas side:

- a) Two layers of insulation, each consisting of heavy weight glass cloth impregnated with graphite suspension, having an approximate weight of 1.00 kg/sqm.
- b) A continuous filament glass cloth coated both sides with a fluoro-elastomer having an approximate weight of 1.5 kg/sq.m.
- c) Two layers of PTFE (Poly Tetra Fluoro-Ethylene) film of minimum thickness 0.15 mm each.
- d) A layer of glass felt of minimum thickness 10 mm and an approximate weight of 1.5 kg/sq.m.

12.08.08 Liner Test Ports



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 96



Gas sampling ports fabricated from stainless steel with flanged ends shall be provided for liner at platform levels where indicated including proper insulation, blank plates, nuts, bolts, etc. The location, orientation and level of ports shall be as per Central Pollution Control Board regulations. Two opacity measurement ports fabricated from stainless steel pipe shall also be provided in each liner at the same platform level of the gas sampling ports.

Bidder shall provide for the purposes of instrumentation other than the sampling ports mentioned above required number of 38 NB conduits including pull wires, junction boxes and pull boxes, all securely tacked / anchored to internal of shell and S 316 L plates below each pipe insert for fixing of measuring instruments.

12.08.09 Staircase

A structural steel staircase shall be provided inside the wind shield, connecting the grade slab to the topmost platform below the roof slab. The staircase shall be supported by a structural steel framework supported from platform to platform independently of the wind shield. Connection of the structural support to the platform beam shall be so chosen as to permit unrestrained deflection of the platform supporting beam. Clear width of the stair treads inside stringers shall be 750 mm. Tread shall be of 25 mm thick M.S. gratings hot dip galvanized with anti-skid nosing. Tread shall be minimum 250 mm wide. Maximum riser shall be 175 mm. Handrail shall be of M.S. pipe type medium of 32 mm NB as per IS:1161 with toe protection of 65x8 mm flats, the complete handrail being hot dip galvanized. 32mm galvanized steel pipes posts at not more than 2000 mm spacing shall be provided for handrail. Height of hand railing shall not be less than 1250 mm. There shall be minimum of three handrails at 450 mm, 850 mm & 1250 mm above platform level. All structural steel work other than stair treads shall be provided with 2 coats of zinc chromate red oxide primer followed by 3 coats of synthetic enamel painting of approved brand and shade. All field connection shall be by bolting only. The arrangement of staircase shall ensure easy accessibility to elevators. Staircase and its connection shall be designed for a live load of 5 kN/sqm.

12.08.10 Ladder

Steel cage ladder hot dip galvanized shall be provided from the last platform to the roof slab. Stringers shall be of flat 75x10 with a clear distance of 400 mm in between; rungs shall be of 20 mm diameter mild steel rods spaced at 300 mm centres. Ladder stringers shall be provided with suitable stays connected to the platform supporting framework. The ladder and its connection shall be designed for a load of 175 kg at any location.

12.08.11 Lift

Lift shall be provided for the chimney inside the wind shield. The lift shall be of open cage type and suitable for corrosive and dusty atmosphere that generally exists in thermal power stations/industrial complexes. It shall generally conform to the provisions of IS:1860 and IS:4289 unless otherwise specified.

The lift shall have a minimum carrying capacity of 400 kg at a speed of 0.70 metre per second. The lift shall be of rack and pinion driven service type of approved make.



All the control devices inside the car shall be housed in a dust free and water proof enclosure. Only copper conductor FRLS insulated armoured cable of suitable size shall be included in BIDDER's scope.

Landing at all locations of platforms shall be provided unless otherwise specified in Data Sheet-A.

Construction of guard cage and supply of other accessories required for satisfactory and safe operation of lift shall be included in BIDDER's scope. BIDDER shall also supply and install safety devices such as automatic stop equipment, over speed governor etc. all complete as per Manufacturer's recommendation.

All the embedments for the lift structure, approach platforms at landing levels and the lift supporting structure including lift car shall be hot dip galvanized.

12.08.12

Doors

(a) Clean Outdoors

Steel flue shall be provided with clean outdoor having clear dimension of 650 mm x 825 mm at appropriate location with proper access for operating the door. The edges of the doors shall be of hollow steel construction with inner plate of 8 mm and outer plate of 6 mm with suitable infill of stiffeners. The hollow space shall be filled up with insulation of the type used around flues. In addition around the door openings, removable type of insulation similar to the insulation provided around flue shall be provided. The door shall be of hinged type and provided with locking device in addition to Swivel studs with wing nuts on the remaining 3 edges. The door shall be openable both from inside and outside.

(b) Removable Cladding / Access Door

Opening provided near the base of the wind shield for the purposes of flue can erection shall be closed using a removable type of colour coated galvanized aluminium sheet min. 0.6 mm thick on structural steel framing which also can be dismantled if required. Within the cladding area, an access door of size 2100x1000 mm shall be provided with sill level at 300 mm from paved level. This door shall be similar to hollow steel doors provided in other buildings. The door shall be provided with a minimum two coats of acid and alkali resistant paint conforming to IS:158 type I to give a DFT of 75 microns. The outside surface shall be provided with 2 coats of zinc red oxide primer and two coats of synthetic enamel paint. The door shall be provided with suitable locking arrangement.

12.08.13

Chimney Roof & Roof Drainage

The chimney roof shall be of RCC slab suitably supported on MS beams. The roof shall be sloped towards rain water down take catch pits covered with CI gratings. The roof shall be designed to cater for differential movement between the shell and the liners including circumferential expansion and contraction due to temperature variation. 1200 mm high RCC parapet formed by windshield shall be provided at roof level.

The roof shall be provided with a hatch for access from the flue support platform. The hatch shall have a single leaf door with a minimum thickness of 6 mm to cover a clear



opening of 750 mm x 1000 mm. The hatch shall include the door, metal curb, draft seal, spring latch, hold-open device and all hardware. All joints shall be welded and ground smooth. The curb shall be 300 mm in height with a suitable lip which shall include a continuous neoprene seal strip to make the hatch air-tight when the cover is closed. The hatch shall be openable from both inside and outside and shall be provided with automatic hold open arm, easy one hand release and spring latch. All the items of the door shall be of stainless steel of grade 316 L and then painted with heavy duty acid and heat resistant paint as per requirement of IS:158.

The roof slab and the inside surfaces of the wind shield shall be lined with 20 mm thick acid proof tiles conforming to IS: 4457. Bedding mortar (of average thickness 10 mm) shall conform to IS: 4832 Part I and shall be of potassium silicate base.

Roof slab structure shall be designed to serve as a lifting platform for supporting the weight of flues during erection.

The tiles shall be pointed using a phenolic based resin cement mortar conforming to IS:4832 (Part-2).

The bedding mortar and phenolic based resin mortar should be acid-proof, chemical resistant and water-proof. They shall in particular be resistant to sulphuric acid and hydrochloric acid.

CI/UPVC rain water pipes shall be provided within the interior of the shell to remove rain water collected on the roof. Rain water inlet into the pipes at roof level shall be provided with CI grating. The rain water down take pipe shall be led to a manhole chamber inside wind shield suitably lined with acid / alkali resistant brick lining. From the manhole the drainage water shall be led out of the chimney wind shield through CI pipe to a manhole chamber outside wind shield and from there to Effluent Treatment Plant.

12.08.14 Acid Drains and Manholes

In the event of flue gas condensation within the flues acids may be drained out at the base with the provision of stainless steel pipes connected to the soot hopper outlets in each flue located outside the wind shield.

The stainless steel pipes, bends, bolts, fixing sleeves, collecting sumps, etc., shall conform to relevant IS codes or BS:3605, and shall be procured, supplied, fabricated and erected in position by the BIDDER.

The sumps shall be of adequate size suitable lined with acid resistant bricks and provided with a RC roof and a heavy duty manhole cover. The effluent shall be led by means of stoneware pipe to the nearest manhole of effluent treatment system.

12.08.15 Louvres

Air outlet louvers shall be provided as per the requirement of this specification near the top. The louver fins shall be of Z-shape in cross section and made from anodized aluminium plates of a minimum thickness of 4 mm. The frame work supporting the louver fins shall be made from extruded aluminium sections of minimum thickness 6 mm. The louvers shall be mounted in the form of panels. The fins shall be closely spaced to cut off any driving rain entering the chimney wind shield. All panels must be



approved by the EMPLOYER before installation. To outside face of louvers ST mesh on SST mesh frame work shall be provided.

12.08.16 Enclosure Walls

Reinforced concrete walls shall be provided at grade level around staircase & elevator to make the enclosed space air tight and free from ash & dust for the comfort & safety of personal, who are required to go into the chimney for maintenance and inspection purpose. Height of enclosure wall shall be 10m (minimum) or as per the requirement of client. All materials for the design of walls shall be as per relevant IS codes.

12.08.17 Maintenance Provisions

The outer face of the chimney wind shield shall be provided with adequate number of stainless steel insert plates of grade 316 L at the top to enable fixing and supporting painter's trolleys and other accessories. The insert plates shall be provided with suitable number of threaded holes and nuts welded at the rear end to enable bolting of the assembly when desired.

Similar arrangement shall be made at each platform level but to fix the painting trolley arrangement directly on the platforms for the purpose of painting the internals of the chimney.

A lifting beam shall be provided at platform level to cater for lifting of materials during maintenance and painting. The size and capacity of the lifting beams shall be as indicated in relevant drawings.

12.08.18 Chimney Painting

The entire inside surface of the shell for full height shall be painted with two coats of acid and heat resistant black bitumen paint over a coat of compatible primer as per IS:158 with total DFT 150microns.

The top 50m of the outside surface of the shell shall be painted with 4-coats of acid and heat resistant paint (Polyurethane) over a coat of primer with total DFT 150 microns in alternate bands of signal red and white colour.

The remaining portion of the outside surface of the shell shall be painted with 4-coats of Synthetic enamel paint (IS:5410) with total DFT 150 microns over a coat of primer in alternate bands of signal red and white colour.

12.08.19 Pressurised Ventilation

Pressurised ventilation shall be provided in the annular space between concrete shell windshield and flue to maintain positive pressure with respect to flue gas by means of centrifugal fans, filters, gravity dampers, short ducting etc. Positive pressure shall be not less than 1mmWC. Pressure equalisation chambers with all necessary accessories shall be provided wherever doors / hatches are provided in the shell.

Design, supply and Construction of ventilation system including supply of other accessories, spares etc, required for satisfactory and safe functioning of ventilation system shall be included in BIDDER's scope.



13.00.00 NATURAL DRAUGHT COOLING TOWER**13.01.00 Scope**

This specification covers the general requirements of engineering by the Bidder, of material, design, supply, manufacture, construction, testing and commissioning for satisfactory performance of natural draught cooling tower including all associated appurtenances and equipment as well as electrical works.

13.02.00 Codes and Standards

a.	IS:383	Coarse and fine aggregates from natural sources for concrete.
b.	IS:432	Mild steel and medium tensile steel and bars (parts 1 & 2) and hard drawn steel wire for concrete reinforcement.
c.	IS:702	Industrial bitumen.
d.	IS:780	Sluice valves for water works purposes (50-300mm size).
e.	IS:1536	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
f.	IS:1554	PVC insulated (Heavy duty) electric cables. (part 1)
g.	IS:1785 (parts 1&2)	Plain hard drawn steel wire for pre-stressed concrete.
h.	IS:1786	High strength deformed steel bars and wires for concrete reinforcement.
i.	IS:1834	Hot applied sealing compound for joint in concrete.
j.	IS:1838 (part 1)	Preformed fillers for expansion joint in concrete pavements and structures (non-extruding and resilient type: Part-1 bitumen impregnated fibre).
k.	IS:2062	Steel for general structural purposes.
l.	IS:2267	Polystyrene moulding and extrusion materials.
m.	IS:3042	Single faced sluice gates (200-1200 mm size)
n.	IS:3589	Seamless or electrically welded steel pipes for water, gas and sewage (168.3mm - 2032mm).
o.	IS:5620	Recommendations for structural design criteria for low head slide gates.
p.	IS:5666	Etch primer.
q.	IS:8112 (Part 1 to 4)	43 Grade Ordinary Portland Cement



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 101



r.	IS:9862	Ready mixed paint brushing, bituminous, black, lead free acid, alkali, water and chlorine resisting.
s.	IS 12330	Sulphate resistant Portland cement
t.	IS:456	Code of practice for plain and reinforced concrete.
u.	IS:800	Code of practice for general construction in steel.
v.	IS:875 (part 1 to part 5)	Code of practice for design loads (other than earthquakes for building and structures).
w.	IS:1080	Code of practice for design and construction of simple spread foundations.
x.	IS:1343	Code of practice for pre-stressed concrete.
y.	IS:1893	Criteria for earthquake resistant design of structures.
z.	IS:2210	Criteria for the design of reinforced concrete shell structures and folded plates.
aa.	IS:2309	Code of practice for the protection of buildings and allied structures against lightning.
bb.	IS:2395 (parts 1&2)	Code of practice for painting, concrete, masonry and plaster surfaces.
cc.	IS:2502	Code of practice for bending and fixing bars for concrete reinforcement.
dd.	IS:2629	Recommended practice for hot dip galvanising on iron and steel.
ee.	IS:2633	Methods of testing uniformity of coating of zinc coated articles.
ff.	IS:2751	Recommended practice for welding of mild steel bars for reinforced concrete construction.
gg.	IS:2950 (part 1)	Code for practice for design and construction of raft foundation.
hh.	IS:3043	Code of practice for earthing.
ii.	IS:3370	Code of practice for concrete structures for storage
jj.	IS:4558	Code of practice for under drainage of lined canals.
kk.	IS:11504	Criteria for structural design of reinforced concrete natural draft cooling towers.
ll.	IS:12200	Code of practice for provision of water stops at transverse contraction joints in masonry and concrete dams.
mm.	IS:1549 (2004)	Guide lines for improving the cyclonic resistance of low rise house and other buildings
nn.	BS:4485	Specification for water cooling towers. (All parts)



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 102



oo. VGB Guidelines Structural design of cooling towers.

pp. ATC - 105 Specification for Cooling Towers - Cooling Tower Institute - USA

13.02.01 Wherever the above Standards are in conflict with the stipulations of this specification, decision of the OWNER / OWNER CONSULTANT will dictate.

13.03.00 General

The cooling tower shall be capable of cooling the rated quantity of water through the specified thermal range at the design wet bulb temperature and it shall conform to the other design parameters as stipulated in Mechanical section of this document.

The scope of the Contractor's work for a cooling tower shall include preparation of detailed designs and construction drawings and execution of work including but not limited to supply of all material for foundations, shell, basin, fill with its supporting structure, staircases/walkways/platforms with handrailing, cold water outlet channels including gates, screens with handling arrangement, painting, access doors, water distribution system, aviation warning system, lighting, lightning protection system, with their associated hardware, etc., complete all as required to give satisfactory performance and as stipulated in various clauses in this document.

CONTRACTOR shall submit detailed design calculations and construction drawings to OWNER for obtaining his approval prior to commencement of work at site.

In the event, Contractor has quoted in collaboration with another firm (either Indian or foreign), each and every drawing and design calculations submitted shall bear collaborator's seal and signature indicating their approval. Contractor shall also furnish, along with the offer, back-up guarantee for the performance of the cooling tower from the collaborator.

For NDCT, three dimensional finite element analysis of the entire system consisting of tower shell, column supports, pedestal, pile cap, pile and soil mass shall be carried out in a single step so that effect of soil structure interaction can be taken care.

13.04.00 Grade of Concrete & Steel

Minimum grade of concrete to be used for all the structural elements shall be as specified below:

<u>STRUCTURAL CONCRETE</u>	<u>Minimum Grade</u>
a) Foundations	M30
b) Basin	M35
c) Shell	M35
d) Precast works (Fill Supporting Structure)	M35
e) Diagonal columns	M40



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 103



Minimum cement content of all RCC structures shall be 360 kg/cum.

Cement to be used for entire NDCT structure including pile cap is sulphate resistant cement with C_3A content between 5 to 8%.

Materials, design, construction and workmanship of prestressed concrete members shall be in accordance with IS:1343.

Reinforcement shall conform to grade Fe 500/550 as per IS:1786 except noted otherwise.

Steel wires for prestressing shall conform to IS: 1785 (part 1&2).

Fusion bonded epoxy coated reinforcement steel, with coating conforming to IS : 13620 shall be used for entire NDCT structure including pile and pile cap.

Steel for all structural steel works shall conform to IS: 2062.

All exposed steel work shall be protected by hot dip galvanising. The minimum coating of zinc shall be 910 gm/sq.m. and comply with the requirements of IS:2629 and IS:2633. In addition, galvanizing shall be followed by the application of one coat of etching primer conforming to IS:5666 and 2 coats of bituminous paint conforming to IS:9862.

As per IS 456, the environmental exposure condition of “very severe” shall be considered for entire NDCT structure below & above ground level including pile cap & Pile. Also, requirement of table 4 & 5 of IS 456 shall be satisfied depending on exposure condition.

13.05.00 Design Criteria

13.05.01 Wind Load

Basic wind speed as well as factors $K_1/K_2/K_3$ shall be taken from IS:875. Additional intensification factor to be considered due to natural turbulence in the incident wind / induced turbulence owing to nearby tall structures shall be 1.43 or based on wind tunnel studies, whichever is higher. Further cyclonic risk factor as per IS:15498 shall also be considered.

Steady pressure distribution around the shell for the wind loading shall be as per clause 5.1.3 of IS:11504, for cooling towers not more than 120m in height and not more than 100 m in base diameter. The value obtained shall be increased by 10 percent to take into account any geometrical imperfections.

For cooling towers of height more than 120m and/or more than 100m in base diameter, wind pressure distribution shall be as determined by model test in a wind tunnel.

13.05.02 Earthquake Load

The coefficient of horizontal acceleration shall be for the appropriate seismic



zone as per IS:1893. Earthquake forces in all the three directions (x,y,z) shall be considered in the analysis of NDCT.

13.05.03 Dead Load

For assessing the self weight of the structure, the specific weight of the concrete shell shall be taken as 25kN per cubic meter. All other dead loads shall be assessed as per IS:875.

The loadings brought upon the shell by permanent fixings shall be minimised to the greatest extent possible. However, when these attachments are made, their effect upon the structure shall be thoroughly investigated.

13.05.04 Constructional Loadings

Contractor shall be fully responsible for ensuring safety by checking the designs, for all the temporary construction loadings as applicable.

13.05.05 Miscellaneous Loads

Effect on account of the following loads shall also be investigated.

- a) Thermal restraint loads
- b) Subsoil deformation

13.05.06 Load Combinations and Permissible Stresses

All structural components except Fill Supporting Structures ,Stairs and Platforms of the cooling tower shall be designed by both working stress and limit state method. The following load / load combinations shall be followed in addition to codal requirement:

- a. For working stress method
 - i. $DL + WL$
 - ii. $DL + 1/3WL + EQ$
- b. For limit state method
 - i. $1.5DL + 1.5WL$
 - ii. $0.9DL + 1.5WL$
 - iii. $1.5DL + 1.5EQ + 0.5WL$
 - iv. $0.9DL + 1.5EQ + 0.5 WL$

where DL = Dead Load
 WL = Wind Load
 EQ = Earthquake Load

While considering the above load combinations, the appropriate stress resultants shall be superimposed most unfavourable. Stress due to subsoil deformation, temperature and constructional loads shall also be added to arrive at the most unfavourable load



combination.

Since cooling tower is more a wind predominant structure, increase in permissible stresses as per B – 2.3 Annexure – B of IS 456, shall not be allowed. Increase in safe bearing capacity for design of foundation under wind load combination shall also not be permitted.

13.0600

Foundations

The design and construction of cooling tower foundations shall be in accordance with the requirements stipulated in IS:1080/IS:2911/IS:2950 as applicable. Continuous foundations shall be provided for cooling towers more than 75 m in height.

The foundation structure shall be designed for loads and load combinations indicated above of this specification and shall in addition consider the following:

- a. Thermally induced local loading where supply culverts pass through the foundation structure without structural isolation.
- b. Cold water basin floor loading.
- c. Surcharge load of 25 KN per sq.metre at the ground / grade level.
- d. In case of subsoil with varying degrees of stiffness, non uniform settlements due to the varying stiffnesses have to be determined. The redistribution of stress resulting from interaction effects between the subsoil and the shell structure have to be taken into account.

For the load combination 0.9DL+1.5WL, uplift of the foundation, not exceeding a sector of 15 degrees is permitted, provided the foundation is a continuous annular raft foundation.

No pressure relief valve shall be provided in any part including foundation & basin slab of NDCT.

13.07.00

Basin and Cold Water Outlet

The basin shall be divided into two compartments to facilitate complete isolation of one half of the basin for the purpose of cleaning and maintenance, while the other half is in service.

The basin floor of each compartment shall be sloped with a slope not less than 1 in 120 towards a collecting sump for effectively draining the water to permit desilting/desludging. To minimise obstructions to the flow of water, only the columns supporting the Fill structure shall be projected above the basin floor. Water shall be drained from the sump into a drain chamber outside the basin by CI drain pipe embedded below the basin floor. Suitable sluice gates of the rising spindle type conforming to IS:3042 or sluice valve conforming to IS:780 shall be provided in the drain chamber. Drainage arrangement from drain chamber to suitable location shall also be made.

A minimum of 300mm free board shall be provided for the basin over the maximum design water level. The basin wall shall project a minimum of 500 mm over the surrounding grade level. Plinth protection of 1 m wide shall be provided all round the



building.

7 m wide paving around NDCT tower from racker column shall also be provided

Each compartment of the basin shall be provided with a concrete channel for outlet of cold water. Cold water outlet channels shall be provided with the stoplogs and screens.

Stoplogs shall be fabricated out of structural steel plate and rolled sections and provided with rubber seals to prevent leakage. Stoplogs shall be hot dip galvanised and provided with etch primer and bituminous paint.

Screens shall be out of 8 gauge 25mm clear opening SS crimped wire netting welded to frame of structural steel section/flats. Frame work shall be hot dip galvanised and provided with etch primer and bituminous painting. Two numbers of screens shall be supplied per tower.

Suitable arrangement of monorails with hoist shall be provided for handling stoplogs and screens.

The basin walls, floor slab and outlet channels shall be of reinforced concrete construction. The design and construction of these water retaining structures shall be in accordance with IS:3370 with provision of construction/contraction and expansion joints. Resistance to cracking shall be checked as per cl. 4.5.2 and cl. 4.5.3 of IS:3370 (PART 2): 2009. Minimum thickness of structural concrete elements shall be 230mm. Basin walls shall also be designed for condition of external surcharge load along with ground water table and basin being empty.

The basin and channel walls shall be designed for a minimum surcharge load of 25kN per sq.m. to allow for construction plant operating in the vicinity.

External pressure due to earth and ground water shall not be relied upon to reduce the effect of the internal water pressure, but account shall be taken of the ground water pressure when considering buoyancy or stresses in the empty water retaining structure.

Construction of the basin and channel shall be watertight with the provision of minimum 230mm wide approved quality PVC ribbed water stops with central bulb of minimum 10mm at all construction joints and expansion joints.

The water retaining structures shall be tested for water-tightness in accordance with IS:3370, without the backfill. Any rectification measures required to satisfy the test criteria shall be executed by the CONTRACTOR at his own cost all as per the directions of the OWNER.

All round Cold water basin, plinth protection in M20, 150 mm thick shall be provided for a width of 3000 mm, sloping away from the basin. Dry rubble soling of 150 mm thick shall be provided below the concrete paving. Suitable drain shall also be provided along plinth protection with a sum at appropriate location.

In any case, the basin slab shall not be used to give lateral resistant to piles below main tower shell structure.



13.08.00 Tower Shell**13.08.01 Shell Geometry**

The shape of the tower shall be hyperboloid in vertical section and circular in plan.

13.08.02 Thickness

The tower shell shall have a minimum thickness of 250mm.

A minimum factor of safety of five (5) against buckling shall be ensured at all levels.

13.08.03 Design

The tower shell shall be designed based on bending analysis and as per elastic theory for thin shells.

Consideration shall also be given to the following effects of temperature and moisture variations that occur in the shell :

- a) The strain resulting from a temperature gradient across the shell thickness.
- b) The strain resulting from moisture content variations through the shell thickness, and
- c) The strain resulting from variations of conditions (a) and (b) caused by rain and sunshine on one side of the tower or partial operation of the tower.

The effect of stress concentration due to any fixtures shall be taken into account.

13.08.04 Reinforcement and Cover

Reinforcement shall be provided on each face of the shell in both directions.

The shell reinforcement of high yield strength deformed bars, in either direction and on each face shall be not less than 0.15% of the concrete cross-sectional area. Further, the circumferential reinforcement on each face shall be not less than 0.20% of the concrete cross sectional area in the top one third height of the shell.

The maximum spacing of reinforcement in either direction on each face shall be restricted to twice the thickness of the shell or 200 mm whichever is less. Further, not more than one third of the reinforcement at any level or section shall be lapped.

Minimum lap lengths in shell shall be 1.3 times L_d where L_d is the development length as described in cl 26.2.1 of IS:456.

Column reinforcing bars shall be carefully anchored in the shell and in the foundations. The minimum anchorage length in the shell shall be $2L_d$ or 80 times the diameter of the bar.



Minimum size of deformed bars used shall be 8mm for circumferential reinforcement and 10mm for Meridional steel.

The concrete cover shall be 50 mm minimum. However, the clear cover shall not be less than 1.5 dia of bars. (for severe exposure condition)

13.08.05 Tolerances

The shell should be constructed within the dimensional tolerances stipulated in clause 7.3 of IS:11504. Permissible allowances for survey inaccuracies while checking of shell geometry shall be as per clause 7.4 of IS:11504.

13.09.00 Fill

PVC splash type bars fill arrangement shall be provided.

The fill shall be adequately supported to minimize sag, possibility of dislodgment and damage as a consequence of induced vibrations in the fill.

The supporting hanger rods/tubes shall be of stainless steel conforming to ASTM 316L.

Density of fill to be considered for the design of fill supporting structure shall be 100 kg/m³ minimum

13.10.00 Fill Supporting Structure

Fill supporting structure with its foundation shall be of reinforced concrete construction.

Fill supporting structure, where formed of precast concrete units, shall be made stable by the use of either bolted, cast-in-situ or glued joints. Members of precast concrete structure shall be either pre-stressed or reinforced concrete units. Where bolts are used for permanent connections, they shall be of a material highly resistant to corrosion or fully protected by embedment or coating.

The columns and beams supporting the Fill shall be adequately braced in all directions. The design of all members shall be checked for resistance to buckling.

The stability of the Fill support structure shall be checked for its capacity to resist a horizontal force of 2% of self-weight, the Fill and supporting structure, assumed to act horizontally in any direction. The structure shall also be checked for the appropriate earthquake loading as applicable.

During erection, care shall be taken to ensure the stability of the potentially unstable, partially completed structure.

The Fill support structure members shall be designed to cater for the likely loads to be imposed thereon, including:

- a) temporary loadings : they are subjected to during handling, transportation and erection at normal design stresses.



- b) loading due to scaffolding for the erection crew if so envisaged to be supported.
- c) loading of personnel during maintenance of pipe work and sprinkler system. The appropriate parts of the pack support structure shall be designed to support a point load of 1.5 kN at any position.

Reinforced concrete members shall be designed for self-weight and permanent loadings by working stress method with allowable stresses limited to 80% of those specified in IS:456.

13.11.00 Maintenance Access Facilities

All areas of the cooling tower requiring inspection, cleaning, repairs and/or adjustment shall be easily and safely accessible by suitable provision of stairs, platforms etc., as per the requirement described herein below :

13.11.01 Stairs

The tower shall be provided with two numbers external RC staircase, leading to a heavy duty door giving access to the distribution system. Staircase shall be minimum 1000 mm wide (clear), with landings of minimum width of 1000 mm at not more than 2500 mm height intervals unless approved otherwise. The steps shall have a rise of about 125 mm and tread of about 250 mm. Anti-skid nosing at each step shall be provided.

All access doors shall be of size minimum 1200 mm wide and 2100 mm height, minimum.

13.11.02 Platforms

Reinforced concrete platform of 1.2m clear width shall be provided around the circumference at the top of the cooling tower on the outside for fixing aviation warning beacons.

13.11.03 Walkways

RCC walkways having a minimum clear width of 1.50 m shall be provided around the circumference inside the cooling tower above the Fill to provide access for inspection and maintenance of all hot water distribution pipes/ducts and nozzles. Walkways shall be supported independent of the Fill structure.

13.11.04 Ladders

Four numbers of hot dip galvanised mild steel rung ladders with etch primer and bituminous painting shall be provided equally spaced around the circumference of the tower.

Safety cage for the ladder shall be provided for the ladders located on the external surface of the tower upto the throat level.



Ladders shall be continued along the inside surface of the tower upto the top of the tower and then on to the top platform. At the throat level a reinforced concrete landing of 1.2m minimum width shall be provided with a hot dip galvanised steel access door for the interchange.

Two of the ladders leading to the platform at the top of the tower shall have approach from the reinforced concrete stairs. Other two ladders shall be directly from the ground level itself.

13.11.05 Handrailings

Handrailing shall be provided on both sides at the edges of platforms, landing slabs, sides of stairs, walkways and cold water outlet channel.

Handrailing shall be of hot dip galvanised construction and shall be out of 32 mm NB pipes of medium class conforming to IS:1239 and provided with etch primer and bituminous painting.

Handrailing shall be 1300 mm high with two intermediate rails at 450mm and 900 mm with the top rail at 1300 mm above the surface of slab/steps. Handrail posts shall be spaced at not more than 1.5 m centres.

A toe plate of hot dip galvanised mild steel of size 65 mm x 8 mm shall be provided for all handrailing.

13.12.00 Painting To Concrete Surfaces

Painting to the concrete surfaces specified herein below shall be with 100% solid high build Polyurethane coating of 2000 microns over compatible primer as per manufacturer's requirement. The prior approval of manufacturer shall be obtained from OWNER for painting of cooling tower.

- a) Basin floor
- b) Internal surfaces of basin wall including the partition wall.
- c) Diagonal columns over complete height.
- d) Fill support columns and beams for the full height and length respectively.
- e) Internal and external surfaces of hot water duct.
- f) Internal and external surfaces of cold water channel upto the terminal point.
- g) Internal and external surfaces of the drain chamber.
- h) Complete internal surface of the shell. For external surface at least 1 metre on the shell at top.

The preparation of concrete surface for painting shall conform to IS:2395(Part-I). For new surface, it is preferable that the surface left unpainted for as long as possible to allow drying. Before painting, the surface shall be thoroughly brushed to



remove all dirt and remains of loose or powdered materials.

All other exposed concrete surfaces shall be given two coat of water proof cement paint of approved make and colour after the surfaces are rubbed down suitably and as approved by the OWNER. All concrete surfaces which are in contact with the earth shall be applied with anticorrosive coat system.

13.13.00 Water Distribution System

The arrangement of water distribution system shall permit a satisfactory distribution of water over the whole area of the tower at all reasonable loads.

Hot water Inlet pipe shall conform to the requirements of Class I of IS:3589 and steel shall conform to IS:2062.

The distribution troughs/pipes shall be independently supported from the structures and shall be easily removable. Provision shall also be made for easy flushing or cleaning of all troughs/pipes.

13.14.00 Lightning Protection

The cooling tower shall be protected against damage by lightning. The installation work shall conform to the requirements of IS:2309.

CONTRACTOR's scope of work includes supply and installation of the complete system upto and including the earth electrodes.

For detailed specification of lightning protection system refer eletrical section of this document..

During the construction of tower, temporary lightning protection shall be maintained by connecting the reinforcement bars to two grounding conductors of size 50 mm x 6 mm.

Lighting protection requirement shall be provided as per mentioned specification of vol. IV 4.

13.15.00 Aviation Warning System, Lighting and Power Receptacles

Refer Volume-III (Mechanical Section)

TECHNICAL DATA SHEET- A

13.22.00 Specific Technical Requirements

a) Number of cooling towers 2 nos

13.22.01 1. Design & Operating Conditions

Refer Volume-III (Mechanical Section)



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 112



13.23.00	Features	
	Refer Volume-III (Mechanical Section)	
13.24.00	Elevations	
13.24.01	Grade level in m	To be decided during during detail engineering.
13.24.02	Sill level in m	-do-
13.24.03	Basin depth in m	-do-
13.25.00	Materials of Construction	
	Refer Volume-III (Mechanical Section)	
13.26.00	Structural Concrete (Minimum Grade)	
	a) Foundations	M30
	b) Basin	M35
	c) Diagonal Columns	M40
	d) Shell	M35
	e) Precast works (Fill Supporting Structure)	M35
13.27.00	Type of Cement	
	a) Below ground	
	(i) Sulphate Resisting Portland cement with C ₃ A content 5 to 8%conforming to IS:12330	
	b) Above ground	
	(i) Sulphate Resisting Portland cement with C ₃ A content 5 to 8%conforming to IS:12330	
13.28.00	Primary Loads	
13.28.01	Wind load (as per IS 875)	
	a) Basic wind speed	50 m /sec
	b) Factor K1	1.08
	c) Terrain category factor K2 Varies w.r.t. height	Category 1



	d)	Factor K3	1.0
	e)	Intensification factor	as per spec.
13.28.02		Earth quake load.	
	a)	Zone as per IS:1893	III
	b)	Importance factor	as per code
13.29.00		Foundation Criteria	
		Ground water table	At grade level.
		Type of foundation	Pile
		Safe bearing capacity of soil	As per soil report
		Type of pile	As per soil report
		Pile capacity and termination depth belowground level	As per soil report
		Minimum thickness of basin base slab	250mm
		Pressure relief valves in the basin floor slab	Not to be provided
13.30.00		Water Distribution Channel	
		Design Pressure	
13.31.00		Performance Test	
		Method	
		Instrumentation	



14.00.00 COAL HANDLING SYSTEM**14.01.00 External Coal Handling System From Coal Berth -3 to Plant Area:**

External coal handling system will consist of conventional conveyor gallery from JTB-3, MCC / Electrical building in NCTPS Stage II. And thereafter pipe conveyor system upto Ennore SEZ.

The pipe conveyor will cross the Buckingham canal, Back water area, railway line, transmission line, oil pipe line & roads before entering Power plant area covering a distance of about 5-6 km.

The pipe conveyors will be supported on cross-over, trestles, piers etc. At the crossing of roads the cross-over should maintain 8.0m clear height from the crest of road and at the railway crossing the cross over should maintain the clear height from the top of rail as per railway norms. Bridge shall be provided for crossing of pipe conveyor, Sea water pipes (CT Make Up & Desal make up) and cables near canal crossing, road crossing & railway crossing.

Considering the declaration of Buckingham Canal & Pulicat back water as National Inland Waterway and Formation of terminal etc., at the crossing of Buckingham canal and Pulicat back water the span of the supporting cross-over and height of the pipe conveyors shall be decided with reference to the Water Resource Department, PWD guideline.

Necessary statutory clearances / approval from Railways / Highway Authority / PWD shall be obtained by Contractor at his own cost.

14.02.00 In-Plant Coal Handling System Necessary For The Proposed Plant:

In-plant coal handling will consist of junction towers (underground and above ground), sampling towers, underground / semi ground tunnels, pent house, conveyor galleries, trestles, MCC room, stacker reclaimer foundation, coal stock pile, stock yard drainage, water sprinkler system, dust extraction / suppression system, pump house, cable tray, cable support, underground cable trenches with RCC cover, rails etc.

14.02.01 Over Ground Transfer Points

Over ground TPs shall have RCC foundations and pedestals at (+) 500 mm above ground level. The superstructure for TPs shall be of steel framed structures with adequate bracing arrangement. The ground floor and all intermediate floors shall be of RCC and will be finished with IPS and metallic hardener having proper slopes for drainage. The roofs shall be of flat RCC slab with water proof treatment and drainage slope. The cladding shall be of permanently color coated zinc alum sheets of minimum thickness 0.6mm TCT. Plinth protection and storm water drain shall be provided around the structure suitably.

Roof and all intermediate floors will be of reinforced concrete minimum 150mm thick of concrete M25 grade. All grade floors will be 200mm thick of M-20 grade concrete with nominal reinforcement of 8 Tor @ 250 c/c top and bottom both ways over PCC, soling over sand cushion of required suitable thickness. However the codal regulations shall also be compiled with. Continuous handrails shall be provided for the staircase with 32 mm NB GI pipe hand rails.



TPs shall be provided with independent steel staircase with steps of MS grating from ground to highest operating floor level. The clear width of the stair shall be minimum 1.0m. The tread shall be atleast 250 mm and riser shall be uniform throughout the height and shall not exceed 180 mm. However the codal regulations shall also be compiled with. Continuous handrails shall be provided for the staircase.

Drive units shall be directly supported on floor beams from suitable structural steel stools and not on concrete floors. All transfer houses shall be provided with adequate no. of windows and doors. The window area shall not be less than 10 percent of total wall area. Maintenance platform inside / outside of transfer house may have chequered plate floors with horizontal floor bracing.

Transfer points / crusher house with metal sheeting as cladding shall have 1.5m high 230 mm brick enclosure from finished ground floor around the building. Brick wall shall be inside face of sheeting with a lapping of 150mm.

Adequate floor washing arrangements shall be made in all TPS.

Provision of floor dust collection and removal by chute shall be made.

The Transfer house structure shall be so designed that transverse deflection at places where conveyor gallery meet, should be equal to the respective transverse deflection of conveyor trestles.

Monorail / beams for electric / manual hoists shall also be provided in junction tower wherever required.

Suitable overhead RCC / syntax water tank shall be provided for service / potable water system.

Piling shall be used for junction tower foundation.

14.02.02

Crusher House and Crusher Foundation

The crusher house will be braced structural steel structure with one brick thick (230 mm) upto 1.5 m from ground level and above 1.5 m the cladding shall be of pre-coated colour steel sheet. Floor and roofs shall be of RCC supported on steel beams. Roof will be provided with roof water proofing treatment in line with architectural requirements mentioned elsewhere in the specification. Adequate steel doors and windows shall be provided for natural lighting and ventilation as mentioned for TPs.

The crusher house shall have an independent staircase for general use like other TPs. In addition, it shall have a separate open staircase for fire escape suitably located to comply with fire fighting norms. An open elevator up to the top floor shall also be provided at suitable location at periphery of the building.

The crusher shall be supported on RCC M30 deck slab of designed thickness mounted on vibration isolation system of GERB comprising springs and viscous dampers, which in turn supported on steel girders. The framework of girders shall be an integral part of the building, which houses the machine. There shall be isolation gap between building floor slab and



crusher deck slab. Suitable provision for maintenance platforms for springs and damper shall be provided.

Monorail / beams for electric / manual hoists shall also be provided in crusher house wherever required.

Piling shall be used for crusher house foundation.

14.02.02 Crusher Foundation

Detailed dynamic analysis shall be done for the top deck together with springs and dampers and the natural frequencies and amplitudes of vibration shall be determined. A mathematical model of the top deck shall be formulated with three dimensional beam / plate finite elements for the purpose of analysis with the spring idealized with vertical and horizontal stiffnesses. The mass of the machine together with that of the top deck shall be considered for the analysis.

Natural frequencies up to at least 10% above the operating speed shall be determined and three frequencies shall be checked against the design criteria.

Forced response dynamic analysis shall be carried out for the operating condition unbalance forces using a sinusoidal forcing function. Unbalance forces as given by this specification shall be used for his purpose.

14.02.03 Isolation Efficiency

The vibration isolation system shall be designed for about 95% isolation efficiency.

14.02.04 De-Coupling

A ratio of the least 10 (ten) shall be ensured between the stiffness of the supporting structure and the stiffness of the spring system in the vertical direction of achieve de-coupling between the two (the stiffness of the spring system being lower). This ensures that dynamic analysis of the supporting structure need not be carried out.

14.02.05 Frequency Criteria

The frequency criterion has already been laid down implicitly foundation isolation efficiency criteria and de-coupling required.

The bending mode frequency of the top deck shall be atleast 20% above the operating speed.

14.02.06 Unbalance Forces

Unbalance forces arising out of all the following cases shall be considered for checking the design and amplitudes.

- (a) Balance quality grade Q40 as per VDI 2060-1966.
- (b) One hammer broken condition. The missing hammer shall be assumed to be closest to the crusher non-drive end of the crusher.



- (c) Three hammers broken condition. All the three hammers broken shall be assumed to be from the same suspension bar and located at the non-drive end of the crusher.

14.02.07**Amplitude Criteria**

The calculated amplitudes (mean to peak values) shall not exceed following limits under the specified conditions:

1) Operating speed of 750 RPM.

- (a) 150 microns for an unbalance force arising out of balance quality grade Q40 as per VDI 2060-1966.
- (b) 300 microns in case of a one hammer broken condition.
- (c) Amplitudes need not be checked for a three hammer broken condition.

2) Operating speed of 450 RPM.

- (a) 200 microns for an imbalance force arising out of balance quality grade Q-40 as per VDI-2060-1966.
- (b) 300 microns in case of a one hammer broken condition.
- (c) Amplitudes need not be checked for three hammer broken condition.

For intermediate operating speed between 450 to 750 RPM, the amplitude limits can be linearly interpolated.

The amplitude limits mentioned above are in both vertical and horizontal directions. The amplitude shall be calculated at critical points on the top surface of the RCC deck. The amplitudes shall be checked for the most unfavourable superposition of modes in any direction. However, phase difference between the maximum amplitude occurring in different directions due to the rotating vector may be considered while superimposing the modes.

14.02.08**Transient Resonance**

Transient resonance, which may occur during the start-up or coasting down condition of the crusher, shall be checked and the amplitudes in such a condition should not exceed one – and half times those at operating speed for each design condition.

14.02.09**Strength Criteria**

The following criteria shall apply for the design of top deck:

Dead loads, live loads, seismic loads and dynamic loads shall be considered for the design. The most unfavourable combination shall considered for design.

Seismic loads shall be assumed to act together with dynamic loads for a one millimeter eccentricity in the rotor. However, seismic loads and dynamic loads arising out of hammer



breakage need not be considered together.

Fatigue shall be considered while designing for dynamic forces. A fatigue factor of 2.0 shall be used on all dynamic forces to arrive at the equivalent static force for the purpose of design.

Working stress method shall be used for the design of RCC deck. In survival condition, 10% overstressing may be permitted.

The RCC top deck shall be atleast of M30 grade of concrete as per IS:456-2000.

Fatigue need not be considered for the three hammer broken condition.

For calculating unbalance forces, the heaviest hammer (plain or toothed) shall not exceed the value specified by the manufacturer.

Loss of contact of foundations at founding level shall not be allowed for any combination of loads.

14.03.00 Coal Handling Control / Electrical Building

The control room for the coal handling plant shall be RCC framed structure with brick masonry walls or steel framed structures with brick masonry walls and RCC roof designed to be completely dust proof. Large glazed windows shall be provided for a complete view of the coal handling plant from the control room. Provision for fire escape stair shall be provided in accordance with TAC requirement. The building shall be provided with toilet/urinals at various locations as per owner's requirement. Air conditioning to be provided for the operators / working area suitably. All windows & doors shall be aluminium only.

14.04.00 Foundations of Stacker-cum-Reclaimer

Foundations for Stacker - Reclaimer shall be designed as a continuous wall or RCC framed structures (in longitudinal and transverse direction). Lateral tie beams shall be provided between two rail supporting elements shall be provided at a regular interval of min. 3.0m center. The foundation shall be designed for the most critical combination of loads as prescribed by the manufacture. The foundation shall also be designed for deflection and settlement as required by the manufacturer.

Piling shall be used for Stacker-cum-Reclaimer foundation.

14.05.00 Over ground Galleries & Trestles

Overhead conveyor galleries shall be structural steel consisting of two vertical girders braced at top and bottom and having rigid jointed portal frame at both ends. Common end portal shall not be used for two adjacent conveyor spans. Roof truss shall be provided at upper node points of latticed girder to form an enclosure. The maximum span of standard gallery shall be 24 m unless higher span is required due to the site condition, which shall be subjected to approval of the engineer. The gallery should as far as possible be erected as a box section keeping all the vertical and horizontal bracing tied in proper position. The Gallery should be checked for all erection stresses that are likely to develop during handling and erection and if required, temporary strengthening of gallery members during erection



shall be made.

The galleries for double stream conveyors shall have one central walkway and two side walkways of clear width 1100 mm and 800 mm respectively. Single stream conveyors shall have two side walkways. Both sides of walkways shall be provided with pipe handrails all along the conveyor. Walkway shall be of chequered plate with anti-skid arrangement. Conveyor gallery having slopes greater than 10 degree, stepped walkways of tread 250 mm of chequered plates with nosing and toe guard shall be provided all along the conveyor.

Each conveyor gallery shall be provided with seal plate (throughout gallery length) of minimum 12 gauge thickness. The conveyor galleries shall be designed for adequate ventilation and natural lighting.

Suitable floor washing arrangement shall be made in the conveyor gallery with down comers. Down comer shall lead the water/coal slurry to pit (of 2.0 cum capacity) to allow settling of coal, which will further discharge into RCC drains.

Cross-over with chequered plate platform, ladder and hand railing for crossing over the conveyors shall be provided at approximately every 100 M intervals of conveyor. Cross over shall be preferably located over four legged rigid trestle locations.

Location of trestles shall be decided carefully so that there is no interference with underground and over ground structures, tunnels, trenches, drains etc. However at the location where overhead conveyor gallery crosses road/ rail line, The minimum clearance of 8.0 m above road crest and 10 m above rail shall be provided. Necessary statutory clearances / approval from Railways / Highway Authority / PWD shall be obtained by Contractor at his own cost.

For calculation of coal load on moving conveyor, a multiplication factor 1.6 shall be used to take care of inertial force, casual overburden and impact factor etc.

Thus coal load per unit length of each moving conveyor shall be

$$1.6 \times \frac{\text{Rated Capacity of Conveyor System}}{\text{Conveyor Belt Speed}} \times \frac{1200}{800}$$

It should be noted that for structural design, Unit weight of coal shall be assumed as 1200 Kgs/ Cu M. instead of 800 Kgs/Cu M. considered for system sizing purpose.

Conveyor gallery shall be designed considering both conveyors operating simultaneously.

In between transfer house / buildings four legged trestles shall be place at a maximum interval of 90m. The arrangement shall be such as to ensure that force in the longitudinal direction (i.e along conv. Length) of conveyor gallery of length not more than 90m will be transferred to four legged trestle. Two legged trestles at regular interval may be placed between four legged trestles. The end supports resting on the four legged trestles can have either ends hinged or one hinged and the other on slide type. Slide type support shall be with PTFE bearing to allow both rotation and logitudnal movement.

End of conveyor gallery which will be supported over transfer points, shall be so detailed



that only vertical reaction is transferred from gallery and no horizontal force in longitudinal direction is transferred from gallery to transfer points and vice-versa.

Transverse deflection of trestle due to wind /seismic load shall not exceed trestle height/1000 as stipulated in IS 11592. Longitudinal deflection of trestle shall also be within limits.

All RC trestle pedestals should be raised to (+) 0.5 m above FGL. Trestles shall be of structural steel braced adequately and provided at suitable locations.

Piling shall be used for trestles foundation.

14.06.00

Coal stock yard

Entire area shall be excavated to average 250mm depth and given slope of 1 in 100 in suitable directions as approved. Entire excavated area shall be watered and rammed and compacted with 10 tonne roller. 100mm thick river sand cushion layer shall be placed over compacted subgrade and consolidated by flooding 150mm thick boulder soling shall be laid over sand cushion, joints filled with river sand. Over boulder soling, 75mm thick lean concrete (1:4:8) shall be spread. Final layer shall be minimum 150mm thick RCC slab of grade M20 having double layer reinforcement. Slope is to be maintained through all layers. The coal stack area shall be graded with suitable slope for draining the surface by longitudinal drains shall be of RCC trenches with graded gravel packets at about 1.5m intervals on the sides to trap coal dust. Weepholes shall be provided in the trench walls at the locations of filter pockets for collecting surface water in the longitudinal rains for discharging into the main surface drain to be provided by the Contractor by the side of the road. Retaining wall 1m depth to be provided around the crushed coal pile to prevent coal spillage into the drain. Necessary control joints in the grade slab shall be considered to avoid temperature and shrinkage cracks in the slab. The design of coal stack area should take care of loads arising due to dozer movement and shall be designed to sustains coal water pressure.

Suitable soiling with mortar cover shall be provided between rails for stacker reclaimer and reclaimer machines.

14.07.00

Cable gallery

Cable galleries shall made of tubular steel sections. The tubular steel sections shall be of circular/ rectangular/ square shape. The circular steel tube shall conform to IS:1161 and rectangular/ square steel sections shall confirm to IS:4923. The steel structures using tubular sections shall be designed and fabricated as per IS:806 – “Code of practice for use of steel tubes in general building construction.” And EN 1993-1-8:2005.

14.08.00

Drainage of CHP Area

Suitable drainage arrangement shall be provided for underground structures if any with sump pumps. Coal stockyards and surrounding areas also shall have suitable surface drainage facilities.

14.09.00

Road / Rail Crossings:



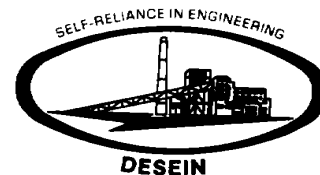
Hume pipes of appropriate size of class NP2 shall be provided under the roads and rail tracks for pipe and cable crossings at the required locations.

14.10.00 Loadings

For different loads on structures, latest IS:875 shall be followed. All structures shall be designed for dead load, live equipment load (including impact / vibration), erection load etc. in addition, seismic load (as per IS:1893) or wind load (as per IS:875) shall also be considered.

The following minimum live loads shall be adopted for design of buildings / structures.

a) Flat Roof	:	Accessible roof – 200 Kg/m ² (150kg/m ² for L.L. & 50 Kg/m ² for dust load)
	:	Non-accessible roof–125 Kg/m ² (75 Kg/m ² for L.L. & 50 Kg/m ² for dust load).
b) Inclined roof (including roof for Conveyor Galleries)	:	A per IS:875 for live load plus 50 Kg/m ² for dust load to be Considered on plan area.
c) All building floors & stairs	:	500 Kg/m ²
d) Toilet rooms	:	200 KG/m ²
e) Walkways of Conveyor Galleries	:	300 Kg/m ² (including Coal dust load) or a concentrated load of 300 Kg. at centre whichever is critical.
f) M.C.C. Floor	:	1000 Kg/m ²
g) Equipment Load	:	As applicable
h) Tunnels under roads, culverts per & its allied Structures including hume pipes.	:	Class “A” or class “70R” as IRC Standard whichever is higher or load due to bulldozers.
i) Underground basement tunnel trenches etc.	:	A surcharge pressure of 2T/m ² .
j) Tunnel	:	The loading shall be highest of the following:



- i) Two bulldozers (maximum capacity indigenously available) operating side by side without any coal heap over reclaim tunnel & surroundings and uncrushed coal storage area.
- ii) Two bulldozers operating side by side over a coal heap of 4.0m.
- k) Rail loads : As per I.R.S. including latest amendments

All structures under influence of Railway load shall be designed as per provisions of Indian railway code of practices and the contractor shall get the designs and drawings of structures approved by railway authorities also.

- l) Other loads : As per IS:875 or as decided by the Purchaser
- m) Seismic Loads : For design purpose the values for Seismic Zone – III as per IS:1893 shall be considered. Importance factors for all buildings shall be considered as 1.75. In addition, provision contained in IS:4326 & 13920 shall also be considered.
- n) Wind Load : As per IS:875. Basic wind speed = 50 m/s.
- o) Minimum thickness of walls / raft for all underground structures will be as follows:

Minimum thickness of R.C.C. raft at bottom shall be 600 mm. Minimum thickness of RCC side walls shall be 600 mm at bottom and 300 mm at top.

- p) A minimum safety factor of 1.2 against uplift of due to underground water shall be ensured during execution and after execution, considering dead weight of the structure to be 0.9 times only, ground water table at adjoining formation level and soil wedge angle of not more than 15 degrees. Also FOS against uplift to be taken as 1.0, considering the dead weight of structure and soil resting on side projections, if any in the vertical plane. Inclined wedge action of soil shall not be considered in this case.
- q) For Underground structures, earth pressure to be considered for design shall be due to earth pressure at rest (K_0) condition only. Earth pressure due to surcharge intensity of Railway Loads (where applicable) or Uniformly Distributed Load (UDL) of intensity 2T/sqm whichever is critical, shall be considered in the design.



- r) For design of coal hoppers, bulk density and angle of repose for coal shall be considered as 1.2 MT/cum and 31 deg. respectively.
- s) For deep underground structures, minimum clear cover for reinforcement shall be 50 mm unless otherwise stated.

For Design of Liquid storage structures , IS: 3370 (Part-I to IV) (Latest) shall be followed. Face of the structure in contact with the water shall be designed as uncracked section.

For design of underground structures/ foundations,
ground water table shall be considered at FFL of respective structure.
Face of the structure in contact with earth shall be designed with crack width limiting to 0.1 mm

- t) Water proofing of underground structures shall be done as /clause 6.11 of this specification.



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 124



15.00.00 ASH HANDLING SYSTEM**15.01.00 Specification for Civil, Structural and Architectural Works will be referred**

Ash handling system shall comprise of fly ash handling systems, ash slurry pump house, ash water pump house, ash compressor house, ash pipe supports including culverts, bridges etc. upto the specified terminal points.

Works shall include dry bottom ash hopper supports, scraper chain conveyor foundation & supports, transition chute foundation & supports, seal trough foundation & supports, clinker grinder, jet pump supports & foundation, bottom ash pipe supports, bottom ash extraction equipment supports, ash slurry pipe supports from ash slurry pump house to ash pond, surge tank, dry fly ash & bottom ash pipe supports, supporting structure for buffer hopper, fly ash silos, wet fly ash slurry pipe & supports from silo to ash dyke. Development of silo area (including paving, fencing, access roads, office block and watchman cabin), pump and equipment foundations, Vacuum pump foundation, BA over flow sump, drain sumps, compressor house, MCC room, RCC thrust blocks, 100 tonne electronic weigh bridge and other buildings, supporting structure facilities required to complete the system upto terminal points.

Structural arrangement, pile foundation system, if required, cladding interior and exterior finishes, area paving etc., shall be as per total plant building design and finish schedule furnished elsewhere in the specification.

Pipelines shall be supported on RCC structures and pile foundations, if required. Pipes shall be suitable anchored with RCC pedestals to resist lateral and vertical movements. For crossing of the pipe lines and maintenance road with nallahs, canals etc. and / or for road / rail crossings, pipes shall be laid through RCC box culverts / bridges. Road leading to silos shall have minimum width of 7.5m with both sides berms 1m and drains.

The compressors and their associated equipments shall be housed in RCC building along with requisite MCC room. Crane / monorail of adequate capacity shall also be provided in all pump / compressor house.

15.02.00 Following facilities shall be provided as per Vol. III of specification.

- i) Ash slurry sump with pump house.
- ii) Ash water sump house with pump house.
- iii) MCC Room / Control room.
- iv) Pipe Rack / trenches etc. in the plant area.
- v) RCC paving in Silo area.
- vi) Office block of minimum 50 sqm and Watchman cabin of minimum 5 sqm area shall be provided.
- vii) Dry ash storage silo area shall have compound wall all around with gate.
- viii) The following densities shall be considered for design of coal bunkers :



- (a) For volume calculation of fly ash silo : 750 kg/cum
- (b) For load calculation of both types of silos : 1600 g/cum
- ix) The concrete ash silo shall be designed generally as per the criteria laid down in IS:4995 (Part I&II). The static pressure calculated at rest shall be multiplied by an over pressure factor of 1.35 for the top $1/3^{\text{rd}}$ portion and by a factor of 1.75 for the bottom $2/3^{\text{rd}}$ portion. Special attention shall be given in assessing the effect of hot temperature of ash on the concrete wall. Temperature of ash shall be taken as 150°C.
- x) Clarifier.
- xi) Ash compressor house.
- xii) Fly ash silos, water wash arrangement lorries shall be provided in the flyash silo area



16.00.00 PLANT WATER PRE-TREATMENT AND DM PLANT SYSTEM

16.01.00 Sea water pre-treatment for CW and DM plant will generally consist of the following facilities / buildings, which will be located in two areas. However, the bidder may add / delete / club facilities as per approved system:

1. Sea Water Intake & Water Treatment In NCTPS Stage – II

- Sea water intake pump house including channel & forebay.

2. Water Treatment Facility Located In Ennore SEZ

- Cascade aerator & stilling chamber.
- Inlet channels.
- Filtered sea water tank & pump house.
- Dual Media Filters
- UF building.
- UF permeate tank & pump house.
- Cartridge filter building.
- RO Stage I building.
- RO Stage I Permeate tank & Pump house.
- Reject sump.
- Filtered water tank & pumphouse.
- RO stage II building including MB.
- DM building for SAC, SBA & MB chain.
- RO Stage II permeate tank & DM water storage tanks.
- Pump foundations in water treatment area.
- Electro chlorination building for CW system.
- Regeneration & bulk chemical storage area.
- CPU regeneration (if separate).
- Neutralization pit.

The stilling chamber and aerator shall be of RCC structure. The chambers and water channels shall be watertight structures.

The high rate solid contact clarifier shall be of RCC construction. The watertight circular RCC structures shall have continuous platform with handrail along periphery at the top. At least 3 nos. ladder shall be provided at the outside and vertical rungs shall be provided inside for maintenance.

The sludge sump (reject sump) shall be an underground RCC pit, part of the pit shall be cover with RCC slab for supporting the vertical sludge pumps. The sludge pumps shall be housed in a pump house with RCC roof supported on RCC columns and beams. There will be hoist and monorail of required capacity for handling of pumps. Capacity of reject sump is indicated in Vol. III & Composite Water Scheme.

Filtered sea water tank/ UF permeate tank/ RO Stage I Permeate tank/ Filtered water tank shall be of water tight RCC construction having two compartments covered with RCC roof. It will be aboveground. Vent pipes shall be provided at roof. The tanks including RCC roof shall be designed as uncracked structure as per IS:3370. The pump house structure shall be of RCC framed construction with RCC flat roof. Side cladding shall be



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 127



of brick masonry. Cranes & hoists as indicated in Vol. III shall be provided for handling pumps. The building shall be complete with doors, windows and rolling shutter. Floor and other finishes shall comply with architectural specification. Capacity of the tanks is indicated in Vol. III & Composite Water Scheme.

Pretreatment chemical house shall be a two storied concrete RCC framed building. Clear height of 5.5m (minimum) shall be provided in each floor. The building shall be complete with brick work, plastering, doors, windows, rolling shutters, flooring, plaster, painting, roofing etc. and all other items necessary for satisfactory performance of the building. The building shall have toilets and the scope shall include supply and fixing W.C.'s urinals, showers and all plumbing sanitary and other work required for satisfactory completion of the above building. The tanks and parts of floor slabs shall be lined with acid / alkali proof tile lining. Monorails of adequate capacities shall be provided as per functional requirements. The building shall be provided with adequate toilet facilities.

Near the chemical house there will be a single storeyed RCC framed building housing the electro-chlorination plant. Hoists with monorail shall be provided for normal plant operation and for handling of equipment during erection / maintenance. The building shall be complete with brick work, plastering, doors, windows, rolling shutters, flooring and painting, roofing etc. and all other items necessary for safety and satisfactory performance of the building. Brick masonry wall with suitable windows and doors will be provided in accordance with architectural specification.

Water treatment facility including RO stage I, UF building, Electrochlorination & Sea water intake PH, and DM plant building in Ennore SEZ will be RCC framed building having brickwork cladding on all four sides. Ground floor shall house MCC and control room. Control Room which shall have false ceiling and shall be air-conditioned. Central chemical laboratory and office rooms etc. shall be at first floor level, which will also have false ceiling and air condition provision. Equipment foundations & trenches in ground floor slab shall be of reinforced cement concrete. Ground floor shall have ironite flooring except at locations, which may come in contact with acid/ alkali where acid / alkali resistant tile lining with epoxy mortar shall be provided. Effluent drain trenches shall also have acid proof lining at inside surfaces of drain as well as soffit of pre-cast removable covers. The building shall be provided with adequate toilet facilities. The lab shall be provided separately in NCTPS & Ennore SEZ.

Floor where acid / alkali spillage are expected shall be isolated with RCC kerb. Neutralizing pit shall be of watertight RCC construction. Internal surfaces shall be lined with acid / alkali proof lining with matching epoxy mortar. Neutralization pit shall be designed as uncracked section. Ceiling as well as floor, supporting pumps shall be given epoxy lining.

Acid / alkali storage tanks shall be resting on RCC saddles on elevated RCC platform. The platform shall be supported on RCC beams, columns with RCC foundations. The saddles along with platforms shall be lined with acid/alkali proof tiles.

Acid / alkali storage and handling area shall also be lined with acid / alkali resistant tiles.

The DM storage tanks shall rest on thoroughly compacted fill of gravel, coarse sand or other stable material topped with minimum 75 mm thick compacted crushed stone, screenings, fine gravel, clean sand or similar material mixed in hot asphalt (8 to 10



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 128



percent by volume) and rolled or compacted. This filling shall be confined within a RCC ring wall with foundation. The tank shall have complete bearing with the foundation fill. All backfilling within tank foundation shall be done by compacted sand. Degasser shall be supported on RCC framed structure. Minimum 2.5m wide RCC pavements shall be provided around each outdoor equipment.

The capacity of all tanks and equipment shall be as per VOL III.



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 129



17.00.00 OUT DOOR CIVIL WORKS**17.01.00 Roads**

Access within the plant site shall be provided by a system of roadways.

All building shall be approached by access road, which shall either be single or double lane road depending upon the functional requirement. Access roads shall also be provided to areas such as transformer areas, steam generator area and other equipment area shown in the plot plan, where access is necessary for inspection, operation and maintenance.

Roads shall be three types: Type I, Type II and Type III. All the roads shall be of reinforced cement concrete with M30 grade concrete.

Type I roads shall consist of 7.5 metres wide RCC paved carriageway with 2.5m wide hard shoulders. The main plant access road and a portion of the main plant complex circumferential road shall be Type I.

Type II roads shall consist of one 4.0 metre wide RCC paved carriageway with 1.5m wide hard shoulders with drains on either side. A turning area at blind ends shall be provided. Plant areas where infrequent access is needed shall be served by Type II roads. Examples of Type II roads are the lay-down area roads.

Type III roads shall be 3.0m wide with 1.0m wide hard shoulders on either side. Type III roads shall be provided along the plant boundary for access for security and maintenance.

Top of all the shoulders shall be finished with interlocking tiles. 80 mm thick M20 grade PCC with minimum 100 mm thick screed sand cushion layer shall be provided below the interlocking tiles.

Road leading to main gate of power house shall be double lane road with suitable berm. Minimum thickness of road shall be 25 cm and width of 7.5m each.

All Type I roads shall have a minimum turning radius of 25 meters and for Type II and Type III roads shall have a minimum turning radius of 7 meter.

Bollards shall be provided along side of all type of roads near equipment which requires protection. Spare duct bank shall be provided under all type roads spaced at 100m intervals.

Sign Boards shall be provided for vehicle management and shall meet the Indian standards. All sign boards shall be dual worded in both English and the local Indian language. Finished top (crest) of roads shall be 250 mm above the surrounding grade level. Geometric design of road shall be in accordance with IRC:73. The ruling gradient for roads in longitudinal direction shall not exceed 1 in 25.

Main roads shall be designed for movement of heaviest equipment of the plant.

The shoulder shall be laid with slope of 1 in 30.



Top level of parking area shall be flushed with crown connecting roads with cross slope. Parking area shall be provided rigid pavements & shall be provided with anti skid tiles.

On either side of type I and type II roads and on one side of type III roads, open drains shall be provided. Minimum clear width of drains shall be 600mm. The drains shall be designed and built using RCC. Drainage lines and other underground services shall be located at least 1m clear from the edge of the roads. All service and utility lines crossing the roads shall be taken through NP3 class RCC pipe designed for impact loading. All culverts carrying storm water shall be cast in place RCC box culverts.

No underground service piping except for drainage and sewage system shall run directly below the road (including upto 1 m. from edge of road) along its longitudinal direction.

Surface drainage of roads shall be provided by giving proper longitudinal slopes and cross falls.

The Minimum thickness of RCC road pavement, Sub-base and minimum reinforcements shall be as follows.

Type I & II roads –

250mm thick with 8mm TOR at 250mm c/c both ways at top and bottom (double layer)
Sub – base : 2 layers of granular sub base plus 100mm thick PCC.

Type III roads –

150mm thick with 8mm TOR at 250mm c/c both ways (Single layer) Sub – base : 250mm thick granular sub base plus 100mm thick PCC The sub-grade shall be compacted to atleast 98% Proctor Dry Density. The actual thickness road pavement, sub-base thickness, reinforcement etc., shall be provided as per design and functional requirements.

Roads shall be designed for IRC and MOST standards (MORTH). Minimum thickness of basement slab and walls and drains to be 200mm thick with 2 layers of reinforcement.

A Separation membrane shall be used between Concrete and sub-base. Membrane shall be impermeable. Plastic sheeting shall be 125microns thick laid flat without creases.

The drainage system shall be designed for precipitation intensity of minimum 80mm per hour.

The joints, dowel bars, tie bars, joint pillars, ceiling compounds tolerances curing shall be as per latest IRC MOST standards.

17.02.00

Surface Drainage

- a) All the paved and unpaved areas shall be adequately drained. The surface drainage system shall be designed for surface washings and / or rain / fire water as the case may be. Unpaved open areas shall be drained through RCC drains and connected to main storm drains.
- b) The paved area shall be sloped towards the drains with a minimum slope of 1 in 100. The maximum drainage travel extent shall be limited to 10 metres.



- c) The surface drainage from uncontaminated area shall be connected to nearest open storm water drains through rectangular drains. Contaminated area surface drainage shall be collected through separate network.
- d) The interconnecting pipes and rectangular drains shall be sized for carrying the design discharge when running full.
- e) The rectangular drains shall be minimum 450 mm wide of RCC construction. The pipes for water drainage system shall be of RCC class NP2 conforming to IS:458 with minimum size of 150 mm NB. However, for road crossings etc., pipe of class NP3 SHALL BE PROVIDED. For rail crossings, pipes conforming to railway loading standards shall be provided. If sufficient clearance cannot be provided between the top of the pipe and road top, the pipes shall be encased in RCC. Minimum clear width of drain shall be 300 mm.
- f) The maximum velocity for pipe drains and open drains shall be limited to 2.4m/sec and 1.8m/sec respectively. However, minimum velocity for self cleansing of 0.6m/sec shall be ensured. Slope of drain shall not be milder than 1 in 1000.
- g) Minimum earth cover of 450 mm shall be provided over drainage pipes in paved areas.
- h) RCC Garland drains minimum 300mm wide shall be provided allround the building to lead away roof drainage to plant drainage system. Plinth protection in PCC grade 1:2:4 shall be provided between brick wall and drain with appropriate slope.

17.03.00**Storm Water Drainage System**

- a) The plant storm water drainage system shall take into account the topography of the plant area, area drainage patterns and intensity of rainfall etc. The drainage system shall be designed for a precipitation intensity equal to hourly rainfall for a return period of 1 in 50 years. However, storm frequency of 100 years return period shall be applied for Coal Storage area. These values shall be based on the recommendations of Indian metrological department (IMD).
- b) All storm water drainage shall preferably be through open storm water drains. These shall be provided on both sides of the roads and shall be designed to drain the appropriate catchment area including road surface, open and covered area etc. The drains shall be minimum 300 mm wide at the base.
- c) All open drains shall be rectangular in cross section & in RCC. In the main plant block, rectangular section RCC drains in minimum M25 grade concrete shall be provided. The thickness of side and bottom shall be minimum 125 mm or as per design considerations whichever is higher.
- d) The pipes for water drainage system shall be concrete pipes of class NP2 conforming to IS:458. However, for road crossings etc. higher strength pipe of class NP3 shall be provided. Diameter of pipes used for drainage / culverts shall be between 300 mm to 600mm. Beyond 600mm, box drains / culverts shall be provided. Water way RCC culvert shall not be less than 1m.



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 132



- e) Surface drains shall normally have a bed slope not milder than 1 in 1000 along longitudinal direction and RCC pipes shall have such slopes so as to have effective discharge. The maximum velocity for pipe drains and open drains shall be limited to 2.4 m/sec and 1.8 m/sec respectively. However, minimum velocity for self cleansing of 0.6m/sec shall be ensured at peak flow condition (i.e. 3 times average flow) for pipes flowing at half full.
- f) Suitable manholes shall be provided to piped drainage lines at every 30m intervals, at junctions and at change of gradient, alignment and diameter of pipe and shall be of masonry or RCC construction. Minimum size of manholes shall be 1.0m x 1.0m. All manholes shall be designed considering maintenance, inspection and cleaning of pipes. Easy accessibility and safety shall also be given due consideration.
- g) The cushion over the pipes for storm culverts shall be minimum 600mm. Where less cushion is available, pipe shall be cased in RCC m-15. Suitable RCC or masonry structures shall be provided at drops / falls to prevent scouring or damage to surface.
- h) Invert of drainage pipe / drain shall be decided in such a way that the water can easily be discharged above the high water level in water course outside the plant boundary to which the storm water is to be led.
- i) The storm water drainage for the contaminated area such as coal stack pile, fuel oil area, oil skids etc. shall be designed separately and the discharge shall be led separately for treatment and disposal.

17.04.00 Paving

Sufficient pavement areas adjacent to administrative building, canteen building, service building, fire station and first aid centre shall be provided for parking facilities.

Concrete paving of grade M-20 with suitable underbed shall be provided in the entire area from Transformer yard to full length up to 5m beyond chimney.

The inside area of fuel oil dyke shall be provided with concrete paving.

The transformer yard, covering area between A row of the turbine building upto the fencing of transformer yard shall be provided with minimum 100 mm thick PCC paving of nominal mix 1 : 2 : 4 of grade M-20. Paving shall be laid over 150mm thick compacted rubble soling and laid to slope towards drains.

Entire switch yard shall be provided with 75mm paving of 20 to 40mm size stone aggregate on top and 75mm paving of 20 mm stone aggregate below. Before laying the paving, the ground surface shall be treated with antiweed chemicals as per manufacturer recommendations.

For auxiliary transformer yard, paving of stone aggregate of 75 mm thick using 20 mm size aggregate shall be provided after compacting the under bed and treating with anti-weed chemicals.



The RCC paving in specified areas shall comprise of following layers :

1. 255 mm thick approved quality boulders shall be placed on well compacted soil underneath. The interstices of the boulders shall be filled with sand. This layer shall be compacted to the satisfaction of engineer.
2. 100 mm thick M15 grade plain cement concrete on layer mentioned (1) above.
3. M20 grade reinforced concrete with nominal reinforcement 8 tor @ 250 c/c both ways top and bottom having thickness 200mm shall be laid over the layer mentioned (2) above.

17.05.00

Security cum Time Office Complex :

Approximate area of this complex shall be a minimum of 400 sqm. The dormitory shall be constructed in the first floor for security persons.

One dormitory of 100 sqm for security personnel to be provided in the time office.

The complete security gate complex consisting of Gates, Guard House, Wicket gate, time and security office, speed breakers, traffic barriers and parking/waiting space shall be carefully planned such that they function smoothly, specifically at the time of Change of shift.

The whole complex shall be aesthetically pleasing merging with the architecture of the compound wall.

Time and Security Office shall have adequate area to house the security staff and time office staff in addition to the record room, waiting rooms, toilet facilities etc.

In Time office, separate dress change rooms shall be provided for ladies and gents.

In addition to inside toilet, another toilet with entry from outside shall be provided for the use of visitors.

Speed brakers shall be provided both out side and inside the compound with manually operated traffic barriers.

Emergency Gate shall be provided in addition to the main gate. Main Gate shall have two separate entry one for project site and other for fly ash silo trucks movement. Gate latches shall be arranged for padlocking with the padlock accessible from both sides of the gate. Padlocks shall be provided and the key shall be in accordance with the Purchaser's requirements.

Cantilever type motorized sliding gate shall be furnished at the main plant entrance. The gate shall be operable by push button at both the guard house and the security office in the Administration / Plant Service area, and by card reader or key switches.

The road near the main entrance to be widened additionally by 7.5 m on either sides of the road for parking of vehicles for security check.

Suitable median arrangements to be made.

Security cabin to be provided on either sides of the road near the main gate.



Elevated platform either in steel structure / Brick work or RCC to carry out checking on Lorries/Tippers by security personnel while the vehicles getting in or going out from the premises.

17.06.00 Fencing

- a. Minimum 3m height fencing above toe wall shall be provided around transformer yard and other areas where fencing is necessary due to statutory requirements.
- b. Fencing shall comprise 3.0m height PVC coated galvanized chain link fencing of minimum 8 gauge including PVC coating of mesh size 75 mm and galvanized concertina.
- c. Galvanized barbed of a height of 0.6m shall be provided above the chain link fence. The diameter of steel wire for chain link fencing excluding PVC coating shall not be less than 12 gauges.
- d. MS entry gate shall be provided for all fenced areas. Top of toe wall shall be min. 200 mm above formation level.
- e. Removable type of fencing shall be provided at suitable location to permit entry and exit of equipment.

17.07.00 Watch Tower

Watch Tower shall be constructed with RCC frame work. Floor of tower shall be at least 6m above graded level.

Covered area for each tower shall be approx. 25 sqm. Number of towers shall be such that the complete periphery of the plant can be watched from the towers but in no case the number of towers shall be less than twelve.

Walking platform of 1.5m wide with hand rails shall be provided all round of watch cabin.

17.08.00 Plinth Protection

All buildings shall be provided with 1000 mm wide and 100 mm thick PCC of grade M-20 for plinth protection all round with surface drain of required size and slope, to suite storm water quantity. Plinth protection shall be laid over prepared subgrade and base formed with broken brickbats or rubble laid to a thickness of 150 mm.

17.09.00 Waste Water Treatment and Drainage System

Waste water treatment plant will receive plant waste water except RO plant reject and CT blow down. The treated water and the solid waste will be used within the plant.

Guard pond will hold the RO Stage-I reject, clarifier sludge treated water from oil water separator and this will be pumped to the sea. For this return water to the sea temperature shall not exceed 5°C over the inlet temperature of cold water.



The cooling tower blow down shall be pumped to sea with the help of blow down pumps installed in the CW pump house.

All necessary civil / structural works for waste water treatment plant shall be under scope of contractor. The major source of plant waste water are Boiler blow down, coal mill area drainage, PH and boiler area oily effluent drain, F.O. pump house oil drainage, boiler and ESP area floor washing drains, water pre-treatment plant effluent, fly ash silo area effluent, transformer yard waste water etc. Design and construction of channels / settling pits / sumps / pipe lines / separators shall be done by the Bidder.

The description of some of the major structures / components covered under the waste water system package is given below:

Coal pile area run-off will be led to settling pond. Earthen settling pond with two (2) compartments will be provided. Top of earthen dyke shall be 500 mm above surrounding finished grade level to restrict ingress of storm water from adjacent areas. Capacity of pond shall be determined on the basis of inlet drain invert. The side slopes and bottom will be protected with PCC blocks of minimum 75 mm thickness with suitable under-bed having interstices filled with cement-sand mortar. At the downstream of pond RCC overflow weir and sump shall be provided. Design and detailing of pond shall be as per good engineering practice so as to satisfy functional requirement as specified in the specification. Necessary sluice gates with hoisting arrangement shall be provided in inlet drain carrying coal pile area run-off so that one settling pond can be operative while the other one under maintenance.

The Power House and boiler area service water waste shall be collected in a RCC underground oily waste retention pit. Necessary pumps and supporting floor / maintenance area shall be provided. This effluent will finally be treated in TPI (tilted plate interceptor). Foundation from TPI shall be designed as per IS:456. RO Stage-II reject shall be led to fire water sump and green belt development. In case the fire sump is full then arrangement shall also be made to lead this to the guard pond.

Oil storage and handling area run-off will be collected to a conventional baffled oil water separator. This oil water separator will be an underground RCC structure having RCC baffle wall and overflow sump for collecting water at outlet end. An oil collection pit shall be provided on sidewall of oil water separator. This structure shall be designed as un-cracked section as per IS:3370. The structure shall project at least 300 mm above finished grade level. Handrail shall also be provided around the pit. The overflow sump shall be covered at top over which pumps will be installed.

RCC sump for collecting boiler blow down and ESP area floor washing is included in scope of bidder. Civil work for outlet of this effluent shall also be under scope of this package.

Guard Pond (effluent monitoring pond and equalization basin) sized for holding waste water from RO Stage-I reject, clarifier sludge, treated water from oil water separator and boiler blow down as per capacity indicated in Vol. III & Composite Water Scheme. The guard pond (earthen) shall have adequate capacity as per design requirement with 750 mm free board. Top of earthen dyke shall be 500 mm above finished grade level. The pond shall be of such construction as to prevent pollution of ground water by seepage of



any wastewater having side slopes and bottom lined with minimum 250 micron LDPE for minimizing seepage loss. Over the LDPE lining, PCC blocks of minimum 75 mm thickness having interstices filled with cement-sand mortar shall be provided. Filter media shall be suitably designed and provided below liner.

17.10.00 Sanitary Sewerage System

Sanitary Sewerage System shall be carried out as specified in VOL – III (Mechanical Spec.).

The treated water to be provided with necessary pumps and distribution lines for reutilization for Horticulture / Green belt development.

The sewerage system of foul water from toilet shall include layout and laying of sewers up to a sewage treatment plant together with all fittings and fixture and inclusive of ancillary works such as connections, installation of man-hole and inspection chambers. The construction of a sewage treatment plant of adequate capacity including settling tank, lifting stations, pump house and all other necessary provisions shall be made for treating the sewage water by using the latest CAACO technology developed by M/s. Central Leather Research Institute, Taramani, Chennai.

The domestic effluent from the plant shall be collected and treated in proper STP to meet the prescribed BIS standard before being discharged or reutilized for green belt development.

17.10.01 Sanitary Sewer Drains

- a) Sanitary sewers shall be designed for a minimum self cleansing velocity of 0.75 m/sec. and the maximum velocity shall not exceed 2.5m/sec.
- b) Very hot (over 60⁰C) water shall be first cooled down to less than 60⁰C in collecting basin by mixing with cold water before connecting to storm drainage system.
- c) The maximum temperature, quality, quantity and location of drain water of individual equipment shall be tabulated and furnished to the Owner's representative.
- d) All underground piping below concrete slab shall be cast iron of minimum 100mm dia and for outdoors it shall be reinforced concrete pipe of minimum 200mm diameter. In buried piping system manholes shall be placed at every change in direction and at every SOM (max.) interval in straight run. Suitable clean outs shall be provided for buried piping under floor slab.
- e) Following minimum drainage slope shall be provided:
 - Pipes of diameter less than 200mm : 1 (vertical) : 100 (horizontal)
 - Pipes of diameter 200mm & more: 1 (vertical): 200 (horizontal).



18.00.00 ARCHITECTURE**18.01.00 Architectural Concepts**

- a) Layout of the plant area shall have definite hierarchy of road network depending upon its usage, aesthetic, visual sensibilities for creating road vistas, focal points, building back drops, building frames. General layout shall be evolved taking over the basis of landform & local climate & due consideration shall be given to orientation & wind direction. The resulting built mass shall present a definite image width in distinct vocabulary in the form of landmarks, nodes & skyline.
- b) Main Plant Building shall be architecturally treated in such a way that it retains a monumental scale, yet presents a pleasing composition of mass and void with suitable and functionally designed projections and recesses. The overall impact of the building shall be one of aesthetically unified architectural composition having a comprehensible scale, blending tonal values with the surroundings and taking full consideration of the climatic conditions, the building orientation and the existing structures nearby.
- c) All other buildings and structures shall be architecturally treated in such a way so as to be in complete harmony with the main plant, surrounding structures and environment. Local architectural characters and materials may be judiciously imbibed. The building shall be designed initiating an architectural control common to all buildings. The architectural control shall be clearly spelt out in terms of scale, man & form.
- d) Overall colour scheme and finish schedule of the plant and other buildings shall be designed judiciously and in a comprehensive manner taking into account the mass and void of buildings, its façade, equipments, exposed structural elements, piping, trestles, bus ducts and other service elements.
- e) Overall emphasis shall be on developing an eco-friendly architecture, merging with the nature with its own sustainable energy management systems.

The scheme shall be conceptually finalized in totality including that of equipments so that the proper coordination with other agencies can be taken up at appropriate time.

18.02.00 Architectural Design

- i) Natural light shall be used to the maximum extent specially in the form of north light / sky light. For adequate light & ventilation, National Building code recommendations shall be followed.
- ii) Entrance canopies, chajjas (projections, recesses) over openable windows and door openings on exterior facades shall be provided.
- iii) All the buildings shall be architecturally designed to meet the National Building Code (SP:7) norms and local building bye laws, wherever applicable.



- iv) Architectural design and detailing aspects of all the buildings shall be rendered through professional services of an Architect. Statutory requirements and any clearances from local authority may be required to be met with, wherever essential. The Architect Consultant shall be of National / International repute having experience in similar kind of works. The consultant shall evolve the design philosophy based on Employer's guidelines and shall present it in the form of presentation drawings, Prospective views, 3-D Models & detail drawings.
- v) Minimum 1000mm high (from floor / roof level) hand railing shall be provided around all floor / roof openings, projections / balconies, walkways, platforms, steel stairs, etc., All handrails and ladder pipes (except at operating floors) shall be 50mm nominal bore MS pipes (medium class) conforming to IS:1161 and shall be galvanized as per IS:4736 treated with etch primer and finished with suitable paint. All rungs and ladders shall also be galvanized. Minimum weight of galvanizing shall be 610 g/sqm.

All stairs and around all floor openings at operating floors, 1000mm high hand railing with 32 NB (polished) stainless steel pipe shall be provided.
- vi) All stairs shall have a maximum riser height of 180mm and a minimum tread width of 250mm. Minimum clear width of stair shall be 1200mm unless specified otherwise.
- vii) All buildings having metal cladding shall be provided with a 150mm high RCC toe curb at the edge of the floor along the metal cladding. 900mm high hand railing shall be provided on this RCC curb, wherever required from the safety point of view.
- viii) In all buildings, structures, suitable arrangement for draining out water collected from equipment blow downs, leakages, floor washings, fire fighting, etc., shall be provided for each floor. All the drains shall be suitably covered with grating or pre-cast RCC panels.
- ix) RCC staircase shall be provided for all RCC construction buildings and structural steel staircase for all structural steel buildings.
- x) Parapet, Chajjas over window and door heads, architectural facias, projections, etc., shall be provided with drip course in cement sand mortar 1:3. Cut lintels over windows/doors shall be avoided as far as possible.
- xi) All fire exits shall be painted with P.O red/signal red colour shade which shall not be used anywhere except to indicate emergency or safety measure. Fire safety norms shall be followed as per National Building Codes and fire safety requirements for providing fire exits, escape stairs and firefighting equipment. In detailing of all buildings, fire safety requirements conforming to IS:1641 and IS:1642 shall be followed.
- xii) All windows shall be provided with granite slab at sill level.
- xiii) All grills of window shall be of 12 mm square MS bars both ways.



18.03.00 Interior Design

A comprehensive interior design scheme shall be conceived with the intention of projecting a definite theme and aesthetic appearance to inside working environment. It shall take into account the multidisciplinary engineering activities involving power plant technology, and architectural and civil engineering for a smooth control hierarchy and man machine interface. All the design aspects such as flooring, false ceiling, furniture, colour scheme, equipment design, layout, illumination, fire fighting, acoustics and ergonomics requirements shall be detailed out so as to present an overall unified aesthetic spatial appearance. The areas to be undertaken for this interior design process shall be control room complex including common control room, computer room, conference rooms and office areas in the main plant building and the following aspects shall be reviewed and evaluated for design. Furniture to be supplied by Bidder for the control room complex shall be as specified under C&I specification.

- a) Layout, keeping in view the main-machine interface and suitable ergonomic practices.
- b) Integration of civil engineering with architecture and interior design.
- c) Illumination levels, noise levels, electromagnetic interference levels, taking into account the equipment and furniture.
- d) Comfort and safety requirements such as air conditioning, fire fighting, fire escapes etc.
- e) Microprocessors based control system to control the functional requirements.

The above design philosophy put into practice shall be detailed out through presentation drawings, perspective views, scale models, detail drawing etc.

18.04.00 Sealant

Silicone sealant or polyurethane shall be used in all expansion joints exposed to weather. All joints around exterior doors, windows and expansion joints shall be sealed for proper water tightness.

18.05.00 Damp Proof Course

50mm thick 1:1.5:3 concrete with water proofing admixture shall be used. Water proofing compound shall be of Zydex, Sikka or similar make.

18.06.00 Finishing Schedule

The minimum quality of finishes used for various building areas are furnished in Table-1 in this section. The Bidder is at liberty to use superior finishes provided all specific requirements for the finish specified in Part-B of Vol-VI.

18.07.00 Roof Drainage and Water Proofing

- a) Roof drainage system shall be provided for quick and efficient draining of rainwater from roof to avoid seepage and damage to roof. The runoff gradient for the roof shall



not be less than 1 in 100. Roof drainage system shall consist of roof drain heads, rain water down comer and fixtures. System shall be designed to handle design rainfall for the specific site and shall be in accordance to stipulations of IS: 1742 and IS: 2527. The down comer pipes shall be suitably concealed with masonry work, cement concrete or sheeting to match with the exterior finish.

- b) Multiple drains (minimum 2) shall be provided for all roof areas. Any roof more than 8 m above grade shall have access from within the building for cleaning of roof drains.
- c) Rain water down comers shall be of HDPE pipe conforming to IS: 4984.
- d) All roofs shall be provided extra with heavy duty water proofing treatment comprising of
 - i. Seven courses as per IS:1346 using layer of Type 2 Grade 1 glass fire based felt as per IS:7193.
 - ii. 50mm thick foam concrete as per IS:6598 for thermal insulation
 - iii. 15mm thick cement sand plaster 1:4.
 - iv. Chequered cement tiles as per IS:13801 shall be provided over water proofing treatment in areas where movement of personnel is expected. Minimum width of pathway if provided only locally shall be 1000mm.
 - v. In areas such as roof of control room bay of Main Turbine building, Bunker bay roof etc where handling of equipment is anticipated, the foam concrete may be replaced by 40mm screed concrete.

Roof water proofing may also be provided using high solid content liquid applied elastomeric water proofing membrane with separate wearing course as per ASTM C-898. Thickness of the membrane shall be a minimum of 1.5mm. The treatment includes application of polymerized mortar over sloped roof to achieve a smooth surface and a primer coat. Wearing course shall be 40mm screed of 1:2:4 concrete as above cast in panels of 1.2m x 1.2m and reinforced with 0.56mm dia galvanised chicken wire mesh and joints sealed using sealing compound. Accessible roof shall be provided with chequered tiles as above.

18.08.00 Sumps

In case of underground structures, sumps with pumping arrangement shall be provided at suitable location to collect and pump out any incidental water collection to nearest storm water drain.

18.09.00 Master Key System

An appropriate serviceable and functional master key system for the whole plant shall be installed. The elaboration of the system itself shall be made in close co-ordination with the Purchaser / Consultant and only after obtaining the Purchaser's / Consultant's approval in writing shall the order of production be placed.

The following requirements shall be met:



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 141



- The general master key shall operate all locks
- The main key shall open all locks of one building
- The single key shall open the lock of a single room.

Necessary attention shall be paid to later extensions of the master key system, which shall be suitable for the entire plant including all final stages.

The profile cylinders shall be sea water resistant and shall suit all plant requirements. The material of the cylinders shall be of massive brass, nickel-plated with six security pawl studs.

The keys shall be made of material approved by the Purchaser / Consultant and shall have an engraved indication of the applicable key system and the building or door number.

Keys shall be supplied in the following numbers:

General Master Key	10	nos
Main keys	10	nos. per each building
Single keys	3	nos. per each door

18.10.00 Land Scaping

18.10.01 General

This specification covers broadly the requirements for Landscaping within the Plant Area. Landscaping shall be carried out after all the underground utilities and drainage systems are in place. The entire work of Landscaping shall be carried out to the satisfaction of the Engineer and in a manner to have a beautiful appearance after completion of the work.

The Landscaping plan should be prepared by the Contractor with the help of an expert Horticulturist with due considerations for Fauna & Flora grown in the adjacent area and which can sustain in the saline climate. Minimum 30% of total plant area shall be covered with grass belt. In addition approximately 1000sqm of area shall be landscaped with Korean grass & latest flowers.

The area to be landscaped shall be clearly demarcated at site and got approved by the Engineer and the work shall be divided into following sub-items.

18.10.02 Preparing Lawn

For this purpose, within the area where lawn is to be grown, about 0.3 metres of earth shall be removed. This shall be replaced by fresh garden soil and manure in 2: 1 proportions spread evenly. Fresh garden soil & manure shall be mixed thoroughly, well watered and left overnight. The next morning, the variety of lawn, as per approved plan and as directed by the Engineer, shall be planted. This grass shall be maintained till well established by watering, weeding, clipping, rolling etc.

18.10.03 Preparing Clipped Hedges



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 142



Hedges made of Casuarinas or other shrubs as directed by the Engineer shall form borders between footpath and the Lawns. The shrubs shall be planted at spacing not more than 25 cms.

18.10.04 Planting Shrubs

Shrubs with coloured leaves like Crotons, Acalyphia, Oleander and Bougainvillea, Hibiscus etc. which are perennial shall be planted in clusters or over a large area at locations and in the manner as per approved layout. These shrubs shall be planted at spacing of not more than 25 cms.

18.10.05 Installation of Watering System

Shall prepare and submit watering System for the Plants. Drip Irrigation and Spray System consisting of complete PVC pipe with all necessary bends, Tees, Elbows etc., valves, stop cocks, Spray nozzles, sufficient lengths of Flexible PVC pipes to reach all area of Landscaping shall be included in the watering system. Only after approval of the Engineer, the Contractor shall commence the work.

TABLE – 1

FINISHING SCHEDULE

Building / Area	Wall (Internal)	Floor Finish	Ceiling	Roof Treatment	Wall (External)
STG Building					
Ground Floor: Maintenance Bay & Unloading Areas	Acrylic washable distemper	Granolithic with non-metallic hardner	Acrylic washable distemper	--	Water proof cement based paint
Ground floor general area	Acrylic washable distemper	Granolithic Flooring	Acrylic washable distemper	--	Water proof cement based paint
Mezzanine Floor	Acrylic washable distemper	Granolithic flooring	Acrylic washable Distemper	--	Water proof cement based paint
Operating Floor					
1. Operating Area, laydown area	Acrylic washer distemper	Corborandum tiles	Acrylic washable Distemper	--	Water proof cement based paint
2. General circulation and movement	Acrylic washable	Glazed vitrified ceramic tiles	Acrylic washable	--	Water proof cement based



Building / Area	Wall (Internal)	Floor Finish	Ceiling	Roof Treatment	Wall (External)
areas	distemper		Distemper		paint
3. Heater area	Acrylic washable distemper	Heavy duty cement concrete tiles (Carborandum)	Acrylic washable Distemper	--	Water proof cement based paint
Toilet	Dadoing for 2100 mm high + Acrylic distemper	Heavy duty ceramic tiles (Anti skid only.)	Acrylic washable Distemper	--	Water proof cement based paint
Roof	--	--	--	Elastomeric water proofing treatment	--
Clarified Water Pump House	Acrylic washable distemper	Granolithic floor with non metallic floor hardener	Acrylic washable Distemper	Heavy duty water proofing as per IS:1346	Water proof cement based paint
Cooling Water Pump House	Acrylic washable distemper	Granolithic floor with non metallic floor hardener	Acrylic washable Distemper	Heavy duty water proofing as per IS:1346	Water proof cement based paint
Raw Water Pump House	Acrylic washable distemper	Granolithic floor with non metallic floor hardener	Acrylic washable Distemper	Heavy duty water proofing as per IS:1346	Water proof cement based paint
Control Rooms	Acrylic emulsion paint	Glaze vitrified ceramic tiles	Aluminum Fall Ceiling	--	Water proof cement based paint
MCC Switchgear Room	Acrylic washable distemper	Granolithic floor with non metallic floor hardener & top finished with epoxy coating.	Acrylic washable Distemper	--	Water proof cement based paint
Office Areas	Acrylic emulsion paint	Heavy duty Ceramic Tiles	Acrylic washable Distemper	--	Water proof cement based paint



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 144



Building / Area	Wall (Internal)	Floor Finish	Ceiling	Roof Treatment	Wall (External)
Cable Vaults	Acrylic Distemper	Granolithic floor with non metallic floor hardener	Acrylic washable Distemper	--	Water proof cement based paint
Control & Switchgear Building					
Central Control Room	Acrylic emulsion paint	Anti skid Marbonite tiles	Aluminum False Ceiling	Elastomeric water proofing treatment	Water proof cement based paint
Electronic cubicle room & Computer room	Acrylic emulsion paint	Heavy duty ceramic tiles	Aluminum False Ceiling	--	Water proof cement based paint
Conference room, senior executive room	Acrylic emulsion paint	Glazed vitrified ceramic tiles	Aluminum False Ceiling	--	Water proof cement based paint
Switchgear room	Acrylic washable distemper	Granolithic with non-metallic floor hardner & top finished with epoxy coating.	Acrylic washable Distemper	--	Water proof cement based paint
Battery Room	Acid & alkali tile dadoing for 2100 mm high + Chlorinated rubber based paint	Acid / alkali resistant tiles	Chlorinated rubber based paint	--	Water proof cement based paint
SWAS room	Acrylic washable distemper	Glazed vitrified ceramic tiles for dry areas. For wet areas Heat resistant, anti skid of approved brand & colour.	Acrylic washable Distemper	--	--
Office, Common areas & corridor	Acrylic emulsion paint	Heavy duty ceramic tiles	Acrylic washable Distemper	--	Water proof cement based paint



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 145



Building / Area	Wall (Internal)	Floor Finish	Ceiling	Roof Treatment	Wall (External)
Cable Room	Acrylic distemper	Granolithic with non-metallic floor hardener	Acrylic washable Distemper	--	Water proof cement based paint
Toilet	Dadoing for 2100 mm high + Acrylic distemper	Heavy duty matt finish ceramic tiles	Acrylic washable Distemper	--	Water proof cement based paint
Lockers room	Acrylic washable distemper	Kota stone.	Acrylic washable Distemper	--	--
Pantry	Dadoing for 2100 mm high + Acrylic distemper	Heavy duty matt finish ceramic tiles	Acrylic washable Distemper	--	--
Laboratory room	Acrylic washable distemper	Heavy duty ceramic tiles	Acrylic washable Distemper	--	Water proof cement based paint
Records Room	Acrylic washable distemper	Kota stone.	Acrylic washable Distemper	--	--
Other Buildings					
Bunker Building	Acrylic washable distemper	Granolithic floor with non metallic floor hardener	Acrylic washable Distemper	Heavy duty water proofing as per IS:1346	Water proof cement based paint
Chlorination Building	Chlorinated rubber based paint	Acid / Alkali resistant tiles	Acrylic washable Distemper	Heavy duty water proofing as per IS:1346	Water proof cement based paint
Chemical House	Acid/Alkali resistant tiles on wall up to 1500mm height & chemical resistant paint above.	Acid/Alkali resistant Tiles	Chemical resistant paint	Heavy duty water proofing as per IS:1346	Water proof cement based paint



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 146



Building / Area	Wall (Internal)	Floor Finish	Ceiling	Roof Treatment	Wall (External)
DM Plant	Chlorinated rubber based paint	Granolithic	Chlorinated rubber based paint	Heavy duty water proofing as per IS:1346	Water proof cement based paint
Switchyard control room building and GIS building	Acrylic emulsion paint in control room and Acrylic washable distemper in other areas.	Epoxy finish on Granolithic flooring.	Aluminum false ceiling in control room and acrylic distemper in other areas.	Heavy duty water proofing as per IS:1346	Water proof cement based paint
Workshop	Acrylic washable distemper in Workshop area and Acrylic emulsion paint in office area.	Granolithic flooring with non metallic floor hardener in workshop area and Heavy duty ceramic tiles in office area.	Acrylic washable Distemper	Heavy duty water proofing as per IS:1346	Water proof cement based paint
Canteen : General Area Kitchen	Dadoing for 2100mm high & Acrylic Distemper above. Dadoing for 2100mm high & Acrylic Distemper above.	Heavy Duty Ceramic Tiles Terrazo Tiles	Acrylic washable Distemper Acrylic washable Distemper	Elastomeric water proofing treatment	Granular finish Granular finish
Fire Station Building	Acrylic washable distemper	Vitrified ceramic tiles in office, dormitory area & granolithic flooring with non metallic floor hardener in parking & equipment store area.	Acrylic washable Distemper	Heavy duty water proofing as per IS:1346	Water proof cement based Paint
Service building: Ent.	Acrylic	20mm thick polished granite	Acrylic washable	Roof of service	Granular finish (Vineratex) or



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 147



Building / Area	Wall (Internal)	Floor Finish	Ceiling	Roof Treatment	Wall (External)
Lobby, Reception, Portico, staircase & Lift Area	emulsion paint	stone	Distemper	building shall be provided with Elastomeric water proofing treatment	equivalent.
Office area	Acrylic emulsion paint	Glaze vitrified Ceramic tiles	Acrylic washable Distemper		
Administrative Building : Ent. Lobby, Reception, Portico, staircase & Lift Area	Acrylic emulsion paint	20mm thick polished granite stone	Acrylic washable Distemper	Roof of service building shall be provided with Elastomeric water proofing treatment	Granular finish (Vineratex) or equivalent.
Office area	Acrylic emulsion paint	Glaze vitrified Ceramic tiles	Acrylic washable Distemper		



2 x 660 MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS
Spec. No. CE/C/ P & E/ EE/ E/OT No.3 /2013-14
Vol. VI: 148



19.00.00 SURVEYING WORKS

19.01.00 Site survey shall be carried out to establish the ground levels and to determine any existing structures, roads etc. The site survey shall be carried out before the commencement of the work and if required during the progress of the work. The site survey shall be carried out at a grid spacing of 5-10 meters and at every change of level of the existing ground to produce contour drawings at 0.25 meter intervals. Scale of the contour drawings shall be as directed by the Consultant. A specialized firm approved by the Consultant shall carry out the site survey.

A single grid pillar will be given by the client with coordinates in plant area. Necessary grids shall be made by EPC contractor including demarcating the structures, buildings and jungle clearance including Cutting, uprooting and removing of trees and dispose the same away from the site etc.

19.02.00 Survey points (reference points and bench marks) : The contractor shall construct adequate number of reference points and bench marks for marking the setting out lines and levels. The reference points shall consist of suitable metal plates set in 400 mm x 400 mm x 500 mm precast concrete plinth (grid pillars) and inscribed with the exact level. All levels of the benchmarks shall be related to the agreed datum. The exposed numbers, locations, co-ordinates and level of the reference points and bench marks shall be plotted on drawings and approved by the consultant prior to the commencement of the work. Survey points in solid walls shall be stainless steel plates or cast iron, fixed firmly and sufficiently deep in the walls.

19.03.00 Safeguard of survey points: The survey points shall not be removed from their position without the permission of the Consultant. If any of the survey points are damaged or lost due to any work carried out near their location, the contractor shall be responsible for replacing such survey points.

19.04.00 Surveying during the progress of work : The contractor shall assist the consultant at any time when checking survey points, setting out, checking construction items and erection parts. The contractor shall provide and arrange the following:

- i) Provision and maintenance of survey instruments and accessories.
- ii) Provision of skilled personnel, supply of all material required for the survey exposing covered survey points.
- iii) Shifting of any machinery used for construction out of the sight lines.
- iv) Stopping all drilling, blasting, driving and any other works.
- v) Causing soil vibrations and stopping during instrument observations.
- vi) Removing all obstructive accumulation of water.
- vii) Taking all necessary safety precautions.

- viii) Furnishing any marking material requested by the Consultant in connection with control surveys.
- ix) Providing additional survey points in accordance with the consultant's instruction.

20.00.00 EXCAVATION AND FILLING

20.01.00 The works to be provided by the bidder in respect of excavation in all types of soils including shoring, dewatering, filling around foundations and to grade, compaction of fills and approaches, protective fencing, lighting, etc. relevant to structures and locations shall be as detailed below:

- a. Furnish all labour, supervision, services including facilities as required under statutory labour regulations, materials, equipment, tools and plants, transportation etc. required for the work.
- b. Prepare and submit working drawings showing the approaches, slopes, beams, shoring, sumps for dewatering including drains and outfall for drainage, space for temporary stacking of spoils, disposal area, fencing etc. and all other details as may be required by the Engineer.
- c. To carryout sampling and testing and submit to the Engineer, results of soil compaction tests if required by the Engineer to assess the degree of compaction.

20.02.00 All works should conform to the requirements of the latest revision of relevant ISS.

IS: 3764 : Indian Standard for Safety Code for excavation work.

IS:1200 (PartI) : Indian Standard Methods of Measurement of Building and Civil Engineering work, Part-I: Earthwork.

20.03.00 The bidder should carryout the work as per the approved drawings. All materials required for the work shall be of best commercial variety. Borrow materials for back- filling shall be excavated from approved locations and shall consist of material, free from roots, vegetation, decayed organic matter, harmful salts and chemicals free from lumps and clods. If specified, clean graded sand free from harmful and deleterious material from approved quarries, shall be used as fill material.

20.04.00 Quality Control: The bidder shall establish and maintain quality control for the various aspects of the work, method, material and equipment used. The quality control operation shall include but not be limited to the following items of work:

a.	Lines, Levels and Grades	:	i.	Periodic surveys.
		:	ii.	Establishment of markers, boards etc.
b.	Back-filling	:	i.	Checking the quality of fill material
			ii.	Checking moisture content

of

the backfill.

- iii. Checking the degree of compaction.

20.05.00 Excavation

- a. **Setting out :** The contractor should submit to the Engineer, detailed drawings of the excavation work to be executed by him showing the dimensions as per drawings and specification adding his proposals of slopes, shoring, approaches, dewatering sumps, beams etc. Upon Engineer's approval the contractor should set out the work from the control points furnished by the Engineer and fix permanent points and markers for ease of future checking. These permanent points and markers shall be fixed at intervals prescribed by the Engineer. The contractor should proceed with the work after Engineer's approval. It should be noted that this checking by the Engineer prior to start of the work shall in no way absolve the contractor of his responsibility of carrying out the work to true lines , levels and grades as per drawing and subsequent corrections, if necessary, should be carried out by the contractor free of cost to the Purchaser.
- b. **Clearing and Grubbing etc.:** The area to be excavated shall be cleared out of fences, trees, logs, stumps, bush, vegetation, rubbish, slush etc. and leveled up. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut, shall be approved by the Engineer and then marked. Felling of trees shall include taking out roots upto 600mm below ground level or 150mm below formation level whichever is lower. After the tree is cut and roots taken out, the pit-holes formed shall be filled with good earth in 250 mm layers and consolidated. The trees shall be cut in suitable pieces as instructed by the Engineer.
Before earthwork is started, all the spoils/ unserviceable materials and rubbish shall be burned or removed from the site to approved disposal areas as specified. Useful materials, saleable timber, firewood etc. shall be the property of the Purchaser and shall be stacked properly at the work site in a manner as directed by the Engineer.
- c. **Excavation in all kinds of soil:** The excavation in all kinds of soil including old (from demolished structures) underground RCC / CC / brick masonry shall be carried out as per the approved proposal, modified and corrected where necessary by the Engineer. The work shall be carried out in a workman like manner without endangering the safety of nearby structures/ services or works and without causing hindrances to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work shall be checked by the Engineer thoroughly and the balance work shall be carried out carefully to avoid any over-excavation. On completion, the work shall be finally checked and approved by the Engineer. In certain cases, where deterioration of the ground, upheaval, slips etc. are expected, the Engineer may order to suspend the work at any stage and instruct the contractor to carryout the balance work just before the foundation work of the structure can be started.

- d. Disposal: The excavated soils shall be disposed of within 5 km crow fly distance from site as directed by the Engineer-in-charge in any or all the following manners:
 - i) By using it for backfilling straightway.
 - ii) By stacking it temporarily for use in backfilling at a later date during execution.
 - iii) By either spreading or spreading and compacting at designated disposal areas.
 - iv) By selecting the useful material and stacking it nearly in areas designated by the Engineer for use in backfilling by some other agency.
- e. Disposal of Surplus: The surplus material from excavation shall be carried away from the excavation site to designated disposal area selected by the Engineer. All goods excavated from the pits and all assorted materials of dismantled structures shall be the property of the Purchaser.

20.06.00 Back-filling

- a. The backfilling material shall consist of materials, approved by the Engineer obtained directly from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated spoils or from borrow pits from selected areas designated by the Engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials, etc. In certain locations, the Engineer may direct sand fillings. The sand should be clean, well graded and be of quality normally acceptable for use in concrete.
- b. Filling and compaction in pits and trenches around structures: As soon as the work in foundations has been accepted and measured, the space around the foundation structures in pits and trenches shall be cleared of all debris, brick bats, mortar droppings etc. and filled with earth in layers not exceeding 250 mm in loose thickness; each layer being watered, rammed and properly compacted to the satisfaction of the Engineer. Earth shall be rammed with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the Engineer. The final surface shall be trimmed and leveled to proper profile as desired by the Engineer. Since the degree of compaction depends on the moisture content of the soil, a close watch should be kept on it and corrections done to optimize the moisture content.

The backfilling shall be carried out at optimum moisture content to achieve 95% of Proctor's Maximum Dry Density.

- c. Plinth filling: The plinth shall be filled with earth in layers not exceeding 250 mm in loose thickness, watered and compacted with approved compaction machine or manually, if specifically permitted by the Engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted, in order to avoid any settlement at a later stage. The finished level of the filling shall be trimmed to the slopes intended to be given to the floor.
- d. Filling in trenches for water pipes and drains: Earth used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not bigger than 150 mm size in any direction, mixed with fine material consisting of disintegrated rock, moorum or earth as available, so as to fill up the voids as far as possible and then the mixture used for filling. Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150 mm, watered, rammed and compacted taking care that no damage is caused to the pipe below.
- e. Filling in disposal area: Surplus material from excavation which is not required for backfilling shall be disposed of in designated disposal areas within the lead for disposal as 5 km crow fly distance from the site. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250 mm thick when loose and compacted with the help of compacting equipment. In wide areas, rollers shall be employed and compaction done to the satisfaction of the Engineer at the optimum moisture content which shall be checked and controlled by the contractor.
In certain cases, the Engineer may direct disposal without compaction which can be done by tipping the spoils from a high bench neatly maintaining always a proper level and grade of the bench.

20.07.00 Approaches and Fencing : The contractor should provide and maintain proper approaches for workmen and for inspection. The roads and approaches around the excavated pits should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the plant. Sturdy and elegant fencing shall be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

20.08.00 Lighting: Full scale area lighting should be provided if night work is permitted or directed by the Engineer. If no night work is in progress, red warning lights should be provided at the corners of the excavated pit and the edges of the filling.

20.09.00 Testing and Acceptance Criteria

- a. Excavation: On „completion of excavation, the dimensions of the pits shall be checked as per the drawings. After the pits are completely dewatered, the

work shall be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by placing ordinary concrete of M10 proportion and/ or richer and/ or by compacted earth, as directed by the Engineer. Over excavation of the sides shall be made good while carrying out the back-filling. The excavation work shall be accepted after the above requirements are fulfilled and all temporary approaches encroaching inside the required dimension of the excavation have been removed.

- b. Back-filling: The degree of compaction required shall be as per IS standards and the actual method of measuring the compaction achieved shall be as decided by the Engineer. The work of back-filling shall be accepted after the Engineer is satisfied with the degree of compaction achieved.

21.00.00 CEMENT, CONCRETE & ALLIED WORKS

- 21.01.00**
- a. This part covers the requirements for general use of Plain and Reinforced Cement Concrete work in structures at all locations, cast-in-situ or precast, including all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work. The special requirements of structures covered in latest IS:456 should also be complied with.
 - b. The works to be provided by Contractor:
 - i) Furnish all labour, supervision services including facilities as required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plant, transportation etc. required for the work.
 - ii) Prepare progressively detailed drawings and bar bending schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.
 - iii) Submit shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedment, hangers, openings, frames etc.
 - iv) Submit detailed drawings of supports, templates, hangers etc. required for installation of various embedment like inserts, anchor bolts, pipe sleeves, joint seals, hangers, openings, frames etc.
 - v) Submit detailed schemes of all operations required for executing the work e.g. material handling, concrete mixing, placement of concrete, compaction, curing, services, approaches etc.
 - vi) Design and submit concrete mix designs required to be adopted on the job.
 - vii) Provide all incidental items necessary for successful completion of the work in accordance with the drawings, specifications and schedule of Items.
 - ix) Supply of specialized materials as directed by the Engineer with a guarantee in approved performa for satisfactory performance.
 - x) Furnish samples and submit for approval the results of various properties of the following materials :
 - a. The various ingredients of concrete including concrete
 - b. Embedments.
 - c. Joint seals

21.02.00 AFTER AWARD OF WORK ACTIVITIES

The following information and data including samples where necessary shall be submitted by the bidder progressively during the execution of contract:

a) **Programme of execution and Requirement of Materials.**

Within 15 days of the award of contract ,the Contractor will submit a Master Programme for completion of the work giving month wise requirements of materials , particularly mentioning in details the materials which are to be supplied by the Owner and for the procurement of which the help of the Owner is required as per the terms and conditions of the contract.

The master Programme may have to be reviewed and updated by the Contractor quarterly or at more frequent intervals as may be directed by the engineer depending on the emergency of the work.

b) **Samples**

Materials supplied by the Contractor have to be tested for physical, chemical and other properties in the reputed labs at their cost. If found unsuitable, the same shall be removed from the site. Samples of the following materials & any other materials proposed to be used, shall be submitted as directed by the Engineer in Charge, in sufficient quantities free of cost for approval. Approved samples will be preserved by the Engineer in Charge for future reference. The approval of the Engineer in Charge shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities :-

- i) Coarse and fine aggregates.
- ii) Cement.
- iii) Reinforcement.
- iv) Admixtures.
- v) Plywood for formwork.
- vi) Embedded & anchorage materials as may be desired by the Engineer in Charge.
- vii) Joint sealing strips and other waterproofing materials.
- viii) Joint filling compounds.
- ix) Foundation quality Rubber Pads.

c) **Design mix**

Design mix as per the specification giving proportions of the ingredients, sources of aggregates & cement, along with test results of trial mixes as per relevant I.S. is to be submitted to the Engineer in Charge for his approval before it can be used on the works.

- a. Detailed drawings & designs of formworks to be used.
- b. Detailed drawings for templates & temporary supports for embedments.
- c. Test reports for cement, reinforcement steel and formwork including inspection reports.
- d. Any other data as per specification.

d) Conformity with Design

The contractor should prepare check lists in approved performa which will be known as “Pour Cards” listing out all items of work involved. The contractor should inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help & assistance to the Engineer for checking required in the pour. On satisfying himself that all details are in accordance to the drawings & specifications, the Engineer will give written permission allowing the contractor to commence placement of concrete. Details of all instructions issued by the Engineer and the records of compliance by the contractor; deviations allowed by the Engineer and any other relevant information should be written on accompanying sheets attached to the Pour Cards. These sheets, termed as “Progress Cards” shall be prepared by the contractor on approved performa. The Pour Cards alongwith accompaniments shall be handed over to the Engineer before starting placement of concrete. One of mix designs developed by the contractor as per the I.S. specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete shall be to Engineer’s approval.

21.03.00 Materials to be Used / Supplied by Contractor

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless stated otherwise and be of best approved quality.

a) Cement

Ordinary Portland Cement (OPC) Grade 43 shall be used for all structures.

For mix design, water cement ratio would not exceed 0.45. Chloride free sulphonated melamine based super plasticizer conforming to IS:9103 shall be added as per mix design and manufacturer’s instructions to improve workability.

b) Coarse Aggregate

Aggregate of sizes ranging between 4.75 mm & 150 mm shall be termed as Coarse Aggregate. Only Coarse Aggregate from approved quarries & conforming to IS: 383 shall be allowed to be used on the works. Aggregates shall be washed to make it free

from deleterious materials, if necessary.

c) **Fine Aggregate**

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS: 383 is termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification shall be allowed to be used on works.

In certain cases crushed stone sand may be added to natural sand in order to achieve the required grading with prior approval of the Owner.

Crushed stone sand alone may be used only with the prior approval of the Engineer for filling and PCC works only.

d) **Water**

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts and other impurities. Normally potable water is found to be suitable. Generally, IS: 3550 shall be followed for routine tests. In case of doubt, the acceptance test for water shall be as per IS: 3025 and Table-I of IS: 456.

f) **Admixture**

Only admixtures of approved quality shall be used when directed or permitted by the Engineer in Charge. The admixture shall conform to IS: 9103.

g) **Reinforcement**

The reinforcement used shall be cold worked steel high strength deformed bars of grade Fe 415/Fe 500 conforming to IS:1786- latest.

21.04.00 Storage of Materials

a) All materials shall be so stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or its otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately. The contractor shall maintain up-to-date accounts of receipt, issue and balance (stack wise) of all materials. Storage of materials shall conform to IS: 4082.

b) Cement shall be stored off the ground in dry, leak proof, well-ventilated ware-house at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter. Sufficient space of storage with open passages should be arranged between stacks. Cement shall be stored in easily countable stacks with consignment identification marks arranged in the order

of their receipts at site. Sub standards or partly set cement shall not be used; and shall be removed from the site, as soon as it is detected.

- c) Aggregates shall be stored on planks or on steel plates or on concrete or masonry surface. Each size shall be kept separated with wooden or steel or concrete or masonry bulk-heads or in stockpiles stacks and sufficient care shall be taken to prevent the material at the edges of the stockpiles from getting intermixed. Stacks of fine & coarse aggregate shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths
- d) Reinforcing shall be stored consignment –wise and size wise off the ground & under cover. It shall be protected from rusting, oil, grease and distortions.

The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

21.05.00 Quality Control

Contractor shall establish and maintain quality control for different items of work and material to assure compliance with spec requirements and submit to the Engineer. The quality control operation shall include but not be limited to the following items of work :-

- a) Admixture : Type, quantity, physical and chemical properties that affect strength, workability and durability of concrete. For air entraining admixtures, doses to be adjusted to maintain air contents within desirable limits.
- b) Aggregates : Physical, chemical, mineralogical qualities, grading moisture contents and impurities.
- c) Water : Impurities test.
- d) Cement : Test to satisfy relevant IS: Specification
- e) Form work : Material shape, dimension, lines, elevation, surface finish, adequacy of form, ties, bracing and shoring & coating.
- f) Reinforcement : Shape, Dimension, Length of splices, clearances ties and supports. Quality & requirement of welded splices. Material test and certificates to satisfy relevant IS: Specification.
- g) Grade of concrete : Usage & Mixdesign. Testing of all

- properties.
- h) Batching & Mixing : Types & capacities of Plant, concrete mixtures and transportation equipment.
 - i) Joints : Location of joints, water stops and filler quality and materials. Dimension of joints, shape of joints material and splices.
 - j) Embedments & anchorage items : Material, shape, location and setting.
 - k) Placing : Preparation, rate of pouring, weather limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application mortar, slurry for proper bond, prevention of cold joints and type of chutes or conveyors.
 - l) Compaction : Number of vibrators, their prime movers, frequency and amplitude of vibration, diameters and weight of vibrators, duration of vibrator, hands spreading and rodding and tamping.
 - m) Setting of base : Lines, elevation and bedding mortar.
 - n) Concrete finishes : Repair of surface defects, screening, floating, steel trowelling and brooming special finishes.
 - o) Curing : Methods and length of time.

21.06.00 Concrete Mix Requirements

Concrete mix requirements shall be in accordance with IS:456 and as supplemented and modified herein or by other best possible standards.

- a) Washing & Screening of coarse and fine aggregates shall be carried out to remove fines, dirt and other deleterious material.
- b) Admixture: All concrete shall be designed for normal rate of setting and hardening at normal temperature and humidity under different climatic conditions. Admixtures shall be used in accordance with IS:456 to modify the rate of hardening, to improve workability or an and aid to control quality. The Engineer reserves the right to order for laboratory test or use test data or

other satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as desired by the Engineer.

- c) Concrete grades to be used in different parts of work shall be as shown on the drawings or as per the Engineer's instructions. In case of liquid retaining structures, IS:3370 shall be followed.
- d) Proportioning of ingredients of concrete shall be made either with preliminary test by designing the concrete mix ["Design Mix Concrete "] or without preliminary test adopting nominal concrete mix. Design mix concrete shall be used on all concrete works while nominal mix concrete, as per IS:456, may be used as shown on drawings and approved by the Engineer. In all cases, the proportioning of ingredients and works control shall be in accordance with IS:456 and its adequacy after obtaining Engineer's approval.
- e) **Mix Design Concrete**

Concrete mixes shall be designed by the contractor to achieve the strength, durability and workability economically with various ingredients. In general the design will keep in view the following considerations :
 - i) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.
 - ii) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.
 - iii) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.
 - iv) Chemical admixtures may be used to modify the rate of hardening and improve workability.
 - v) The finished concrete should have adequate durability in all conditions, to withstand satisfactorily the weather and other destructive agencies which it is expected to be subjected to in actual service.
 - vi) Concrete Mix Design and Strength requirements

Concrete mix design shall be as per IS: 10262 and SP: 23. The strength requirements of both design mix and nominal mix concrete where ordinary Portland cement or Portland slag cement is used shall be as per Table-2 of IS: 456. All other relevant clauses of IS: 456 shall also apply.

f) **Minimum cement content**

The minimum cement content for each grade of concrete shall be as shown below:

TABLE – I
MINIMUM CEMENT CONTENT & MAX. W / C RATIO SPECIFIED
FOR
DIFFERENT GRADES OF CONCRETE

Sl no	Class	Conc Grade	Min cement content (kg/cum)	Water, Cement ratio	Slump (mm)
1	Plain concrete used for lean concrete.	M 10	-	-	-
2	Backfill	M 15	250	0.5	-
3	Pavement around buildings, Base plate encasement, etc.	M 20	320	0.55	80+/-20
4	Precast concrete	M 25	365	0.50	Do
5	a) Reinforced concrete for structural work in foundation & superstructure	M 30	365 - 400	0.45	Do
	b) Reinforced concrete for Water retaining structure (not in contact with sea water)	M 30	365 - 400	0.45	Do
6	TG top deck, Chimney shell & structures coming in contact of sea water.	M 35	365-400	0.45	Do
7	Natural draft Cooling Tower	M 40	365-400	0.40	Do

The Engineer will always have the unquestionable right to revise the minimum cement content as decided above, if, in his opinion, there is any chance of deterioration of quality on account of use of lower cement content or any other reason.

g) **Water-Cement Ratio**

The choice of water-cement ratio in designing a concrete mix will depend on

- i) The requirement of strength.
- ii) The requirement of durability.

i) **Strength Requirements of Concrete Mix**

In case of 'Design Mix Concrete', the water-cement ratio of such value as to give

acceptable test results as per IS: 456 will be selected by trial and error. The values of water- cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer.

Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, the maximum water-cement ratio for different grades of concrete is specified in Table-9 of IS: 456 and no tests are necessary. The acceptance test criteria for nominal mix concrete shall be as per IS: 456.

ii) Durability

Tables 4 of IS:456 give the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by durability consideration is lower than that required from strength criterion, the former shall be adopted.

In general the water cement ratio between 0.4 and 0.45 will be desirable to satisfy the durability requirement and from the consideration of Impermeability of concrete. The contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer / super- plasticizer.

h) Workability

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedment's and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. The limits of consistency for various types of structures as per Table – I With the permission of the Engineer. For any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively where facilities exist or if required by the Engineer, the compacting factor test in accordance with IS: 1199 and Clause 7 of IS: 456 shall be carried out.

i) Size of Coarse Aggregates

The maximum size of coarse aggregates for different locations shall be as follows

unless otherwise directed by the Engineer:

Reinforced concrete except foundation mm	-	20
Ordinary Plain concrete and Reinforced concrete foundations mm	-	40

Grading of coarse aggregates for a particular size shall conform to relevant I.S. Codes and shall also be such as to produce a dense concrete of the specified proportions, strength and consistency that will work readily into position without segregation.

Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles 40 mm to 20 mm and 20 mm to 5 mm.

In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal

j) **Mixing of Concrete**

Concrete shall always be mixed in mechanical mixer for unimportant works & in small quantities. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued for uniform distribution of the materials with uniform mass in colour and consistency, but in no case shall mixing be done for less than 2 minutes and at least 40 revolutions after all the materials and water are in the drum. When absorbent aggregates are used or when the mix is very dry, the mixing time shall be extended as needed. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

Controlled concrete only in batching plant shall be used for power house column foundation, TG, boiler foundation, ID, FD, PA, BFP foundations, chimney cooling tower & other important structure.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time, the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement at no extra cost to the Purchaser to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as per IS: 4634 on all mixers employed at site. Only those mixers whose efficiencies are within the tolerances

specified in IS: 1791 should be allowed to be employed. Batching Plant where used shall conform to IS: 4925.

Hand mixing if permitted shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch at no extra cost to the Purchaser.

Crushed ice shall be used in concrete mixing water so as to maintain temperature in the concrete in the top decks of the machine foundations. Arrangements for standby weight batching plant and equipment shall also be made available by the contractor for continuous pour of concrete.

k) Conveying Concrete

Concrete shall be handled and conveyed from the place of mixing to the place of laying as rapidly as practicable by approved means, concrete shall be placed and compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way preventing segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design should be used. If, in spite of all precautions, segregation does occur during transport, the concrete shall be properly remixed before placement. During very hot weather, concrete shall be transported in deep container to reduce the rate of loss of water by evaporation or loss of heat. If necessary, the container should be covered. Conveying equipment for concrete shall be well maintained and thoroughly cleaned before commencement of concrete mixing. Such equipment shall be kept free from set concrete.

l) Placing and Compacting of Concrete

- i) Relevant I.S. Code should be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. Concrete shall be placed against the surfaces of formwork or construction joint in concrete or masonry. The surface against which concrete is placed shall be cleaned thoroughly. Old construction joint has to be roughened by wire brushing, chipping sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. shall be removed by air water jetting or water at high pressure.

Concrete shall be placed in the formwork by approved means, and shall not be dropped from a height or handled in a manner which may cause segregation.

- ii) Construction joint shall be kept moist for at least 72 hours prior to placement. Concrete shall be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution shall be adopted. Formwork shall be cleaned thoroughly and smeared lightly with form oil or grease of approved quality

just prior to placement.

- iii) 12 mm thick mortar with less w/c ratio as that of the concrete being placed and cement slurry shall be spread thoroughly on the construction joint just prior to placement of concrete. The concrete shall be spread, and thoroughly compacted without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS. In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, doubtful, in addition to immersion vibrators, the contractor should employ form vibrators conforming to IS: 4656. For slabs and other similar structures, the contractor should employ screed vibrator as per IS: 2506. Care must be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or distorted during placing and consolidation of concrete.
- iv) The rate of placement of concrete shall be such that no cold joint is formed; and fresh concrete is placed always against green, plastic and workable concrete. No concrete shall be placed in open during rains. During rainy season, no placement in the open should be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.
- v) Slabs, beams and similar members shall be poured in one operation. Moulding, throating, drip course, etc., shall be poured as per the drawings. Holes shall be provided and bolts, sleeves, anchors, fastenings or other fixtures shall be embedded in concrete as per drawings. In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement. Once the concrete is deposited, consolidated and finished in its final position, it shall not be disturbed.

21.07.00 a) Construction Joints

Concrete structure shall be completed by continuous pouring in one operation. However, due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete at certain predetermined stages. These joints shall be formed as per drawings. Vertical construction joints shall be made with rigid

stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. For water retaining structures and leak proof buildings suitable and approved water stops shall be installed at the construction joints as per clause 12.4 of IS:456. Where the location of the joints are not specified, it shall be in accordance with the following :-

- i) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.
- ii) Concrete in a beam shall preferably be placed without a joint, but if provision of a joint is unavoidable, the joint shall be vertical and at the middle of the span.
- iii) A joint in a suspended floor slab shall be vertical and at the middle of the span and at right angles to the principal reinforcement.
- iv) Feather-edges in concrete shall be avoided while forming a joint.
- v) A construction joint should preferably be placed in a low stress zone and at right angles to the direction of the principal stress.

b) Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The contractor should always remain vigilant to avoid cold joints. If however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it :-

- i) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete should be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible, and the joint thoroughly and systematically vibrated.
- ii) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface shall be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness, shall be placed on the cold joint, fresh concrete shall be placed on the mortar layer and the joint shall be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.
- iii) In case the concrete at the joint has become so stiff that it cannot be remolded and mortar or slurry does not rise inspite of extensive vibration, the

joint shall be left to harden for atleast 12 to 24 hrs. It shall then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as indicated above.

c) Expansion And Isolation Joints

- i) Expansion and isolation joints in concrete structures shall be provided at specific places as shown on the drawings with materials and types of joints as specified. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as specified on the drawings. All materials should be procured from reliable manufacturers to the approval of the Engineer. Test certificates for the materials should be furnished. Joints shall be formed true to line, level, shape, dimension and quality as per drawings and specifications. Prior approval from concerned engineer of the method of forming the joints should be obtained.

- ii) Duraboard HD or its equivalent of approved manufacturer shall be used as filler for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as recommended by the manufacturer.

Commercial quality of expanded polystyrene products commonly used for thermal insulation can also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material should be procured from reliable manufacturers as approved by the Engineer. The method of installation shall be similar to that recommended by the manufacturer for fixing on walls. A coat of bitumen paint shall be applied on the board against which concrete is placed.

- iii) Joint sealing strips shall be provided at the construction, expansion and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure. General strips shall be of PVC or otherwise as specified. Sealing strips shall not have any longitudinal joint; and shall be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material shall be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations. The contractor should supply all labour and materials for installation including the material and tools required for jointing, testing, protection, etc. The joints in rubber seals shall be vulcanised as needed.

- iv) The minimum thickness of P.V.C. sealing strips shall be 3 mm and the minimum width 100mm. The actual size and shape shall be as shown in drawings. The material should be of good quality Polyvinyl Chloride highly resistant to tarring, abrasion and corrosion as well as to chemicals likely to come in contact with during use. The physical properties shall generally be as follows:

i)	Specific Gravity	:	1.3 to 1.35
ii)	Shore Hardness	:	60A to 80A
iii)	Tensile Strength	:	10 to 15 N/Sq.mm
iv)	Maximum Safe Continuous Temperature	:	70 Deg.C
v)	Ultimate Elongation	:	Not less than 275%

- vi) Bitumen Compound: When directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per Manufacturer's recommendation. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834.

- vi) Isolation Joints: Strong and tough alkathene sheet or equivalent, about 1 mm in thickness shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete, to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

- vii) Rubber Pad: Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings. The rubber shall have a unit weight of 1500 kg/cum, shore hardness – 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

- viii) All foundation structures in contact with soil shall be coated with two coats of Bituminous coating.

21.08.00 Repairs, Finishes and Treatment of Concrete Surfaces

- a) Adequate and sound concrete surfaces, whether formed or unformed, should

be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing and consolidation by experienced workmen.

- b) Unsound concrete resulting from improper mix design, incompetent methods, equipment and form work, poor workmanship and protection shall not be accepted and shall be dismantled, removed and replaced by sound concrete at the contractor's cost. All concrete work shall be inspected by the contractor immediately after the forms are removed and he should promptly report of occurrence of any defects to the Engineer. All repair works should be carried out as per the instructions and in the presence of the Engineer. Generally, repair work shall consist of any or all of the following operations :
 - i) Sack rubbing with mortar and stoning with carborundum stone.
 - ii) Cutting away the defective concrete to the required depth and shape.
 - iii) Cleaning of reinforcement and embedments.
 - iv) Roughening by sand blasting or chipping.
 - v) Installing additional reinforcement/ welded mesh fabric. vi) Dry packing with stiff mortar.
 - vii) Plastering, guniting, shotcreting etc.
 - viii) Placing and compacting concrete in the void left by cutting out defective concrete.
 - ix) Grouting with cement sand slurry of 1:1 mix.

c) Finishing Unformed Surface

The requirement of finishes of formed surfaces are specified hereunder separately. The contractor should include for concrete, the provision of normal finishes in unformed surfaces which can be achieved by screeding, floating, trowelling etc. A few typical and common cases of treatment of concrete surface are cited below :

- i) Floor: For non-integral floor finish, the surface of reinforcement concrete slab shall be struck off at the specified levels and slopes and finished with a wooden float fairly smooth removing all laitance. No over trowelling, to obtain a very smooth surface, shall be done as it will prevent adequate bond with the subsequent finish. The surface shall be scored and marked to provide better bond.

For monolithic finish, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type; and then floated with a wooden float. Steel trowelling should then started after the moisture film & shine disappeared from the surface; and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done should flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples and trowel marks. A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water should be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface. To provide a better grip, the floor should be marked in a regular geometric pattern after initial trowelling.

ii) Beams, Columns & Walls: If on any other concrete structure, it is intended to apply plaster or such concrete surfaces against which brick- work or other allied works are to be built, the contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop.

d) Protection and Curing of concrete: Newly placed concrete shall be protected from rain, sun and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days. Steps shall be taken to protect immature concrete from damage by debris, excessive loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, hessian, canvas or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water shall be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the contractor.

The contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. In case any lapse on the part of the contractor is noticed, the Engineer will inform the contractor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the contractor within 3 hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost thereof from the contractor.

21.09.00

a) Reinforcement

The reinforcement used shall be cold worked steel high strength deformed

bars of grade Fe 415/ Fe 500 conforming to IS:1786 – latest.

All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.

b) Bar Bending Schedules

The contractor shall submit to the Engineer bar bending schedules with working drawings showing clearly the arrangements proposed by the contractor. Upon receipt of the Engineer's final approval of the bar bending schedule and drawings, the contractor shall submit the final drawings with one reproducible print after incorporating necessary modifications or corrections, for final record and distribution. Approval of such detailed drawings shall not relieve the contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the contractor.

c) Bending

Reinforcing steel shall be bent in accordance with the procedure specified in IS:2502. Bends and shapes shall comply strictly with the dimensions corresponding to the approved bar bending schedules which shall be rechecked by the contractor before any bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Re-bending can be done only if approved by the Engineer. Reinforcing bars shall be bent by machine or other approved means producing a gradual and even motion. All the bars shall be cold bent.

d) Placing in position

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings. Bars at crossing points, shall be securely tied together by # 20G annealed soft iron PVC coated wire or by tack welding in case of bar larger than 25 mm dia. binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained with FBEC spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases, he should not start placing any bar before obtaining clearance from the Engineer.

e) Welding

Normal bond laps in reinforcement should be placed by lap or butt welding reinforcement bars. The work should be done with suitable safe guards as per

IS for welding of mild steel bars used in reinforced concrete construction as per IS: 2751 and IS: 456. Welded mesh fabrics to IS:566 shall also be as per drawings.

f) **Control**

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be as per IS: 456. If the bars in a lap are not of the same diameter, the smaller will guide the lap length. The laps shall be staggered as far as practicable. Arrangements for placing concrete shall be such that reinforcement in position do not have to bear extra load and get disturbed.

The cover for concrete over the reinforcements shall be as shown on the approved drawings. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1part cement to 2 parts sand by volume and cured in a pond for at least 14 days. The type, shape, size and location of the concrete blocks shall be as approved by the Engineer.

g) **Cold Weather Concreting**

When conditions are such that the ambient temperature may be expected to be 4.5 Deg.C or below during the placing and curing period, the work shall conform to the requirements of clause 13 of IS: 456 and IS: 7861.

h) **Hot Weather Concreting**

When depositing concrete in very hot weather, the contractor shall take all precautions as per IS: 7861 and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 38oC while placing.

21.10.00 Form Work

- a) The contractor shall prepare, before commencement of actual work, designs and working drawings for formwork and centering. The formwork shall conform to the shape, grade, lines, levels and dimensions as shown on the drawings. Materials used for the formwork inclusive of the supports and centering shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel.
- b) The centering shall be true to vertical, rigid and thoroughly braced both

horizontally and diagonally. Rakes shall be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight of the concrete as a liquid as well as the working load. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel or concrete of adequate strength shall be used. Bolts passing completely through liquid retaining walls/ slabs for the purpose of securing and aligning the formwork shall not be used.

- c) The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion-resistant devices. Rigid care shall be exercised in ensuring that all column forms are plumb and true and thoroughly cross braced to keep them so. All floor and beam centering shall be crowned not less than 8 mm in all directions for every 5 meters span. Bevelled forms 25 mm x 25 mm shall be fixed in the form-work at all corners to provide chamfering of the finished concrete edges. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base of vertical forms and at other places as necessary. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

d) Cleaning and Treatment of Forms

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, saw dust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/ or water jet along with wire brushes, brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil or other compound before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork.

e) Design

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork. Removing any props or repropping shall not be done except with the specific approval of the Engineer. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

f) Inspection of Forms

Casting of concrete shall start only after the formwork inspection and approval by the Engineer. The concreting shall start as early as possible within 3 days after the approval of the formwork; and during this period, the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Engineer shall be obtained.

g) Removal of Forms

Before removing any formwork, the contractor must notify the Engineer well in advance to enable him to inspect the concrete if he so desires. The contractor shall record the date on which concrete is placed in each part of the work; and the date on which the formwork is removed there from. The contractor shall be responsible for the safe removal of the formwork; and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him. Forms for various types of structural components shall not be removed before the minimum periods as detailed below:

SCHEDULE OF REMOVAL OF FORM

Part of Structure	Ordinary Portland Cement Concrete				Rapid Hardening Portland Cement Concrete			
	Temperature ($^{\circ}\text{C}$)				Temperature ($^{\circ}\text{C}$)			
	Above 40°C	40°C to 20°C	20° to 5°C	Below 5°C	Above 40°C	40°C to 20°C	20° to 5°C	Below 5°C
	Days	Days	Days	Days	Days	Days	Days	Days
a) Columns & Walls	2	1	1	Do not remove forms until	1	1	1	Do not remove forms
b) Beam sides	3	2	3		2	1	1	

c) Slabs, 125 mm	10	7	8	site cured test specimen develop atleast 50% of the specified 28 days strength	7	4	5	until site cured test specimen develop atleast 50% of the specified 28 days strength
d) Slabs over 125 mm thick and soffit of minor beams	18	14	16		12	8	9	
e) Soffit of main beams	24	21	22		14	10	12	

Wherever exposed surfaces of concrete can be effectively sealed to prevent loss of water, the periods specified for temperature above 40oC can be reduced to those of the temperature range of 20oC to 40oC.

Construction joints in beams shall be located at the middle of span. In such cases, however, entire span of beam shall have to be kept supported by formwork till its removal for the portion of beam, cast at a later date.

h) Tolerance

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances :-

i)	Sectional dimension	-	± 5 mm
ii)	Plumb	-	1 in 1000 of height
iii)	Levels	-	± 3 mm before any has taken

deflection
place

The above tolerance shall be for local aberrations in the finished concrete surface, and should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible. Any error, within the above tolerance limits if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

i) Re-use of Forms

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired and inside surface treated as specified hereinbefore. Formwork shall not be used / re-used if declared unfit or unserviceable by the Engineer.

- j)** Generally, the “ordinary” class formwork shall be used in places where

ordinary surface finish is required and shall be composed of steel and/ or approved good quality partially seasoned timber. Plywood formwork shall be used in exposed surfaces, where a specially good finish is required and shall

be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by the Engineer. He may also permit utilization of used plywood for the “ordinary” class, if it is still in good condition. Ornamental formwork shall be used where ornamental and curved surfaces are required and shall be made of selected best quality well seasoned timber or plywood, which can be shaped correctly. The contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings.

21.11.00 Anchor Bolts, Anchors, Sleeves, Inserts, Hangers / Conduits / Pipe and Other Misc.Embedded Fixtures

The contractor shall build into concrete work all the items as noted below; and shall embed them partly or fully as directed and secure the same as may be required. The materials shall be as specified and be of best quality available according to relevant IS and of approved manufacture to the satisfaction of the Engineer. Exposed surfaces of embedded materials shall be painted with one coat of approved anti-corrosive paint and/or bituminous paint. If welding is to be done subsequently on the exposed surfaces of embedded material, the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line. Necessary templates, jigs, fixtures, supports etc. shall be used as required items to be embedded shall be as follows:

- i) Inserts, hangers, anchors, frames around openings, manhole covers, Frames, floor clips, sleeves conduits and pipes.
- ii) Anchor bolts and plates for machinery, equipment and for structural steel work.
- iii) Dowel bars, etc. for concrete work
- iv) Lugs or plugs for door and window frames occurring in concrete work. v) Flashing and jointing in concrete work.
- vi) Any misc. embedments and fixture as may be required.
- vii) Convextra-GP2, Sikka grout or equivalent grouting material shall be used as per manufacturer’s specification.

Correct location and alignment, as per drawings/instructions of all these embedded items shall be entirely the responsibility of the contractor.

21.12.00 Precast Concrete

The precast concrete shall be similar as for the cast-in-place concrete described herein. All precast work shall be carried out in a yard which shall be dry, properly levelled and having a hard and even surface. It shall be paved with concrete or masonry as needed; and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Casing shall be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 7 days of curing and can be removed for erection after 28 days of curing. The moulds shall be of steel or of timber lined with G.I. sheet metal.

Lifting hooks as necessary shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection. Precast concrete units, when ready, shall be transported to site by suitable means. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, levelling and plumbing shall be done as per instructions of the Engineer. The contractor shall render all help with instruments, materials and men to the Engineer for checking the proper erection of the precast units.

21.13.00 Sampling and Testing

The contractor shall carry out all sampling and testing as per IS for the following items:

a) Cement

Representative samples shall be taken from each consignment of cement received from the manufacturer / supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths as per IS:269. Soundness Tests shall also be carried out as required. No cement from a particular consignment / batch shall be used on the works unless satisfactory 3 days and 7 days test results for compressive strength are known. These tests shall be of great importance as their results shall have bearing on the acceptance of concrete or otherwise.

b) Aggregates

The contractor shall carry out any or all the tests of aggregates as required as per IS:2386 Parts-I to VIII. The acceptance criteria of the samples tested shall be as per the relevant IS.

c) Water

Water for concrete works shall be tested as per IS: 3550 by the contractor at regular intervals and whenever directed by the Engineer. The final acceptance criteria in case of doubt shall be as per IS: 3025 & IS: 456.

d) Admixture

Air Entraining Agents (AEA): Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cylinder cube crushing strength vis-à-vis quantity of A.E.A. used for all types of concrete shall be established by the contractor by carrying out sufficiently large number of tests. After than, at regular intervals and whenever directed by the Engineer, the contractor should check up, the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results. Tests for establishing the various properties of any other admixtures which may be required to be added shall be carried out by the contractor.

e) Concrete

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be as per IS:516 and IS:1199 with the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed apart from other tests as per IS:516. Sampling procedure, frequency of sampling and test specimen shall conform to clause 15 of IS: 456. To control the consistency of concrete from every mixing plant, slump tests and / or compacting factor tests in accordance with IS:1199 and as per clause 7.3.7(f) above shall be carried out by the contractor every 2 hours. Slumps corresponding to the test specimens shall be recorded for reference. The acceptance criteria of concrete shall be in accordance with clause 16 of IS:456. Concrete work found unsuitable for acceptance shall have to be dismantled and replacement shall be done as per specification by the contractor. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good by the contractor to the satisfaction of the Engineer.

f) Concrete for Equipment or Steel Structures Foundations

Concrete for equipment foundation, whether principal or auxiliary, shall be poured continuously so that the structure becomes monolithic, particular care being exercised to see that the base slabs, if any, are of compact impervious construction. Tunnels, passages apertures and so forth shall be provided in accordance with the drawings for the installation of mechanical and electrical equipment, pipes or cables. The top elevation of the equipment foundations or parts shall be accurately cast to 20/50 mm (or more as may be specified on the drawings) above the level required for grouting and it shall be pneumatically chiseled of and well roughened just prior to the erection of the equipment concerned. All embedded anchor bolts or bolt sleeves shall be accurately and firmly set with the aid of approved templates, steel supports

and / or other accessories. For holding the embedded bolts or sleeves in the correct position during concreting, template shall have to be of steel of suitable section approved by the Engineer in Charge. Two (2) sets of templates shall have to be provided, one to hold the bottom and the other the top of the bolts or sleeves. The bottom template shall be securely and rigidly fixed by providing anchorage arrangement and by welding to the lowest part of the steel reinforcement and other structural supports. The top templates shall be securely fixed by tying with guy wires and turn buckle arrangement to firm and rigid adjoining structures and stagings.

Bolt pockets, where required, shall be cast with wooden taper wedges. These shall be withdrawn at an appropriate time when the concrete has set, the pockets cleaned roughened and then covered or blocked thoroughly to prevent debris getting into these. The exposed portions of bolts and embedded parts shall be kept well greased and adequately protected from damage throughout construction. Any damages found shall have to be corrected at the contractor cost. The Purchaser shall have the right to use the foundations, pads, piers, slabs, floors and all concrete work as needed for other works or equipment erected prior to its "Taking over".

21.14.00 Acceptance Criteria

- a) Standard deviation shall be based on test results; and determination of standard deviation shall conform to clause 14.5 of IS:456. The strength requirements and acceptance criteria shall conform to clause 15 of IS:456. Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to clause 16 of IS:456.
- b) **Load Test**
 - i) Load tests of structural members as required, when the strength of test specimen results fall below the required strength, as per „Load Test on Parts of Structures”, clause 17.6 of IS:456. If load testing is decided by the Engineer, the member under consideration shall be subjected to a test load equal to 1.25 (one and a quarter) times the specified live load used for design and this load shall be maintained for a period of 24 (twenty four) hours before removal. The detailed procedure of the test shall be decided by the Engineer. Load tests shall not be made until the structure is at least 56 days old.
 - ii) If the member shows evident failure, such changes as necessary to make the structure adequately strong, shall be made by the contractor, if permitted under Statutory Regulations to the discretion of the Engineer, the structure under test or a portion thereof may be retained as such without any modification by derating its load bearing capacity, provided the design criteria allows such derating.
 - iii) A reinforced concrete beam, floor or roof shall be deemed to have passed the test, if the maximum deflection at the end of 24 hours does not exceed the deflection given in clause 17.6 of IS: 456. If a portion of the structure is

found to be unacceptable, it shall be dismantled and replaced by a new structure as specified. If, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same shall be made good, by the contractor to the satisfaction of the Engineer.

21.15.00 Tolerances

The permissible tolerances are as follows :-

- a)** Tolerances for RC buildings
- b)** Variation from the plumb
- c)** In the lines and surfaces of columns, piers, walls and in arises 5mm per 2.5m but not more than 25mm.
- d)** For exposed corner columns and other conspicuous lines:

In any bay upto 5m	=	5mm
In 10m or more	=	10mm
- e)** Variation from the level or from the grades indicated on the drawings:
 - i.** In slab soffits, ceilings, beam soffits and in arises:

In 2.5m	=	5mm
In any bay upto 5m	=	8mm
In 10m or more	=	15mm
 - ii.** For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines:

In any bay upto 5m	=	5mm
In 10m or more	=	10mm
 - i.** Variation of the linear buildings lines from established position in plan and related position in plan and related position of columns, walls and partitions.

In any bay upto 5m	=	10mm

In 10m or more = 10mm

- ii. Variation in the sizes and locations of sleeves, openings in walls and floors = 5mm
(Except in the case of and for anchor bolts.)

- iii. Variation in cross-sectional dimensions of columns and beams the thickness of slabs and walls:-

Minus = 5mm
Plus = 10mm

f) Footings

g) Misplacement or eccentricity

2% of footing width in the direction of misplacement but not more than 50mm

h) Reduction in thickness

Minus = 5% of specified thickness subject to a maximum of 50mm

i) Variation in steps

In a flight of stairs

Rise = 3mm

Tread = 5mm

In consecutive steps

Rise = 1.5mm

Tread = 3mm

j) Tolerances in other concrete structures

i) Variation of the constructed linear outline from established position in plan.

In 5 m = 10mm
In 10m or more = 15mm

- ii. Variations of dimensions to individual structure features from established positions:
- | | | |
|------------------------|---|------|
| In 20m or more | = | 25mm |
| In buried construction | = | 50mm |
- iii. Variation from plumb, from specified batter or from curved surfaces of all structures:
- | | | |
|--------------------------|---|-------------------------|
| In 2.5 m | = | 10mm |
| In 5m | = | 15mm |
| In 10m or more | = | 25mm |
| In buried – construction | = | Twice the above amounts |
- iv. Variation from level or grade indicated on drawings in slab, beams, soffits, horizontal grooves and visible arises:
- | | | |
|--------------------------|---|-------------------------|
| In 2.5 m | = | 5mm |
| In 7.5m | = | 10mm |
| In buried – construction | = | Twice the above amounts |
- v. Variation in cross-sectional dimensions of columns, beams, buttresses, piers and similar members:
- | | | |
|-------|---|------|
| Minus | = | 5mm |
| Plus | = | 10mm |
- vi. Variation in the thickness of slabs, walls, arch section and similar members:
- | | | |
|-------|---|------|
| Minus | = | 5mm |
| Plus | = | 10mm |
- vii. Misplacement of eccentricity:
2% of footing width in the direction of misplacement but not more than 50mm.
- viii. Reduction in thickness:
5% of specified thickness subject to a maximum of 50mm.

Tolerance in other types of structures shall generally conform to those given in clause 2.4 or recommended practice for concrete formwork (ACI347).

ix. Tolerance in fixing anchor bolts shall be as follows:

(i) Anchor bolts without sleeves +1.5mm in plan.

(ii) Anchor bolts with sleeves +5.0mm in elevation.

a) For bolts upto and including 25mm dia +mm in all directions.

b) For bolts 32mm dia and above +3mm in all directions.

(iii) Embedded parts +5mm in all directions.

21.16.00 Special Conditions For Construction of TG Foundation

a) Scope

i) The work to be performed under this contract consists of providing all materials except those supplied by the Purchaser, shuttering, staging, inserts, construction equipment, labour and all incidental items not shown or specified but reasonably implied or necessary for the proper completion of the work, all in the strict accordance with the drawings, schedules and specifications and including revisions and amendments thereto and such detailed drawings as may be provided by the Consultant, during the execution of the work.

ii) It is not the intent to specify completely herein all the details of designs and construction of the structure. However, the structure shall conform in all respects to high standards of Engineering, design and workmanship and be capable of performing in continuous commercial operation upto contractors guarantee in the manner acceptable to the Purchaser / Consultant who will interpret the meaning of drawings and specifications and shall have the power to reject any work or materials which in his judgment are not in full accordance therewith.

b) Form Work

i) All forms shall be abundantly wetted on both sides before concrete is poured. The date of removing forms for each individual stage of construction shall be fixed by the Purchaser / Consultant.

ii) The minimum period for striking of formwork shall be as follows:-

- Vertical sides of beams and pedestals -7 days
- Bottom of beams / slabs -28 days

However, the vertical faces shall be loosened after 24 hours of completion of concreting the supports.

- iii) Concrete surface shall not normally be patched or otherwise treated after the removal of forms. Where the surfaces exposed on stripping is not of a satisfactory nature, owing to the contractors failure to take necessary precaution before, during or after the concrete placing, such surfaces shall be worked and finished in accordance with the instructions of the Purchaser / Consultant at the cost of the contractor. The pores shall be filled in with a neat solution of cement and water applied by brush and when dry the surface shall be rubbed down with carborundum stone. The cost of the above treatment shall be deemed to be included in the unit rate entered by Contractor. The top surface of the T.G. deck shall be float-finished, unless otherwise specified to the required levels. There must be no surface grouting or treating which might draw the “fines” to the top. All shuttered surfaces shall be left as they strip without removing boards or panel markings.

Any serious honey combing will render the concrete work liable to rejection and cutting out and re-concreting wholly or partly as the Engineer in Charge directs. All costs involved in repairing defect shall be borne by the Contractor.

- iv) The arrangement and method for movement of workers during TG construction to various levels of the TG foundations shall be submitted well in the advance to the Engineer- in – Charge for his approval far taking up the work.
- v) In addition to the above paras the contractor shall also satisfy all other requirements for formwork mentioned in elsewhere in the specification.

c) Staging

- i) The entire staging for supporting the formwork, walkways and platforms for placing concreting equipments such as vibrators, etc., shall be of structural steel. The staging shall be designed for the worst combination of loading as specified hereinafter.
- ii) The Contractor shall submit 6 copies of design calculations and drawing to prove adequacy of the staging for approval of the consultant. On receipt of final approval, the contractor shall supply 20 copies of approved drawings for distribution.

- iii) The staging shall be so designed that no load from platforms are passed on to the formwork at the top.
- iv) All platforms, walkways etc. shall be clear of the formwork and at least 200 mm above it. The width of platforms and walkways shall be at least 1.2 metres for easy movement of labour both ways.
- v) The platforms shall be of planks or bamboo mats (clamped with steel strips suitably stiffened to avoid springing).
- vi) The form work and staging shall be designed for a live load of 1000 Kg/m².
- vii) Unit weight of green concrete shall be considered as 2500kg/m³ for design of form work and staging.
- viii) The staging shall be braced in both the directions.
- ix) The staging shall be supported on rigid surfaces at ground level.
- x) The staging shall be sufficiently rigid to prevent any distortion in the form work.

d) Special Precautions

- i) The contractor shall take all precautions to ensure concreting of TG Raft, columns and TG Deck in one pour each. Concreting shall be continuous and no break in concreting shall be permitted.
- ii) The Contractor shall prepare a scheme for concreting giving details of number of mixers, labour, vibrators, pouring schedule and obtain prior approval of the same from the Engineer-in-Charge before starting of concreting.
- iii) The Contractor shall ensure that at no time the temperature of the green concrete exceeds 38 degree C by taking proper precautions. If required, ice shall be added to control the temperature at no additional cost to the Purchaser.
- vi) Approved “Retarders” shall be used by the contractor in the proportions specified by the manufacturer for total concreting work of the TG foundation. The cost of the admixture shall be included in unit rates quoted by the Bidders.

e) Test for Soundness of Concrete

- i) After completion of the construction of TG foundations and all major machine foundation like BFP, FANS, MILLS etc, the contractor shall get the Deck and column tested for soundness of concrete by “ultrasonic wave – non – destructive test method” from reputed research institutions like “SERC-CHENNAI” “CWPRI – POONA”, at no extra cost to the Purchaser.
- ii) If the test report calls for any rectification in the concrete works by way of pressure grouting or otherwise, the same shall be carried out by the contractor at no additional cost to the Purchaser to the satisfaction of the Purchaser / Consultant
- iii) If require, any additional test to establish the adequacy of the rectification works carried out shall be done by the contractor at no extra cost to the Purchaser

f) List of Codes and Standards

All work under this specification shall conform to the latest revisions of Indian Standard specifications and Codes of Practice:

IS : 216	-	Indian Standard Specification for Coal Tar Pitch
IS : 226	-	Indian Standard Specification for Structural Steel [Standard quality]
IS : 269	-	Indian Standard Specification for Ordinary, and Low Heat Portland Cement
IS : 383	-	Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete
IS : 432	-	Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement
IS : 455	-	Indian Standard Specification for Slag Cement and Reinforced Concrete
IS : 456	-	Indian Standard Code of Practice for Plain and Reinforced Concrete
IS : 516	-	Indian Standard Specification for Methods of Test for Strength of Concrete.

IS : 1139	-	Indian Standard Specification for Hot Rolled Mild Steel and Medium Tensile Steel and High Yield Strength Steel Deformed Bars for concrete Reinforcement
IS : 1199	-	Indian Standard Specification for Methods of Sampling and Analysis of Concrete
IS : 1200	-	Indian Standard Specification for Method of measurement Cement Concrete Works. Part-II
IS : 1200	-	Indian Standard Specification for Method of Measurement of Part-V Formwork.
IS : 1332	-	Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing.
IS : 1489	-	Indian Standard Specification for Portland – Pozzolona Cement
IS : 1566	-	Indian Standard Specification for Methods of Sampling and Analysis of Concrete
IS : 1609	-	Code of Practice for Laying Damp proof Treatment using Bitumen felts
IS : 1786	-	Indian Standard Specification for Cold-twisted Steel Bars for Concrete Reinforcement
IS : 1791	-	Indian Standard Specification for Batch Type Concrete Mixers
IS: 2210	-	Indian Standard Specification FOR Design of Reinforced Concrete Shell Structures and Folded Plates.
IS : 2386	-	Indian Standard Specification for Methods of Test for Aggregates for Concrete – Part-I to VIII
IS : 2502	-	Indian Standard Code of Practice for Bending and Fixing of Bars for concrete reinforcement
IS : 2505	-	Indian Standard Specification for Concrete Vibrators, Immersion Type
IS: 2506	-	Indian Standard Specification for Screed Board Concrete Vibrators

IS : 2514	-	Indian Standard Specification for Concrete Vibrating Tables
IS : 2722	-	Indian Standard Specification for Portable Swing weigh Batchers for Concrete (Single and Double Bucket type)
IS : 2770	-	Indian Standard Specification for Method of Testing Bond in Reinforced Concrete.
IS : 3025	-	Indian Standard Specification for Methods of Sampling and Test (Physical and Chemical) for Water used in Industry.
IS : 3201	-	Indian Standard Specification for Design and for construction of Precast Concrete Trusses.
IS : 3370	-	Indian Standard Specification for Code of Practice Concrete Structures for Storage of Liquids.
IS : 3550	-	Indian Standard Specification for Method of Test for Routine Control for Water used in Industry.
IS : 3558	-	Code of Practice for use of Immersion Vibrators for Consolidating Concrete
IS : 3590	-	Indian Standard Specification for Load Bearing Light Weight Concrete Blocks.
IS : 3696	-	Safety Code for Scaffolding and Ladders
IS : 3812	-	Indian Standard Specification for Fly Ash for use as Admixture for Concrete.
IS : 4031	-	Indian Standard Specification for Method of Tests for Hydraulic Cement.
IS : 4082	-	Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site.
IS : 4634	-	Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixes.
IS : 4656	-	Indian Standard Specification for Form Vibrators for Concrete.

IS : 4925	-	Indian Standard Specification for Concrete Batching and Mixing Plant.
IS : 4926	-	Indian Standard Specification for Ready Mixed Concrete.
IS : 4990	-	Indian Standard Specification for Plywood for Concrete Shuttering work.
IS : 4995	-	Indian Standard Specification for Design of Part-I&II Reinforced Concrete Bins for the Storage of Granular and Powdery Materials.
IS : 5512	-	Indian Standard Specification for Flow Table for use in Tests of Hydraulic Cement and Pozzolanic Materials.
IS : 5513	-	Indian Standard Specification for Vicat Apparatus.
IS : 5515	-	Indian Standard Specification for Compaction Factor Apparatus.
IS : 5751	-	Indian Standard Specification for Precast Concrete Coping Blocks.
IS : 5816	-	Indian Standard Specification for Method of Test for Splitting Tensile Strength of Concrete Cylinders.
IS : 5891	-	Indian Standard Specification for Hand Operated Concrete Mixers.
IS : 6452	-	Indian Standard Specification for High Alumina Cement for Structural Use.
IS : 6909	-	Indian Standard Specification for Supersulphated Cement.
IS : 6923	-	Indian Standard Specification for Method of Test for Performance of Screed Board Concrete Vibrators.
IS : 6925	-	Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures.
IS : 7242	-	Indian Standard Specification for Concrete Spreaders.

IS : 7246	-	Indian Standard Specification for Table Vibrators for Consolidating Concrete.
IS : 7251	-	Indian Standard Specification for Concrete Finishers.
IS : 7320	-	Indian Standard Specification for Concrete Slump Test Apparatus.
IS : 7861 Part-I&II	-	Indian Standard Specification for Recommended Practice for Extreme Weather Concreting
IS : 7969	-	Safety Code for Storage and Handling of Building Materials.
IS : 8041E	-	Indian Standard Specification for Rapid Hardening Portland Cement.
IS : 8112	-	Indian Standard Specification for high strength Ordinary Portland Cement.
IS : 8142	-	Indian Standard Specification for Determining Setting time of Concrete by Penetration Resistance.
IS : 8989	-	Safety Code for erection of Concrete Framed Structures.
IS : 9013	-	Indian Standard Specification for Method of Making, Curing and Determining Compressive Strength of Accelerated-cured Concrete Test Specimens.
IS : 9077	-	Code of Practice for Corrosion Protection of Steel Rails in RB and RCC Construction.
IS : 9103	-	Indian Standard Specification for Admixtures for Concrete.

22.00.00 CONSTRUCTION OF SHELL BY SLIP-FORM METHOD

22.01.00 Shell construction has to be done by slip form shuttering technique. Type of slip form proposed should be indicated in the offer with sketches, drawings and construction statement as explained hereinafter. Number, type and capacities of jacks, the control system and achievable rate of progress in mm/hour should also be indicated. The chosen scheme shall be of a past proven design. A certified performance record of the scheme should be submitted with the offer to guarantee workability of the scheme both from execution time and safety point of view.

22.02.00 The Contractor should furnish a brief but comprehensive statement indicating the planning & programme and method of work to be followed, for the approval of Purchaser at the time of submitting tender. This statement shall include the following items:

- i) Type and description of slip-form equipment and its accessories
- ii) Design of scaffolding and staging
- iii) Description of materials including admixtures to be used for construction.
- iv) Manpower planning, construction spaces required, standby arrangement.
- v) Rate of slip-forming
- vi) Proposed workability requirement of concrete and type of cement and admixture to be used
- vii) Quality assurance programme
- viii) Method of transportation of material
- ix) Method of curing and rectification of defects
- x) Planned interruption, if proposed, and activities during planned interruption. Treatment of construction joint.
- xi) Contingency solution for unplanned interruption
- xii) Time of completion

22.03.00 While selecting the Contractor, due consideration will be given to the merit of the above mentioned statement proposed by the Contractor and minimum time of completion, apart from his past experience in such types of work as also technical and

financial resources of the Contractor.

22.04.00

Notwithstanding what have been specified in earlier clauses, following guide lines are being presented which should be kept in view by intending Contractor, while quoting for slip form method of construction.

- a)** Care to be taken to prevent dragging of concrete along with upward movement of the shuttering. For this purpose following steps are advisable.
 - i)** Shutter plates have to be smooth and should be thoroughly Before fixing them in position all the surfaces which will be in contact with concrete to have a coat of epoxy paint.
 - ii)** In areas where concrete thickness is 750 mm or more rate of should be such that minimum slipping of shuttering is 100 mm hour.
 - iii)** Mix design should be so done that it will be self-lubricant at contact face of shutter and concrete and thus reduce friction cement of approved manufacturer (conforming to relevant specification) may be used for the purpose. An optimum ratio coarse / fine aggregate should be established to suit the depending on availability of aggregates.
 - iv)** Mix design also should be so done that it has a slump of 50mm at the point where concrete is placed under an ambient temperature of around 40 Deg.C. This will also keep vibration by needle vibrators to required minimum. Slump should not drop down to zero in less than 45 min. Suitable retarding agent and plasticizer of approved manufacture may be added in mix to achieve this purpose. These admixtures to be properly identified by preliminary tests both for Performance and for compatibility with particular type of cement Prosed to be used.

Additional steps like spraying of water over the shutters and keeping down the temperature of coarse aggregates by continuous spraying of water over those may be resorted to if ambient temperature is more than 40oC.

- b)** Care must be taken to prevent twist, which predominantly occur in the initial stages because of low slipping rate, in the horizontal plane of slip-form assembly. A thorough check on this aspect must be kept at every 15 minutes interval. One person should exclusively be assigned to this work together with rectifying any defect.
- c)** Every endeavor has to be made so as not to occur any tilt in the shutter assembly. To achieve this following steps need be taken:
 - i)** Performance of jacks has to be closely observed and any defective one needs immediate replacement. Difference in levels of opposite aggregates offer better performance in slip form technique. These help to keep down water

/ cement ratio and also offers better lubrication between concrete and shutter surface. 40 mm down size of coarse aggregates should be preferably be used unless reinforcement detailing calls for lesser size aggregates.

- d) From the creep point of view, shrinkage as well as initial setting property of concrete, cement content should not preferably be more than 400 kg per cum of concrete.
- e) Minimum compressive strength (after 4 to 6 hours of mixing) of concrete immediately below the shutter as slip form proceeds should be between 0.1 to 0.2 Newton/sq.mm.
- f) Large diameter vibrator needles should not be used for vibrating concrete. Sizes of these needles should preferably be restricted to 25 mm diameter and to 40 mm diameter – only in exceptional cases. Atleast two nos. standby vibrator units should always be maintained on top of working deck at all times during the entire period of slip form operation.
- g) It is preferable to have membrane curing compounds sprayed on fresh surfaces emerging out of shutter panels for ensuring proper curing at greater heights.

In case such spraying is not envisaged then elaborate arrangement has to be made for adequate supply of water both on inside and outside vertical surfaces with spraying arrangement, necessary length of pipelines and pump of adequate head to serve the purpose. It is always advisable to have a standby pump for effective utilization of the system.

- h) If slip forming is carried out in summer, rate of slipping should be around 400 mm per hour. If lesser value is contemplated appropriate retarders should be specified.
- i) Exact number and capacity of jacks as well as spacing of yoke frames are to be determined taking into account various loadings including self weight of the system, dead and live loads on working and other platforms, horizontal load on formwork, wind load etc.

It is desirable that jacking system, based on which the entire slip form system works, should consist of jacks 3 tonne / 6 tonne capacity and a hydraulic pump with necessary pipe connections.

Spacing of yoke legs should preferably be kept within 2 meters to prevent overloading on jacks and consequent failure resulting in twist of the formwork.

Jacking rods should be of 25 mm diameter for 3 tonne jacks and 32 mm

diameter for 6 tonne jacks.

- j)** Atleast 30% spare jacks and jacking rods should be kept ready during the entire operation. It is obligatory to maintain spare hydraulic pump along with a set of loose pipes in perfect working condition on top of working deck.
- k)** In sections where thickness is 500 mm or more it is prudent to go in for two nos. of jacks for each slip form yoke.
- l)** For effective utility of this technique following areas need careful attention at the very conceptual stage:
 - i Detailed quality assurance programme
 - ii Advance planning and preparations
 - iii Arrangement for on site supervision and adequate access facilities.
- m)** Construction methods including description and types of different equipment proposed to be used, structural arrangement and analysis of the system, description and type of different materials, planned interruptions, descriptions and frequency of various checks and tests for slip form technique as well as for material, method of preparing, transporting and pouring of concrete, solution for probable defects during slipping, sequence of operations during planned interruptions etc. should be prepared before hand by executing agency and to be approved by Engineer before starting the actual work.
- n)** Placing and binding of reinforcement is also a very critical item and needs special attention. From practical considerations not more than two or three layers of horizontal steel can be tied at a time and this causes a definite limitation in placement of reinforcement.

Vertical reinforcements should be kept vertical by providing suitable holders within the slip form system.
- o)** It is desirable to have a break of atleast one day for every two weeks of continuous operation. Such break should be utilized for various maintenance activities, removal of jacks rods etc.
- p)** Numbers and locations of hoists for lifting concrete, reinforcement and other materials have to be planned well in advance. Capacity of hoists should be such as to match with hourly requirement of concrete and reinforcement. It felt necessary one hoist may be exclusively earmarked for transporting concrete.

For movement of personnel supervising the work a separate hoist must be arranged for.

- q) The system being operative round the clock it is obligatory to have adequate lighting arrangement both on various platform levels as well as on ground below. Arrangement has to be made for facilitating continuous upward movement of the entire system along with slip form.
- r) Winches for lifting men and material and mixers, if located within unsafe area around chimney, should be protected by adequate shelter from possible damage.
- s) Proper telecommunication system has to be established between the personnel working on top of chimney and control room below.
- t) A small laboratory should be maintained at site for testing different materials like cement, coarse and fine aggregates. A cube testing machine may also be installed at site for getting quick feed back results.

Apart from using plumb bobs, level and theodolite instruments for survey purpose arrangement should also be kept for lasers.

- u) In case of interruption in the course of slipping of formwork following measures should be taken:
 - i Provision of a key and additional reinforcement at the junction of new and old concrete.
 - ii Slip form system should be brought up freely to have a minimum overlap of 100 mm or so over previously cast concrete.
 - iii Washing of old concrete surface with compressed air and water jet and thereafter pouring a layer of neat cement grout.
 - iv Clearing of shuttering panels of loose materials, concrete etc. by compressed air and applying a coat of epoxy paint, if felt necessary by Engineer.
 - v Neatly preferable the interface of old or new concrete as soon as it comes out of shutter panel.
- v) It is preferable to suspend the construction work under high wind condition.
- w) It is of utmost importance that for effective implementation of this system an Engineer fully conversant with slip form technique with enough experience in planning and control of formwork should be in overall command of the site and he should be ably supported by well trained mid level supervisory staff, skilled workers and operators.

- x) Operation of slip form method of construction is a continuous one and it demands continuous / intermediate inspection of accuracies in line, level, dimensions and position and immediate rectification of any noticed deviation. All these ask for personnel of high quality having constant vigilance over the construction activity.
- y) While all the activities in effective implementation of the work needs utmost care keeping safety of men and material in mind it is obligatory that all activities should be carried out under the guidance of a qualified and trained safety engineer.

Safety measures as listed below must be adhered to but should not be limited to only these:

- i. Safety helmets and belts to be provided to all supervising staff and workers.
- ii. Safety nets to be provided below both inside and outside platforms as instructed by Engineer.
- iii. Hand railing and toe guard to be provided around all openings and platforms.
- iv. Regular maintenance of equipment, checking of hoists, scaffolding etc.
- v. Passenger hoist must have multiple ropes with adequate factor of safety.
- vi. Emergency lights, coloured lamps to be provided in accordance with relevant Indian Standards and as supplemented in the specification and to be operative in case of sudden power failure emergency standby generator must be kept ready during the entire period of slip form method or construction.
- vii) Emergency vehicles, first aid facilities must be kept ready during the entire period of work.

22.05.00 Construction tolerances

The following shall be the limit of construction tolerances to be strictly adhered to by the contractor:

- Wall thickness : (+) 10mm
- Shell diameter : (+) 10mm for every 3m diameter without any abrupt changes but in no case more than (+) 40mm.
- Verticality : 1 in 1000 subject to a maximum of 75 mm.

In addition, no two points 10m apart vertically shall be more than 20mm out

of plumb w.r.t. each other

22.06.00

Although deviations in general will not be encouraged, the Contractor, however may mention in his offer, the additions to or deviations from drawings/ technical conditions/schedule of items issued with the tender papers and any other special requirement implied with the adoption of the slip form method, which may include but need not be limited to the following items as applicable.

- i. Particular requirement of type and brand of cement, if any.
- ii. Special admixture to be added to concrete
- iii. Any change required in the geometry of the chimney including the shell thickness or side slope from that shown in the NIT drawing.
- iv. Any change/special requirement in the arrangement of reinforcement.
- v. Implications if any of necessary in-situ bending of rebars for /brackets etc. and straightening/cleaning of the same prior to casting of brackets.
- vi. Any additional constructional opening in the shell required at ground level for concreting.

All deviations from specification must be justified and tender price shall include all such variation / deviation. Such deviation without assigning any reason will be rejected.

23.00.00 FABRICATION OF STRUCTURAL STEEL WORK

23.01.00 The details of fabrication, shop testing, painting and delivery to site of structural steel work including supply of all consumable stores, bolts, nuts, washers, electrodes and other materials as required including field connections are indicated below to be performed by the contractor:

- a) Preparation & submission of complete detailed fabrication drawings and erection marking drawings as required including design calculations.
- b) Furnish all materials, labour, tools & plant and all consumables required for fabrication and supply of all necessary bolts, nuts, washers, tie rods and welding electrodes for field connections.
- c) Furnish shop painting of all fabricated steelwork as specified.
- d) Suitably mark, bundle and pack for transport all fabricated materials.
- e) Prepare and furnish detailed bill of materials, dispatch lists (including bought out items) as required for fabrication of structural steelwork.
- f) Load and transport all fabricated steelwork to site with field connection materials.
- g) Maintain a fully equipped fabrication shop at site for modification and repairs as required.

No work under this specification will be provided by any agency other than the contractor, unless specifically mentioned otherwise elsewhere in the contract.

23.02.00 Codes and standards

The work should conform to the requirements of the following latest relevant Indian standard specifications and codes of practice:

IS : 800	-	Code of practice for general construction in steel.
IS : 80	-	Code of practice for use of cold formed light gauge steel structural members in general building construction.
IS : 806	-	Code of practice for use of steel tubes in general building construction.
IS : 808	-	Dimensions for rolled steel beams, channels and angle sections.

IS : 813	-	Scheme of symbols for welding.
IS : 814	-	Covered electrodes for metal arc welding of carbon and carbon manganese steel.
IS : 815	-	Classification coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.
IS : 816	-	Code of practice for use of metal arc welding for general construction in mild steel.
IS: 228	-	Method of chemical analysis of pig Iron, cast Iron & plain carbon and low alloy steel
IS: 817	-	Code of practice for use of Structural steel in General building construction.
IS: 818	-	Code of practice for use of metal arc welding for general construction in mild steel.
IS: 819	-	Code of practice of resistance spot welding for light assemblies in mild steel.
IS:823	-	Code of practice for manual metal arc welding for mild steel.
IS: 919	-	Recommendations for limits and fits for engineering.
IS 1161	-	Specifications for steel tubes for structural purposes.
IS1181	-	Qualifying test for metal arc welders
IS1599	-	Method of bend tests for steel products other than sheet strip wire & tube.
IS 1731	-	Dimension for steel flats for structural & general engineering purposes.
IS 7205	-	Safety code for erection steel work.
IS2595	-	Code of practice for radiographic testing.
IS : 822	-	Code of practice for inspection of welds.
IS : 1182	-	Recommended practice for Radiographic Examination of fusion welded butt joints in steel plates.
IS : 1200 (Part - 8)	-	Method of measurement of steel work and iron work.

IS : 1363 (Part - 1 to 3)	-	Hexagon head bolts, screws & nuts of product grade C.
IS : 1364 (Part - 1 to 5)	-	Hexagon head bolts, screws and nuts of product grade A&B.
IS : 1367 (Part - 1 to 18)	-	Technical supply conditions for threaded steel fasteners.
IS : 1608	-	Method for tensile testing of steel products.
IS : 1730	-	Dimensions for steel plate, sheet and strip for structural and general engineering purposes.
IS : 1852	-	Rolling and cutting tolerances for hot-rolled steel product.
IS : 1977	-	Structural steel (Ordinary quality)
IS : 2016	-	Plain washer
IS : 2062	-	Steel for general structural purposes.
IS : 3644 and	-	Code of practice for ultrasonic pulse echo testing by contact immersion method.
IS : 3757	-	High Strength Structural Bolt
IS : 4000	-	High strength bolts in steel structure
IS : 5369	-	General requirements for plain washers and lock washer.
IS : 6005	-	Code of practice for phosphating of iron and steel.
IS : 6649	-	Specification for hardened and tempered washers for high strength structural bolts and nuts.
IS : 6623	-	Specification for high strength structural nuts.
IS : 7215	-	Tolerances for fabrication of steel structures.
IS : 7280	-	Bare wire electrode for submerged arc welding
IS : 8500	-	Structural steel micro alloyed (medium & high strength quality).

IS : 8629	-	Code of practice for protection of iron steel & structures (Part - I to III) from atmospheric corrosion.
IS : 9595	-	Recommendation for metal arc welding of carbon manganese steels.
IS : 117	-	Specification for ready mixed paint, brushing, finishing, exterior, semi-gloss, for general purposes.
IS : 128	-	Specification for ready mixed paint, brushing, finishing, semi-gloss for general purposes, black.
IS : 1477	-	Code of practice for painting of ferrous metal in building (Part - I & II).
IS : 2074	-	Ready mixed paint, air-drying red-oxide zinc chrome priming.
IS : 2339	-	Specification for aluminum paints for general purposes in dual container.
IS : 2932	-	Specification for enamel, synthetic exterior type - I.
IS : 2933	-	Specification for enamel, synthetic exterior type - II.
BS 4465	-	Specification for water cooling towers.
ACI	-	Reinforced concrete cooling towers shall – practice & Commendatory

23.03.00 Conformity with designs

The contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings. The method of painting, marking, packing and delivery of all fabricated materials shall be as approved by the Engineer.

23.04.00 Materials to be used

Standard structural steel sections shall be used instead of fabricated steel sections as far as possible.

- a) All steel materials required for the work shall be supplied by the contractor. All steel materials shall comply with the following IS:-
 - i) IS:801 - Cold formed light gauge steel structural member.

- ii) IS:2062 - Grade – A, Structural Steel for plate thickness upto 20mm
- iii) IS:2062 - Grade – B (Killed), Structural Steel for plate thickness above 20mm
- iv) IS:2062 - Grade – C, for crane gantry girder in turbine hall.
- v) IS:806 - Steel tubes in general building construction.

b) Electrodes

The arc welding electrodes shall conform to the relevant IS; and shall be of heavily coated type having uniform thickness. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and amperage (polarity in case of D.C. supply) for which the electrodes are suitable. All electrodes shall comply with the following IS:

- i) IS: 814 - Covered electrodes for metal arc welding structural steel.
- ii) IS:815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.
- iii) IS:7280 - Base wire electrode for submerged arc welding.

c) Bolts and nuts

All bolts and nuts shall conform to the requirements of IS:1367 - Technical Supply Conditions for Threaded Fasteners. Materials for bolts and nuts shall comply with the following IS codes. Mild steel for bolts and nuts tested to following IS shall have a tensile strength of not less than 44 Kg/mm²; and minimum elongation of 23 per cent on a gauge length of 5.6 ÖA, where 'A' is the cross sectional area of the test specimen :

- i) IS:1367 - Technical supply conditions for threaded fasteners.
- ii) IS:1608 - Method for tensile testing of steel other than sheet, strip, wire and tube.
- iii) High tensile steel material shall have the mechanical properties as per IS:1367 or as approved by the Engineer.

d Washers

Washers shall be made of steel conforming to the following IS:

- i) IS:1977 - Structural steel (Ordinary Quality) St-39-0
- ii) IS:2062 - Steel for general structural purpose
- iii) IS:6623 - High Strength Structural Nuts
- iv) IS:6649 - Hardened and tempered washers for high strength structural bolts & nuts.

Paints for shop coat of fabricated steel shall be of epoxy based paint to withstand severe corrosive conditions prevailing at site.

23.05.00 Painting

- a) All steel structures shall receive two primer coats and two finish coats of painting. First coat of primer shall be given in shop after fabrication before dispatch to erection site after surface preparation as described below. The second coat of primer shall be applied after erection and final alignment of the erected structures. Two finish coats shall also be applied after erection.
- b) Steel surface which is to be painted shall be cleaned of dust and grease and the heavier layers of rust shall be removed by chipping prior to actual surface preparation. The surface shall be abrasive blasted to Sa-2½ finish as per SIS05-5900. Primer paint shall be zinc silicate of approved brand. Dry film thickness of each primer coat shall be 50 microns.
- c) Finish paint shall be 2 coats of High built epoxy finish of approved brand. Dry film thickness of each finish coat shall be 90 microns. The undercoat and finish coat shall be of different tint to distinguish the same from finish paint. The total dry film thickness shall be 300 microns. All paints shall be of approved brand and shade as per the OWNER's requirement.
- d) Joints to be site welded shall have no paint applied within 100 mm of welding zone.

Similarly where Friction grip fasteners are to be used no painting shall be provided. On completion of the joint the surfaces shall receive the paint as specified.
- e) Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly.

Surfaces inaccessible after erection including top surfaces of floor beams supporting gratings or chequered plate shall receive one additional coat of finish paint over and above number of coats specified before erection. Portion of steel member embedded / to be encased in concrete shall not be painted.

23.06.00 Storage of Materials

- a) All materials shall be stored to prevent deterioration ensuring the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged shall be removed from the contractor's yard immediately. The contractor shall maintain upto date account in respect of receipt, use and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials shall be stacked separately with easily identifiable marks.
- b) The steel used for fabrication shall be stored in separate stacks off the ground section-wise and lengthwise so that they can be easily inspected, measured and accounted for at any time. If required by the Engineer, the materials should be stored under cover; and suitably painted for protection against weather.
- c) The electrodes for electric arc welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition [if necessary by resorting to heating].
- d) Bolts, nuts, washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length and quality.
- e) Paints shall be stored under cover in airtight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

23.07.00 Quality Control

23.07.01 The contractor shall establish and maintain quality control procedures for different items of work and materials to ensure that all works are performed as per specification. As far as possible, all inspections by the Engineer shall be made at the contractor's fabrication shop. The contractor shall co-operate with the Engineer in permitting access for inspection to all places where work is being done and in providing free of cost all necessary help in respect of tools & plant, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the contractor.

Materials or workmanship not in reasonable conformance with the provisions of this specification would be rejected at any time during the progress of the work. The quality control procedure shall cover but not be limited to the following items of work:

- i) Steel : Quality, manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.
- ii) Bolts, Nuts : Manufacturer's certificate, dimension & washers checks, material testing.
- iii) Electrodes : Manufacturer's certificate, thickness and quality of flux coating.
- iv) Welders : Qualifying tests
- v) Welding sets : Performance tests
- vi) Welds : Inspection, X-ray, Ultrasonic tests
- vii) Paints : Manufacturer's certificate, physical Inspection Reports.

23.07.02

- a) The dimensions, forms, weights and tolerances of all rolled shapes, bolts, nuts, studs, washers etc. and other members used in the fabrication shall, wherever applicable, conform to the requirements of the latest relevant IS.

b) **Fabrication Drawing**

The sequence of submission of fabrication drawings for approval shall match with the approved fabrication and erection schedule. It should be ensured that the correctness of general arrangement for centerline dimensions and levels, section sizes, and adequacy of connections including splice joints as to the number of bolts, weld length, size of gusset/end plates are maintained. The approval of the drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of spec.

The fabrication drawings shall include but not be limited to the following:

- i) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.
- ii) Dimensional drawings of base plates, foundation bolt location etc.
- iii) Details of all connections with supporting calculations.

- iv) Any other drawings or calculations that may be required for the clarification of the works.

The fabrication drawings shall give all the necessary information for the fabrication, erection and painting of the steelwork in accordance with the provisions of this specification. Fabrication drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Fabrication drawings shall give complete information necessary for fabrication of various components of the steelwork, including the location, type, size and extent of welds. These shall also clearly distinguish between fabrication and field bolts and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the fabrication drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence; and technique of welding shall be carefully controlled to minimize the locked-up stresses and distortion. Welding symbols used shall be in accordance with the requirements of IS:813; and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

All steel structural wall beam/columns shall be encased with nominal reinforcement and chicken wire mesh fouling / connecting in brick masonry works. Also, chicken wire mesh shall be provided at the junction of RCC and brick work. The wall beam/tie beam shall be provided at every 2.5 meter height of the brick wall.

All columns shall be encased with RCC upto the height of 500 mm above zero level of STG power house building.

23.08.00 Workmanship

- a) All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of IS:800 and other relevant Indian standards or equivalent.
- b) Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by IS:1852. If straightening is necessary, it shall be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600 Deg. C.
- c) Cutting shall be effected by shearing, cropping or sawing. Use of a mechanically controlled gas cutting torch is permitted for mild steel only. Gas cutting of high tensile steel is permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically

controlled torch shall be permitted if special care is taken and done under expert hand.

To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, subjected to substantial stress or which have weld metal deposited on them, shall be reasonably free from gouges. Occasional notches or gouges not more than 4 mm deep will be permitted. Gouges greater than 4 mm, that remain from cutting, shall be removed by grinding. All re-entrant corners shall be shaped notch-free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

- d) Finishing of sheared or cropped edges of plates or shapes of edges gas-cut with mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed.
- e) The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams without web cleats shall be not more than 3 mm at each end, but where, for practical reasons, greater clearance is necessary, suitably designed cleatings shall be provided.
- f) **Bolted construction:**
 - i) Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching shall be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size; and reamed after assembly to the full diameter.

Holes for black bolts shall be not more than 1.5 mm or 2 mm (depending on whether the diameter of the bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the black bolt passing through them.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of H8 to IS:919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thicknesses in one operation shall be drilled to a smaller size and reamed out after assembly. Holes for bolts shall not be formed by gas cutting process.

- ii) Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes to be enlarged to admit the bolts shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be so assembled that they are neither twisted nor otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Bolted construction shall be permitted only in case of field connections if called for on the drawings and is subjected to the limitation of particular connection as may be specified.

Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project out through the nut at least one thread. In all cases, the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer, one spring washer or lock-nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as indicated on the drawings.

g) Welded Construction

- i) Welding shall be in accordance with relevant IS. Welding shall be done by experienced and good welders qualified by tests in accordance with IS:817. Surfaces to be welded shall be free from loose scale, slag, rust, grease, paint and any other foreign material except that mill scale which withstands vigorous wire brushing may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas-cutting shall, wherever practicable, be done by a mechanically guided torch.
- ii) Parts to be fillet welded shall be brought in as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces which are not completely sealed by welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected; and in making the correction, the parts shall not be drawn into a sharper slope than two degrees (2 Deg.). The work shall be positioned for flat welding whenever practicable.
- iii) In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses. Where it is impossible to avoid high residual stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is

welded to other parts of the member. Long girders or girder sections shall be made by shop splicing not more than 3 sub-sections, each made in accordance with this paragraph. Welded assemblies shall be stress relieved by heat treating in accordance with the provisions of the relevant IS.

- iv) All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 mm thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross-section. Groove welds made with the use of the backing of the same material as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be terminated at the ends of joint in a manner ensuring soundness. Where possible, this should be done by use of extension bars or run-off plates which need not be removed upon weld completion. To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall conform to the welds made, and the methods of correcting defective work shall conform to the relevant IS.

- v) If welding is to be undertaken at low temperature, adequate precautions as recommended in relevant IS shall be taken. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20°C, all requirements regarding preheating of the parent material shall be in accordance with the relevant IS.
- vi) Where required, intermediate layers of multiple-layer welds shall be peened with light blows from a power hammer, using a round-nose tool. Peening shall be done after the weld is cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld & base metal from over peening.
- vii) The equipment shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of type and capacity as recommended by the electrode manufacturer.
- viii) Column splices and butt joints of compression members for stress transmission shall be accurately machined and close-butted over the whole section with a clearance not exceeding 0.2 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc., after welding together, should be accurately machined

so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles or channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 2 mm.

- ix) Bases and caps fabricated out of steel plates, except when cut from material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face which is to be grouted direct to a foundation need not be machined if such face is true and parallel to the upper face. To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air. The ends of lacing bars shall be neat and free from burrs. Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used. Provision shall be made for all necessary steel bearing plates to take up reaction of beams & columns and the required stiffeners & gussets whether or not specified. Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.
- x) All shop connections shall be welded as specified. Certain shop connections, may be changed to field connections if desired by the Engineer for convenience of erection; and the contractor shall make the desired changes. The steelwork shall be temporarily shop-erected complete so that accuracy of fit may be checked before dispatch. The parts shall be shop-erected with a sufficient number of parallel drifts to bring and keep the parts in place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected facilitating the check of interchangeability.

23.09.00 Shop Painting

- a) The steelwork concealed by interior building finish need not be painted; steelwork to be encased in concrete shall not be painted. All other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned as below, by brush, spray, roller coating, flow coating or dipping. Before leaving the shop, all steelwork to be painted shall be cleaned by hand- wire brushing or by other mechanical cleaning methods to remove loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by solvent. Steelwork having no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners; and shall be cleaned of dirt and other foreign material by through sweeping with a fiber brush. After completion of the pre- cleaning, the metal surface shall be immediately painted with epoxy based paint.
- b) Inaccessible surfaces after assembly, shall receive two coats of shop paint, positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections. Contact surfaces shall be cleaned as per para (a) above before assembly.

Machine finished surfaces shall be protected against corrosion by a rust inhibitive coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection. Surfaces within 50 mm of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

- c) All the grills shall be galvanized

23.10.00 Testing, Acceptance Criteria and Delivery

- a) The contractor shall carry out testing as per IS. The contractor shall get the specimen tested in a laboratory approved by the Engineer and test results shall be submitted to the Engineer in triplicate within 3 days after completion of the test. All electrodes shall be procured with test certificates. The correct grade and size of electrodes not deteriorated in storage shall only be used. The testing of welding shall be performed as under with quantum of minimum non-destructive tests to be conducted during fabrication and after erection as below:
 - i) Ultrasonic test should be performed on the columns; girders; Built-up beam fabricated with plates.
 - ii) Fillet welds at junction of flange & web of built-up beams, columns, all shear connections of main beams and all butt welds shall be 100% ultra sonic tested
 - iii) 100% radiographic test shall be performed for butt weld joints of crane girder & its supporting columns, deaerator supporting beams and columns. The minimum percentage of Radiographic test to be carried out at other locations shall be 25 percent.
 - iv) Dypenetration test, Ultrasonic test, Radiographic test shall be carried out at any other location also, if required as per Engineer's approval.

In cases, the test results shows deficiency, the Engineer shall have option to reject or instruct any remedial measures to be carried out by the contractor.

- b) All bolts, nuts and washers shall conform to the relevant IS. If desired by the Engineer, representative samples of these materials should be tested in an approved laboratory and in accordance with the procedures described in relevant IS. All paints and primers shall be of standard quality; and shall conform to the provisions of the relevant IS. The paint shall be epoxy based. The tolerances on the dimensions of individual rolled steel components shall be as per IS:1852. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures subjected to dynamic loading (like wind,

seismic etc.) and thin walled construction (like box girders) shall be as per IS:7215.

- c) Should any structure or part of a structure be found not to complying to the provisions of the specification, the same shall be liable to rejection. No structure or part of the structure, once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check the test results obtained at the contractor's works by independent tests at an approved laboratory and should the items, so tested, be found to be unsatisfactory.

When all tests to be performed in the contractor's shop have been successfully carried out, the steelwork will be accepted forthwith; upon receipt of which, the items shall be shop painted, packed and dispatched. No item should be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Purchaser to accept the work, should it, on further tests before or after erection, be found not in compliance with spec.

- d) The contractor should deliver the fabricated structural steel materials to site with all necessary field connection materials in a sequence permitting an efficient and economical performance of the erection work. The Purchaser may prescribe or control the sequence of delivery of materials, at his own discretion. Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings; and shall bear such other marks as will further facilitate identification and erection.

23.11.00 Inspection of Welding

The extent of quality control in respect of welds of structural elements shall be as follows:

a) Visual Examination

All welds shall be 100% visually inspected to check the following:

- i) Presence of undercuts
- ii) Surface cracks in both welds and base metals.
- iii) Unfilled craters
- iv) Improper weld profile and size
- v) Excessive reinforcement in weld

- vi) Surface porosity

Before inspection, the surface of weld metal shall be cleaned of all slag, spatter matter, scales etc. by using wire brush or chisel.

b) Dye penetration Test (DPT)

This test shall be carried out for all fillet welds and groove welds to check the following:

- i) Surface cracks
- ii) Surface porosities

c) Ultrasonic Testing

Ultrasonic test shall be conducted for all groove welds and heat affected zone in dynamically loaded structures and for other important load bearing butt welds in statically loaded structures as desired by Purchaser to detect the following:

- i) Cracks
- ii) Lack of fusion
- iii) Slag inclusion
- iv) Gas porosity

Ultrasonic testing shall be carried out in accordance with American National Standard ANSI/AWS D1.1-92 Chapter 6 Part-C.

Before Ultrasonic test is carried out, any surface irregularity like undercuts, sharp ridges etc. shall be rectified. Material surface to be used for scanning by probes must allow free movement of probes. For this purpose, surface shall be prepared to make it suitable for carrying out ultrasonic examination.

d) Radiographic Testing (X-ray and Gamma-ray Examination)

This test shall be limited to 2% of length of welds for welds made by manual or semi-automatic welding and 1% of length of weld if made by automatic welding machines. The location and extent of weld to be tested by this method shall be decided by Purchaser to detect the following defects:

- i) Gas porosity

- ii) Slag inclusion
- iii) Lack of penetration
- iv) Lack of fusion
- v) Cracks

Radiographic testing shall be conducted in accordance with American National Standard ANSI/AWSD1.1-92.

Any surface irregularity like undercuts, craters, pits, etc. shall be removed before conducting radiographic test. The length of weld to be tested shall not be more than $0.75 \times$ focal distance. The width of the radiographic film shall be equal to width of the welded joint plus 20 mm on either side of the weld.

EPC Contractor shall provide testing equipment for conducting non-destructive tests for confirming the integrity of welding wherever necessary as directed by the Purchaser.

e) Acceptable Limits of Defects of Weld

Limits of acceptability of welding defects shall be as follows:

i) Visual inspection and Dye penetration test

The limits of acceptability of weld defects detected during visual inspection and dye penetration test shall be in accordance with clause 8.15.1 and clauses 9.25.3 of American National Standard ANSI / AWS D1.1-92 respectively, for statically and dynamically loaded structures.

- ii) Ultrasonic testing The limits of acceptability of weld defects detected during ultrasonic testing shall be in accordance with clause 8.15.4 and clause 9.25.3 of American National Standard ANSI/AWS D1.1-92 respectively for statically and dynamically loaded structures.

iii) Radiographic testing:

The limits of acceptability of weld defects detected during Radiographic testing shall be in accordance with clause 8.15.3 and 9.25.2 of American National Standard ANSI/ AWS D1.1-92 respectively for statically and dynamically loaded structures.

f) Rectification of Defects in Welds

In case of detection of defects in welds, the rectification of the same shall be done as follows:

- i) All craters in the weld and breaks in the weld run shall be thoroughly filled with weld
- ii) Undercuts, beyond acceptable limits, shall be repaired with dressing so as to provide smooth transition of weld to parent metal.

Welds with cracks and also welds with incomplete penetration, porosity, slag inclusion etc., exceeding permissible limits shall be rectified by removing the length of weld at the location of such defects plus 10 mm from both ends of defective weld and shall be re-welded. Defective weld shall be removed by chipping hammer gouging torch wheel. Care shall be taken not to damage the adjacent material.

24.00.00 ERECTION OF STRUCTURAL STEELWORK

24.01.00 The works related to the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at site, installing the same in position, painting and grouting the stanchion bases all complete are detailed below:

- a) Providing all construction & transport equipment, tools, tackles, consumables, materials, labour and supervision as required for the erection of the structural steelwork.
- b) Receiving, unloading, checking and moving to storage yard at site including prompt attendance to all insurance matters as necessary.
- c) Transportation of all fabricated structural steel materials from site storage yard, handling, rigging, assembling, bolting, welding and satisfactory installation in proper location as per approved erection drawings. If necessary suitable temporary approach roads should be built for transportation.
- d) Checking centerlines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. Any defect observed in the foundation shall be brought to the notice of the Engineer. The contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.
- e) Aligning, plumbing, leveling, bolting, welding and securely fixing the fabricated steel structures as per drawings.
- f) Painting of the erected steel structures.
- g) Minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following:-
 - i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.
 - ii) Cutting, chipping, filling, grinding etc. if required for preparation and finishing of site connections.
 - iii) Reaming of holes for use of higher size bolt if required.
 - iv) Welding of connections in place of bolting for which holes are either not drilled at all or wrongly drilled during fabrication.
 - v) Refabrication of parts damaged beyond repair during transport and handling or refabrication of parts which are incorrectly fabricated.

- vi) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.
- vii) Drilling of holes which are either not drilled at all or drilled in incorrect location during fabrication

24.02.00 **a)** The work shall conform to the latest revisions of the following IS Codes:

IS-800	:	Code of Practice for general construction in Steel
IS-456	:	Code of Practice for plain or reinforced concrete
IS-7205	:	Safety Code for erection of Structural Steel work
IS-12840	:	Tolerance for erection of Steel Structures

- b)** Conformity with designs: The contractor should erect the fabricated steel structures, align all the members, complete all field connections as per approved drawings. All works shall conform to the provisions of the relevant IS. The testing and acceptance of the erected structures shall be in accordance with the provisions of this specification.

24.03.00 **a)** The contractor should take delivery of all the materials at site. He shall unload the materials and perform all formalities such as checking of materials and attend to insurance matters as specified above.

Contractor shall make good any such deficiency, if detected later, either by repair or with fresh material as may be directed by the Engineer at the contractor's own cost. All field connection materials such as bolts, nuts, washers and electrodes, other consumables such as oxygen and acetylene gas, paints, fuels, lubricants, oil, grease and any other material as required for the execution of the works shall be supplied by the contractor for erection work.

- b)** All materials shall be stored preventing deterioration and ensuring the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site. The contractor should establish a suitable yard at site for storing the fabricated steel structures and other materials. The yard shall have proper facilities such as drainage, lighting, suitable access for large cranes, trailers and other heavy equipment. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding. All field connection materials, paints, cement etc. shall be stored on well designed racks and platforms off the ground in a properly covered store building.
- c)** The contractor shall establish and maintain quality control procedures for different items of work and materials; and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the following:

- i) Erection : Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.
- ii) Painting : Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

24.04.00 Workmanship

- a) The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be efficient, dependable, in good working condition. The method and sequence of erection shall have the prior approval of the Engineer. The Erection shall arrange in most economical method; and sequence available to him consistent with the drawings.
- b) Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install, temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.

If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure during the course of the erection of the steel framing, arrangement for installation by the erector shall be made.

The responsibility of the contractor in respect of temporary bracings and guys shall cease when the structural steel is once located, plumbed, leveled, aligned and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer. The temporary guys, braces, false work and cribbing shall be removed immediately upon completion of the erection

- c) Positioning and leveling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be as per approved drawings. Anchor bolts and other anchor steel shall be embedded. The contractor shall check the positions and levels of the anchor bolts, etc. before concreting and get them properly secured against disturbance during pouring operations. He shall remain responsible for correct positioning. For heavy columns, the contractor shall set proper screed bars to maintain proper level. Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance allowable. No permanent field connections by bolting or welding shall be carried out until proper alignment and plumbing has been attained.
- d) All relevant portions in respect of bolted construction for fabrication of

structural steelwork shall also be applicable for field bolting as below:

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled; and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except light mill scales. They shall be free of dirt, loose scales, burns, and other defects that would prevent solid seating of the parts. Contact surfaces within friction-type joints shall be free of oil, paint, lacquer, or galvanizing. High tensile bolts shall be tightened to provide the required minimum bolt tension by any of the following methods:-

Turn-of-nut method: When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "Snug tight" condition to ensure that the parts of the joint are brought into good contact with each other. "Snug tight" is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation as below with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation, there shall be no rotation of the part not turned by the wrench.

Bolts length not Bolt length exceeding 8 times dia or 200mm	Bolts length not Bolt length exceeding 8 times dia or 200mm	Remarks
½ turn	2/3 turn	Nut rotaion is relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotaion – 30 over or under

Bolts shall be installed without hardened washers when tightening is done by the turn-of-nut method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the nut match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks shall be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

Torque Wrench tightening: When torque wrenches are used to provide the

bolt tensions, the bolts shall be tightened to the torques as below. Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

The above torque values are approximate for providing tensions of 14.7 MT for 20 mm dia; 18.2 MT for 22 mm dia; and 21.2 MT for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular torque wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening shall be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds.

Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be as per IS.

- e) Field Welding: All field assembly and welding shall be carried out as specified for fabrication work, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.
- f) Holes, cutting and fitting: No cutting of sections, flanges, webs, cleats, bolts, welds etc. shall be done. The erector shall not cut, drill or otherwise alter the work of other trades, or his own work to accommodate other trades, unless such work is clearly specified. Wherever such work is specified the contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work.

24.05.00 Drifting

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock shall be considered as permissible. For this, light drifting shall be used to draw holes together; and drills shall be used to enlarge holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any shop work error which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

24.06.00 Testing and Acceptance Criteria

- a) Loading tests shall be carried out on erected structures to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall be dismantled and replaced with suitable member. On the basis of the tests, the Engineer will decide and his decision will be final. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing; and the tests shall be conducted as indicated below:-

- i) Stiffness Test: In this test, the structure or member shall be subjected, in addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 per cent of the maximum increase in strain or deflection recorded during the second test.
- ii) Strength Test: The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

b) Structure of same design:

Where several identical same design structures exists as a prototype, one structure shall be fully tested, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

- c)** Repair for subsequent test and use after strength tests: The structure passed the "Strength Test" as above and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in above.

24.07.00 Tolerances

Considering expected variation in the finished dimensions of structural steel frames, these shall be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabrication tolerances for the finished parts; and the rolling tolerances for the profile dimensions permitted under the specification for fabrication of structural steelwork shall be as indicated below:

	Component	Description	Variation Allowed
a	For Buildings Containing Cranes		
	i) Main Colomn	a) Shifting of column axis at foundation level with respect to building line	
		i) In longitudinal direction	(+/-) 3.0mm
		ii) In lateral direction	(+/-) 3.0mm
		b) Deviation of both major column axis from vertical between foundation and	

	Component	Description	Variation Allowed
		other member connection levels :	
		i) For a column upto including 10M	(+/-) 3.5 mm and from true height vertical
		ii) For a column greater than 10M but less than 40M height	(+/-) 3.5 mm from true vertical for length measured between connection levels, but not more than (+/-) 7.0 mm per 30 m length
		c) For adjacent pairs of columns across the width of the building prior to placing of truss.	(+/-) 9 mm on true span.
		d) For any individual column deviation of any bearing or resting level from levels shown on drawings.	(+/-) 3 mm
		e) For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating level supposed to be at the same level.	3 mm
	ii) Trusses	a) Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord	1/1500 of the span or not greater than 10 mm whichever is the least
		b) Lateral displacement of top chord at centre of span from vertical plane running through centre of supports.	1/250 of depth of truss or 20 mm whichever is the least.
	iii) Cranes Girders & Tracks	a) Difference in levels of crane rail measured between adjacent columns.	2.0 mm
		b) Deviation to crane rail gauge	(+/-) 3 mm
		c) Relative shifting of ends of adjacent crane rail in plan and elevation after thermit welding.	1.0 mm

	Component	Description	Variation Allowed
		d) Deviation of crane rail axis from centre line of web.	(+/-) 3.5 mm
	iv) Setting of expansion gaps	At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per Deg.C per unit length.	
b	For Buildings without Cranes		
	The maximum tolerances for line and level of the steel work shall be $\pm 3\text{mm}$ on any part of the structure. The structure shall not be out of plumb more than 3.5 mm on each 10 m section of height and not more than 7 mm per 30 m section. These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.		

25.00.00 MASONRY AND ALLIED WORKS

25.01.00 The masonry and allied works associated with the offered power plant cover furnishing, installation, repairing, finishing, curing, protection, maintenance and handing over of all the associated works for use in structures as per the locations shown in approved drawings in accordance with latest IS:2212/IS:2250/ IS:5134.

25.02.00 Brick masonry

i) All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

ii) Mortar

Mix for mortar shall be as specified. Cement sand mortar cement and sand in 1:4 proportions shall be mixed dry in a mechanical mixer; and then water added and mixed further to achieve working consistency. Surplus mortar droppings from masonry, if received on surface free from dirt shall be mixed with fresh mortar with additional cement. No mortar which has stood for more than half an hour shall be used.

iii) Brick

Fly ash Bricks shall be soaked by submergence in clean water for at least 2 hours in approved vats before use. Bricks shall be laid in English bond. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. Bricks shall be laid with frogs upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in mortar. Inside faces shall be buttered with mortar before the next bricks are placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar.

Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool with green mortar to provide bond for plaster or pointing. Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. 2 brick thick or more brickwork shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

iv) Exposed Brickwork

Almost all the brickwork shall be plastered with cement mortar. Brickwork in superstructures uncovered by plaster shall be executed by skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of window sills and lintels shall be used to control uniformity of brick courses. Masons should check workmanship frequently with plumb, spirit level, rule and

string. All brick work shall be cleaned at the end of day's work. In case of face bricks involvement the brickwork shall be in composite shape with face bricks on the exposed face and balance in routine bricks, maintaining the bond fully; using carborandum stone for rubbing down. Where face bricks are not needed, bricks for the exposed face shall be specially selected from routine bricks. All exposed brickwork on completion of work shall be rubbed down, washed clean and pointed as specified.

v) **Reinforced Brickworks**

Reinforcements shall be as specified. The reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. columns or welded to steel stanchions. For partition walls 2 reinforcement bars shall be placed at every fourth layer.

vi) **Encasement of Structural Steel**

The fixtures shall generally be embedded in mortar and masonry units shall be cut as required. Encasement of structural steel shall be done by brick masonry work round flanges, webs etc. and filling the gap between steel and masonry by minimum 12 mm thick mortar. Encased members shall be wrapped with chicken wire mesh with a lap of 50 mm.

vii) All wall beams shall be provided with gunniting of 50 mm thick around with nominal reinforcement and chicken mesh. Also, chicken wire mesh shall be provided at the junction of RCC & brick work. The wall beam/tie beam shall be provided at every 2.5 meter height of the brick wall. Chicken wire mesh shall be provided at the joints of brick masonry and RCC beams/column.

vii) **Curing**

The brick masonry works shall be cured for a period of fourteen (14) days after laying and the plaster shall be cured for a period of seven (7) days.

26.00.00 ARCHITECTURAL FINISHES

26.01.00 Plastering

- a) The plastering work including the application of cement punning (Neru) or plaster of Paris treatment on brick or concrete faces with architectural features shall be executed as per in accordance with the following latest IS codes: POP shall be used only on inside surfaces of ceiling and walls for aesthetic and architectural requirement.

IS:1542 : Sand for plastering

IS:1661 : Code of practice for application of cement and cement lime plaster finishes.

IS:2333 : Plaster of Paris

IS:2402 : Code of practice for external rendered finishes

IS:2394 : Code of practice for application of lime plaster finishes

- b) Mortar for plastering shall be mixed in the proportion in a dry state and then wetted and mixed thoroughly to obtain the required consistency. The mortar shall be mixed in an approved manner including machine mixing in batches for its consumption within half an hour of mixing. Any mortar for partially set plaster shall be rejected and removed from site. The mix for plastering shall be as follows:

Brick wall:

- i) Outside plaster (or rough side): 20 mm thick in 2 coats, 1st coat of 12 mm thick in C:M 1:3 & 2nd coat of 8 mm thick in C:M 1:2 sand faced.
- ii) Inside plaster (or plain face) : 12 mm thick (1 cement : 3 sand)
- iii) Concrete ceiling: Plaster : 6 mm thick (1 cement : 3 sand)

- c) Before application of plaster, the surface shall be prepared as per IS:1661. In all plaster work, mortar shall be applied in an uniform layer slightly more than the required thickness and well pressed into the joint and in the surface and rubbed & levelled with a flat wooden rule to give required thickness.

Plaster, when more than 15 mm thick, shall be applied in two coats, base coat followed by the finishing coat. Thickness of base coat shall be just sufficient to fillup all unevenness in the surface; no single coat, however, shall exceed 12 mm in thickness. The under-coat shall be thicker than the upper coat. The overall thickness of the plaster shall not be less than the minimum thickness shown on the drawings. The undercoat shall be allowed to dry and shrink before applying the second coat of plaster. The undercoat shall be scratched or roughened before it is fully hardened to form a mechanical key. The method of application shall be "thrown on" rather than "**applied by trowel**". The finished surface shall be true to line & plumb; and the contractor shall make up any irregularity in the masonry/concrete work with plaster. The mortar shall adhere to the surface intimately when set; and there should be no hollow sound when struck.

All vertical edges of pillars, door jambs etc. shall be chamfered or rounded off. All corners must be finished to their true angles or rounded. Any plastering damaged shall be repaired and left in good condition at the completion of the job.

- d) All plastered surfaces after laying and sufficiently hardened shall be cured for a minimum period of seven days and shall be protected from excessive heat and sunlight by suitable approved means.
- e) **Plaster of Paris Finish:** The plaster of Paris shall be calcium sulphate hemi-hydrate variety. Its initial setting shall be less than 13 minutes. The material shall be mixed with water to workable consistency. Plaster of Paris shall be applied to the surface in the uniform layer slightly more than 2 mm thick and shall be finished to an even and smooth surface with a steel trowel. Thickness of finish shall not be less than 2 mm. All corners, arises, angle and junctions shall be carefully and neatly finished.

26.02.00 Wall Cladding

26.02.01 Permanent colour coated sandwiched insulated metal cladding system

- a) Permanent colour coated sandwiched (insulated) M.S. / High tensile steel metal cladding of approved colour combination shall be provided for main plant building and any other building with metal cladding where thermal insulation is required as per thermal requirements.
- b) Troughed zinc-aluminum alloy coated (both sides) M.S. sheet having 0.6mm minimum thickness (or high tensile steel sheet of 0.5 mm minimum thickness) shall be used on external face (outer face) of cladding system. Weight of coating shall not be less than 150gms /sq.m. The outer side (exposed face) shall be permanently colour coated with Polyfluro Vinyl Coating (PVF2) of Dry Film Thickness

(DFT) 20 microns (min) over primer. Inner side of external sheet shall be provided with suitable pre-coating of minimum 7 microns.

- c) Galvanised M.S. sheets of minimum 0.6 mm thickness shall be used as inner liner (internal face) of cladding system. The exposed face shall be permanently colour coated with silicon modified polyester paint of DFT microns (min) over primer. Inner face of external sheet shall be provided with suitable pre-coating of minimum 7 microns. The rate of galvanization shall not be less than 180 gm/sq.m.
- d) The permanent colour coated sheet shall meet the general requirements of IS:14246 and shall conform to class 3 for the durability.
- e) Inner sheet shall fixed directly to side runner and Z spacers made of at least 2 mm thick galvanized sheet of grade 375 as per IS:277. Inner sheet shall be fixed at the rate not more than 1.50m centre to centre to hold the insulation and external sheeting.

26.03.0

Permanent colour coated non-insulated metal cladding system

- a) Permanent colour coated (non-insulated) M.S / High tensile steel metal cladding of approved colour combination shall be provided for bunker building and cladding over parapet walls of buildings where metal cladding is specified 0.8mm with galvanization rate of 275 gm/sqm.
- b) Troughed zinc-aluminum alloy coated not less than 150 gm/sqm M.S. sheet having 0.6mm minimum thickness (or high tensile steel sheet of 0.5 mm minimum thickness) shall be used for cladding system. The outer side (exposed face) shall be permanently colour coated with with PVF2 paint of minimum DFT 20 microns over primer and the inner side (internal face) shall be coated with same paint of minimum DFT 12 microns over primer. These shall be fixed directly to runners. The sheets shall meet the general requirements of IS: 14246 and shall conform to class 3 for the durability. For roof sheeting the specification remains same as that of side cladding except the thickness and galvanization. The minimum thickness of roof sheeting shall be 0.8mm with galvanization rate of 275 gm/sqm.

26.04.00

Roof Decking And Suspended Ceiling

- a) The roof decking includes furnishing of cold rolled formed troughed profile sheets manufactured from tested quality CR rolls conforming to IS:513 including fixing. The profile sheet section shall be obtained from feeding strips of uniform coil thickness through successive pairs of shaped rollers, each pair of rollers progressively forming the sheet until finished section is obtained.

In general the troughed profile shall have minimum depth of valley 44mm and center to center of valley about 130mm. The thickness of sheet shall be 0.8 mm (minimum). To suit the spacing of purlin, the length of sheet may vary between 1.50 to 2.00 m. The overall minimum width of sheet

shall be 824.20mm and covering width as 780mm i.e. side overlap shall be 22.10 mm.

- b. Pre-Treatment & Phosphating: The pre-treatment process shall conform B to medium class-B conforming to IS:3618. Next operation of rust removal shall be done by dipping in a tank containing highly diluted hydrochloric acid (HCL); and traces of HCL shall be removed by double rinsing in a water tank for about 5 minutes each. Subsequently sufficient conditioning shall be done by dipping in the next tank containing surface conditioner. Hot phosphating shall be accomplished in the next tank followed by water rinsing and finally passivated by heat process in the passivation tank. Thereafter traces of moisture shall be removed by hot compressed air before application of primer and final paint coating as required. In general the pre- treatment stages shall be as under :

Sl.NO	STAGES	CHEMICALS	PROCESSING	PROCESSING
1	Degreasing	Cleaner	55 to 75° C	3 to 10 mins
2	Water Rinsing	-	Room Temp	-
3	Derusting	Rust remover	R. Temp to 60°C	1 to 10 Mts
4	Water Rinsing	-	Room Temp	-
5	Surface conditioning	Surface conditioner	Room Temp	15 to 30 sec
6	Phosphating solution	Phosphating	50 to 55° C	3 to 5 Mins
7	Water Rinsing	-	Room Temp	-
8	Passivation solution	Passivation	Room Temp	15 to 30sec
9	Water Rinsing	-	Room Temp	-
10	Defonised water	-	Room Temp	-
11	Drying	-	-	-

After pre-treatment, the sheet shall be painted with a coat of zinc chromate red oxide primer on both faces.

26.05.00 Flooring

The nominal total thickness of floor finish shall be 50 mm including under bed and topping. The flooring shall be laid on already matured concrete base. The under bed for floors shall consist of cement concrete 1:2:4 with stone chips 12.5 mm down graded as coarse aggregates. The under bed shall be provided with appropriate slope towards catch pit for floor drainage.

26.05.01 False Flooring System

Removable type false flooring system shall be provided in computer rooms and control rooms as required. RCC floor slab shall be sunk to a depth 800 mm which shall be height of the false floor system. The flooring shall consist of fire resistant phenol formaldehyde bonded particle board panels 600x600x35mm size, mounted on steel pedestals of adjustable height and supporting steel grid system to provide under floor space. 2 mm thick flexible anti-static pvc topping on top and

pvc strip edging on sides of each panel shall be provided .

26.05.02 PVC Floor Finish

Two mm thick PVC as per IS:3462 laid as per IS:5318 over concrete under bed of 48 mm .

26.05.03 Carborandum Tiles

Polished heavy duty cement concrete tiles (carborandum) of 300x300x22 mm thick manufactured as per IS:1237 using colouring pigment and hard chips like carborandum, quartz etc shall be laid as per IS:1443 over concrete under bed to result in overall thickness of 50 mm.

26.05.04 Terrazzo Tiles

Tiles shall generally be of size 250 x 250 x 20 mm laid over concrete bedding to result in an overall thickness of 50 mm.

26.05.05 Granolithic flooring

- a) Granolithic flooring (cement concrete flooring in 1:1:2) with non metallic floor hardener topping 12 mm thick with a total thickness of 50 mm shall be provided in maintenance and unloading area of Station building, Mill and bunkerbay, Workshop floors, operating floor
- b) Granolithic flooring without floor hardener shall be provided in all MCC and switch gear rooms which are not air-conditioned.
- c) Granolithic flooring shall also be provided in areas which are not provided with any special finish. Areas which are likely to be subjected to oil spillage shall be provided with two coats of oil resistant painting over Granolithic flooring.

of pump house,

26.05.06 Heavy Duty Ceramic Tiles

Heavy duty anti skid ceramic tiles with matt finish shall be used in toilets, pantry, dining hall of canteen, locker rooms etc. The tiles shall be 300 x 300 x 7 mm of approved shade brand and colour. Dado in toilets and pantry ,locker rooms etc shall also be of similar finish.

26.05.07 Acid / Alkali resisting Tiles

Battery rooms, and other areas coming into contact with acid / alkali vapors or fumes shall be given acid / alkali resistant tiles 25 mm thick, jointed with acid / alkali resistant cement slurry. Bedding shall

comprise of potassium silicate mortar conforming to IS:4832 (Part-I) and resin based mortar like epoxy for jointing. Total thickness of flooring shall be 50 mm. Ceramic unglazed vitreous tiles conforming to IS:4457 with minimum thickness of 20 mm may also be used as acid / alkali resistant tile. The above specification do not apply to D.M. Plant.

26.05.08 Integral floor finish

For cable vaults room, floors of wagon tripler shed, reclaim hopper shed, crusher house, junction towers, pent house shall be provided with floor finish integral to the concrete base shall be provided as per IS:2571.

26.05.09 Cast-in-situ Terrazzo

Cast in situ terrazzo flooring shall be laid as per IS:2114, using white cement or cement with colouring pigment. Chequered finish shall be provided for treads. Total thickness of the finish shall be 25 mm.

26.05.10 Acid / Alkali resistant Tiling / Brick lining in D.M Plant

- a) Bitumen primer followed by 12 mm thick bitumastic layer, 6 mm thick potassium silicate mortar bedding and 38 mm thick alkali / acid resistant bricks as per IS:4860 shall be provided for CPU regeneration area, Chemical house floor, effluent drains, floors around equipment & chemical handling vessels, chemical storage area for the floor, curbs and sumps, all as per the acid / alkali proofing specialist Contractor's requirement.
- b) For floor of neutralizing pit the finish shall be as follows.
 Bitumen primer followed by 18 mm thick bitumastic layer, 6 mm thick potassium silicate mortar bedding and 75 mm thick acid / alkali resistant brick as per IS:4860.
- c) For walls of neutralizing pit, the same specification as 1.10.2 shall apply except that thickness of the brickwork shall be 115 mm with suitable pilasters at 2000 mm c/c.
- d) Special instruction to be followed for acid resistant lining in neutralizing pit shall be as follows.
 - i) The structures shall be tested for water tightness.
 - ii) Surface on which lining is to be applied shall be prepared as per IS:2395.
 - iii) Joints between acid resistant bricks / tiles shall be filled with resin type mortar conforming to IS:4832 (Part II). Seal coat of ready made epoxy paint shall

be provided at the joints to cover up any porosity.

- iv) Acid resistant bricks shall be laid with 6 mm wide and 20 mm deep pointing. Pointing shall be with epoxy / furane / CNSL as per the requirement of the agency guaranteeing the performance of lining.
- v) Under side of all precast slabs / steel covers over effluent drains shall be given two coats of epoxy coating, 150 microns thick.
- vi) Acid / alkali resistant treatment shall extend at least 1 meter on all sides from the outermost periphery of pedestals / saddles for indoor installations and 2 meters all round for outdoor installations.

26.05.11 Glazed vitrified tiles

Polished vitrified tiles shall be of 600 mm x 600 mm x 7.5 mm in size and shall be approved shade, brand and colour and shall be laid with CM 1:3. These are proposed in the following areas:

Operating floor, Control room area including control room, computer room, control equipment room, SWAS Room and Conference room, senior executive room – The floor shall be vitrified tiles of size 2 feet X 2 feet

26.05.12 Miscellaneous

- a) PVC nosing / Aluminum angle nosing with minimum size (150 x 25 x 3) shall be provided for edge protection of R.C.C. stair treads.
- b) Angles 50x50x6 mm(min) with lugs shall be provided for edge protection of cutouts / openings in floor slabs, edge of drains covering gratings, edge of R.C.C cable / pipe trenches and at any other place where breakage of edges / corners is expected.
- c) Floors of switchgear rooms shall have embedded steel channel suitable for easy movement of breaker panel.

26.06.00 Skirting / Dado

- a) 150 mm skirting matching with floor finish shall be provided in all areas unless specified otherwise elsewhere.
- b) Toilets & locker rooms shall be provided with dado of 2100 mm high.
- c) For main Control room and control equipment room minimum 5 mm thick decorative coloured ceramic tiles shall be provided upto false ceiling level.

- d) For battery room and other areas coming in contact with acid / alkali spillage/ fume, dado of acid / alkali resistant tiling as per IS:4457 shall be provided to a height of 2100 mm set in potassium silicate mortar and joints pointed with resin bonded mortar.
- e) Staircase wall shall be given dado of cast in situ terrazzo to a height of 2100mm. If Entrance lobby and lift area in Service building and Admin building shall be provided with granite tile dado to a height upto false ceiling level.

26.07.00 Doors, Windows, Ventilators, Louvers Etc.

26.07.01 Unless specified all doors, windows and ventilators of air conditioned areas, entrance lobby of all buildings and windows/ventilators provided on the outer face of all buildings shall have, electro colour coated (anodized) aluminum framework with glazing. All doors of office areas shall be of factory made pre-laminated particle board (MDF exterior grade). All other doors (unless otherwise specified) shall be of steel.

Main entrance of the control room and control equipment room shall be provided with air-locked lobby with provision of double doors / glazed panels of aluminum frame work with toughened safety double glass glazing conforming to IS 2553 hermitically sealed and separated by 12 mm thick cup for thermal insulation. Doors shall be of double swing type or sliding type.

For common control building, double glazed wall panels with aluminum frame shall be provided between air-conditioned and non air- conditioned areas and on the side of control room and control equipment room facing the operating floor to have a clear view.

Single glazed panels with aluminum frame work shall be provided as partition between two air-conditioned areas wherever clear view is necessary.

Coal conveyor galleries shall have steel windows/ventilators shall be as per IS 1038

All steel doors shall consist of double plate flush door shutters. The door shutter shall be 45 mm thick with two outer sheets of 18 G rigidly connected with continuous vertical 20 G stiffeners at the rate of 150 mm centre to centre. Side, top and bottom edges of shutters shall be reinforced by continuous pressed steel channel with minimum 18 G. The door shall be sound deadened by filling the inside void with mineral wool. Doors shall be complete with all hardware and fixtures like door closer, tower bolts, handles, stoppers, aldrops, etc.

Steel windows and ventilators for coal conveyor gallery shall be as per IS:1361 and for all other areas as per IS:1038. Windows of coal galleries shall be provided with wire mesh.

Wherever functionally required rolling shutters with suitable operating arrangement Manual / Electric shall be provided to facilitate smooth operations. Rolling shutters shall conform to IS:6248.

All windows and ventilators on ground floor of all buildings located in isolated areas shall be provided with suitable anodized aluminum grill.

Fire proof doors with panic devices shall be provided at all fire exit points as per the recommendations of Tariff Advisory Committee (TAC). These doors shall generally be as per IS:3614 (Part I and Part II). Fire rating of the doors shall be as per TAC requirements. However minimum rating shall be 2 hours. These doors shall be double cover plated type with mineral wool insulation.

Hollow extruded section of minimum 3mm wall thickness as manufactured by INDAL or equivalent shall be used for all aluminum doors, windows and ventilators.

All door sizes shall be decided carefully, keeping in view the size of the machinery/panels to be erected inside the building. In any case opening height shall not be less than maximum height of machinery/panel installed inside the building.

IS Codes

Following are some of the important IS codes (latest edition) applicable to this section:

IS:204 (Part-II)	: Tower bolts non ferrous metals
IS:208	: Door handles
IS:2002 (Part-I)	: Flywood face panels
IS:1341	: Steel butt hinges
IS:1868	: Anodic coatings on aluminum and its alloys
IS:3564	: Door closers (hydraulically
regulated) IS:5187	: Flush bolts
IS:6315	: Floor springs (hydraulically regulated) for heavy doors

IS:7195	: Hold fast
IS:7452	: Hot rolled steel sections for doors, windows and ventilators
IS:10019	: Mild steel stays and fasteners
IS:1038	: Steel doors, windows and ventilators
IS:1361	: Steel windows for industrial ventilators
IS:1948	: Aluminum doors, windows and ventilators
IS:1949	: Aluminum windows for industrial buildings
IS:4351	: Steel door frames
IS:3614 (Part-I)	: Fire check doors
IS:10451	: Steel sliding shutters (top hung type)
IS:4021	: Timber door, window and ventilator frames
IS:1003 (Part-I)	: Timber paneled and glazed shutters– door shutters.

26.07.02**Wall paneling**

All the exposed structural steel i.e. wall, columns, bracings in STG control room and air-conditioning areas shall be provided with wooden wall paneling. The wall panel shall consist of teak wood batten grid of size 600x600 mm or as per site requirement. The size of batten shall be 2 inch x 1 inch. BWP grade plywood conforming to IS:710 shall be fixed on this grid. The Vanner of approved quality and shade shall be fixed on the plywood as exterior finish with suitable adhesive. The entire work shall be carried out to the satisfaction of engineer.

26.08.00**Glass and Glazing**

All ventilators and windows on external face of turbine building, conveyor gallery, pump house, compressor house, DG set building, transfer points, workshop building, fire escape staircase and those buildings located in fire prone areas shall be provided with wired glass of minimum 6 mm thickness conforming IS:5437.

Glazing in control room between AC and Non AC areas shall be double glazing consisting of two 6 mm thick clear toughened safety glass conforming to IS:2553, hermetically sealed and separated by 12 mm thick gap for thermal insulation.

For single glazed aluminum partitions and doors, Float glass or flat transparent sheet glass of minimum 6 mm thickness shall be used.

Ground glass / frosted glass of minimum 4 mm thickness shall be used for all windows / ventilators in toilets.

Unless specified otherwise in this specification minimum thickness of plain sheet glass used for windows/ventilators shall be 4 mm.

Float glass or flat transparent sheet glass shall conform to IS:2835. All

glazing work shall conform to IS:1083 and IS:3548

26.09.00 False Ceiling and Under Deck Insulation

All air conditioned areas shall be provided with the suspended false ceiling system. Under deck insulation system shall be provided on the under side of the roof / floor slab of the air conditioned areas based on the functional requirement. Ceiling of air washer room shall also be provided with under deck insulation.

Aluminum false ceiling system shall comprise of 84 mm wide 12.5 mm 6 deep closed type plain panels of approved colour, roll formed out of 0.5 mm thick corrosion resistant aluminum alloy AA 5050 fixed on roll formed carriers. Additional hangers and height adjustment clips shall be provided for return air grills, supply air diffusers, light fixtures, AC ducts etc.

Gypsum board false ceiling system shall consist of 600x600x12 mm board with one coat of primer and two or more coats of acrylic emulsion paint. The suspension system shall consist of 6 mm dia galvanized steel rods suspended from ceiling supporting aluminum grid of 38x25x1.5 mm and cross tie of 25x25x1.5 mm and aluminum angle of 25x25x1.5 mm.

Suitable M.S channel (minimum ISMC100) grid shall be provided above false ceiling for movement of personnel to facilitate maintenance of lighting fixtures, AC ducts etc.

CONTRACTOR shall prepare a layout of the false ceiling system incorporating light fixtures, supply air diffuser, return air grills, fire protection sprinklers etc. such that the ceiling looks aesthetically pleasing. Work shall commence only after the OWNER approves the layout.

Under deck insulation shall comprise of 50 thick PUF material of density 36 kg/cubic meter . This mat shall be backed with 0.05 mm thick aluminum foil and 24 Gx25 mm wire mesh netting. They shall be fixed to ceiling or wall as the case may be with 100x50x6 slotted mild steel plate welded to M.S. plate inserts embedded at the soffit of the slab at 600 mm c/c and 14 G steel wire drawn through slots and fixed to wire netting.

26.10.00 **Painting**

Details furnished here in below are the minimum acceptable standard for painting. Superior finish if any required by CONTRACTOR to Enhance overall appearance will be permitted if such finish meet with the technical requirements.

Water proof cement based paint as per IS:5410 shall be provided on external faces of walls, sunshades etc.

Inside surfaces shall be provided with Acrylic washable distemper for all areas as per IS:428 except for Control room, Control equipment rooms, all air conditioned areas for which Acrylic emulsion paint shall be provided as per IS:5411.

Inside surfaces shall be provided with Acrylic distemper as per IS:428 for plant buildings like Workshop, Permanent stores, D.G. house, Compressor house, pump houses, Ash handling pump house etc.

Walls in D.M.Plant shall be provided with chlorinated rubber based paint as per IS : 9862 over walls. Walls above Dado in battery rooms shall also be provided with similar painting.

All plastered ceilings shall be provided with acrylic washable white distemper as per IS:42.

Oil resistant paint as per IS:161 shall be provided for oil canal and oil equipment room.

All wood work shall be provided with fire resistant transparent paint as per IS : 162 over french polish as per IS:348 or flat oil paint as per IS : 137.

Painting for structural steel have been specified else where in this document.

Following general instruction for painting shall be followed.

- i) For painting on concrete, masonry and plastered surfaces IS:2395 parts I and II shall be followed.
- ii) For painting on wood work IS:2338 part I & II shall be followed.
- iii) All paints shall be of brand and make to the approval of OWNER.
- iv) A minimum of two finishing coats of paint over a primer shall be provided to give a smooth uniform finish for the painted surface.
- v) All painting on masonry or concrete surfaces shall preferably be applied by rollers.

- vi) Thinner shall not be used with textured paint (sandtex matt etc) finish.
- vii) All fire exits shall be painted in Post office red colour shade which shall not be used anywhere except to indicate emergency or safety measure.

26.11.00

Sanitary Facilities

Toilet and shower facilities shall be provided for personnel in finished areas of all major buildings and in other areas as determined by project requirements.

Janitor closets and cleaning material storage areas shall be provided in finished areas of all major buildings.

Minimum one toilet block with all the facilities shall be provided on each floor of main plant building and service building. Separate toilets for ladies shall be provided wherever required. Attached toilets shall be provided for all senior executive rooms and conference rooms. One toilet shall be provided in the boiler area. All other buildings where toilet is specified shall have one toilet block each. The facilities provided in the toilet block shall depend on the number of users. However, minimum facilities to be provided shall be as stipulated below. IS: 1172 shall be followed for working out the basic requirements for Water supply, drainage and sanitation. In addition, IS: 2064 and IS: 2065 shall also be followed.

Each toilet block shall have the following minimum facilities. Unless specified all the fittings shall be of chromium plated brass (fancy type).

- i) WC (Indian type) Orissa pattern (580x440 mm) as per IS: 2556 (Part-3) and 1 no. bibcock with all fittings including flushing arrangement of appropriate capacity and type-1 no.
- ii) WC (western type) 390 mm high as per IS: 2556 (part 2) with toilet paper roll holder and bibcock and all fittings including, flushing system of appropriate capacity and type-1 no.
- iii) Urinal with all fittings with photo voltaic control flushing system as per IS: 2556 (Part-6, Sec. 1) – 2 nos. (Minimum).
- iv) Wash basin (oval shape) with all fittings as per IS: 2556 to be fixed on concrete platform finished with 12 mm thick polished granite stone – 2 nos.
- v) 1200x900x5.5 size Bathroom float glass mirror with beveled edges including all fittings.
- vi) Stainless steel towel rail (600x20 mm) – 2 nos.
- vii) Stainless steel liquid soap holder cum dispenser – 2 nos.
- viii) Provision for installation of water cooler.
- ix) Provision of ventilation shaft.
- x) Attached toilets provided for senior executive rooms and conference rooms shall have 1 WC, 1 Urinal, 1 washbasin, 1 mirror, 1 no. towel rail, 1 liquid soap holder cum dispenser.

WC shall be of western type 390 mm high as per IS: 2556 (Part-2) with toilet paper roll holder and all fittings including flushing valve of appropriate capacity and type. All toilets shall have at least 1 no. of exhaust fan. Final no. of exhaust fans shall be decided as per ventilation requirements to maintain hygienic conditions in the toilet.

- xi) Unless specified all fittings and fixtures in the toilets shall follow technical specification.
- xii) In main Turbine generator building, Service building and Administrative building at least one toilet block shall be provided for ladies.
- xiii) Other buildings which are not specifically mentioned if found necessary shall be provided with adequate toilet facilities in accordance with NBC (National Building Code (latest)). Final requirement shall be as indicated by the owner.

All sanitary fittings and plumbing fixtures shall be of the best quality and make, and shall be subject to Owner's approval. All water supply fittings in toilets, kitchen etc viz., Bib cocks, pillar cocks, P-traps, towel rail, shower rose, gratings etc., shall be of best quality chromium plated brass of approved make.

Supreme B class stoneware pipes or equivalent shall be used for sanitary works above ground level.

26.12.00

Chemical Resistant Treatment Battery Room

- a) Battery room floors and other surfaces as required shall be provided with acid/alkali resistant tiles and treated suitably as detailed below by supplying & furnishing of all labour, materials & equipment in accordance with the following latest codes:
 - 1. IS:3384 : Specification for bitumen primer for use in water proofing & damp proofing
 - 2. IS:4443 : Code of practice for use of resin type chemical resistant mortars
 - 3. IS:4457 : Specification for ceramic unglazed vitreous acid resistant tiles.
 - 4. IS:4832 : Specification for chemical resistant mortars (Part I to III).
 - 5. IS:4971 : Recommendation for selection of Industrial floor finishes.
- b) The surfaces to be treated against acid shall be levelled smooth, dry & clean. The entire surface shall be tapped by wooden hammer to determine hollows if any. In case hollows are found, they shall be suitably sealed with concrete or other approved materials.
- c) The unsatisfactory surfaces shall be replaced by new concrete or other suitable material after ensuring proper bond between the new and old surface. Surface to be prepared shall be wetted for 24 hours; use of epoxy resins for bonding fresh concrete during repairs shall be permitted with Engineer's subject to its execution as per Manufacturer's instructions. All patched areas shall be properly cured by sprinkling water for a period of not less than 10 days.

26.13.00**Acid/Alkali Resistant Tiles on Floors & Walls**

- a.) The surface after preparation shall be applied with a coat of bitumen primer conforming to IS:3384 (latest). The primed surface shall be subsequently applied with a uniform coat of bitumen conforming to IS:1580.
- b.) For bedding of tiles, potassium silicate based cement mortar [15 mm thick] as per IS:4832 shall be used spreading on the back & two adjacent sides of the tile. The tile shall be pressed on the floor or wall & push against floor or wall until the joint in each case of 6 mm thick & 6 mm width is maintained with spacers. Before the bedding mortar sets completely, the jointing material shall be removed to a depth of 20 mm. After the bedding mortar is properly set, the joints shall be cured with resin type mortar filling up the entire length of the joint. The excess mortar shall be trimmed off to make the joints smooth & place. Seal coat shall then be applied over the epoxy mortar to cover up porosity that may be left in mortar. Acid resistant tiles shall be provided for a height of at least upto lintel level on all the walls of battery room. The rest of the battery room walls & ceiling shall be provided with 2 coats chlorinated rubber paint. The tiles used for flooring & walls shall be 20 mm thick conforming to IS 4457. Tiles of approved quality and shade shall be used.

Acid curing shall be carried out as per manufacturer's directions using the safety precautions normally used when handling acids. The mortar joints shall be cured with 20 to 25 percent hydrochloric acid or with 30 to 40 percent sulphuric acid no sooner than 2 days and not later than 6 days after the masonry units are bonded with the mortar. The curing time shall be at least 60 minutes.

Performance guarantee: The contractor shall be responsible for the safety, suitability & efficient functioning of all the acid resistant treatment. He should guarantee for efficient performance of the treatment for a period of five years time from the date of the completion. During the guarantee period, if at any stage, it is found that any of such treatments has given way or has not been functioning satisfactorily, the same shall be made good by the contractor at his own cost.

27.00.00 WATER SUPPLY, DRAINAGE AND SANITATION

27.01.00 The technical details of permanent water supply, storm water drainage, sewerage disposal system and sanitary appliances required for proper supply drainage, disposal and completion of buildings are detailed below:

27.02.00 Sewerage Pipes

a) Glazed Stoneware Pipes

Glazed stoneware pipes of diameter not exceeding 150 mm can be used in localized areas not subjected to any traffic loads. The glazed stoneware pipes with spigot and socket ends shall conform to IS: 651 Grade “A” or “AA” as specified. These shall be sound, free from visible defects such as fine cracks or hair cracks. The glaze of the pipe shall be free from erasing. The pipes shall give a sharp clear note when struck with a light hammer. There shall be no broken blisters. The pipes shall be handled with sufficient care to avoid damage to them.

b) HDPE soil, waste, vent pipes and fittings

- i) HDPE soil, waste, vent pipes and fittings shall be of “Approved make” conforming to I.S. 4984-1995. The outer and inner surfaces of the pipes and fittings shall be smooth and clean and shall in all respects be free from cracks, pin holes, laps or other imperfections, which may impair the strength and durability of the pipes and fittings. The ends of the pipes shall be reasonably square to their axes.
- ii) The clamps for fixing the pipes to the external wall shall be of approved design and shall fit closely round the pipe or accessory directly beneath the socket.
- iii) The HDPE. soil, waste and vent pipes shall normally be fixed externally to the wall or in suitably designed shafts as per alignment shown on the drawings or as directed by the Engineer. The pipes shall be fixed and kept in position by means of brackets or holder clamps which shall be securely embedded in the wall. For vertical runs, each pipe shall hang freely on its own brackets fixed just below the socket. For horizontal runs, an additional clamp shall be provided at the centre. The brackets or clamps should be of such a design so as to maintain a minimum distance of 50 mm between the surface of the pipe and the wall.

- iv) The soil, waste or vent pipes shall be carried up, above the roof by a least 1.5 m and shall have a cowl of suitable design at the upper end.

c) RCC Pipes

- i) RCC pipes shall be used below ground level for sewage disposal. Pipes connecting toilet facilities to manholes shall be minimum 100 mm diameter NB. Pipes connecting various manholes shall be minimum 150 mm diameter NB. RCC Hume pipes shall be supplied and laid as required as per latest editions of the following IS codes:

IS : 458 : Concrete pipes (with and without reinforcement)

IS : 783 : Code or practice for laying of concrete pipes

IS : 4111(Part-1) : Code of practice for ancillary structure in sewerage system

- ii) The contractor shall supply the RCC hume pipes [to class NP3/NP2 of IS:458 as required] of various diameters along with fittings required for carrying out the work. The contractor should furnish manufacturer's test certificates from recognized authorities. PCC encasement shall also be provided whenever required as per design requirement.

iii) Alignment, Levels and Grade

The work shall be carried out in conformance to the alignments, levels and grades specified. The layout and levels shall be made by the contractor from one reference grid and bench mark given by the Engineer with the assistance of instruments, materials and men for checking the detailed layout and levels as and when required. Making of reference layout and level pillars along the pipeline route and maintaining them upto completion of the work shall be the Contractor's responsibility.

iv) Laying of Pipes

The laying of RCC pipes shall conform to IS:783. To suit the site conditions, the pipes should be laid as per drawings and instructions of the Engineer. Under the culvert condition, the pipe shall be laid under embankment and may project wholly or partly above the original ground surface.

Under trench condition, the pipe shall be laid in the excavated trench which shall be refilled with thoroughly tamped earth after laying and jointing of pipes in an approved manner. Adequate sand fill

cushioning shall be provided below pipes. Minimum depth of cushion shall be 600 mm.

Under open condition, the pipe shall be laid such that it projects wholly or partly above original ground surface, there being no superimposed burden on the pipe.

v) Bedding and Supports

Under culvert condition, the pipes shall be laid generally on “First Class bedding” as per IS:783. Under trench condition, the pipes shall be laid generally on “First Class Bedding” as per IS:783. If shown on the drawing or so instructed by the Engineer, the pipes shall be laid on concrete cradles, conforming to IS:783. Minimum crushing strength shall be 140 Kg/sqm. Under open condition, the pipes shall be supported over rigid C.C. pedestals constructed at intervals not greater than the length of one individual piece of pipe, as per drawings and instructions of the Engineer. In no case shall the joint between two pieces of pipe shall lie at center of the span between the supports. The pedestal shall be of plain/reinforced concrete with a properly shaped out top to receive the pipe. Manholes shall be provided as per latest IS:4111 (Part-I) for pipe drains at the change of diameter of pipe, alignment and direction at a max. spacing of 30 m c/c upto 900 mm diameter and 45 m c/c for higher diameters of the pipe. Each manhole shall be provided with a heavy duty C.I. cover as per IS:1726.

d) Jointing

i) Glazed Stoneware Pipes

The cement mortar for jointing shall be 1:3 (1 cement: 3 fine sand) with spun yarn in neat cement. Tarred gasket or hemp/ spun yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be placed well into the socket of the pipe previously laid. Then pipe shall be adjusted and fixed in the correct position and gasket/ spun yarn caulked tightly so as to fill not more than $\frac{1}{4}$ th of the total depth of the socket.

The remainder of the socket shall be filled with stiff mixture of cement mortar in the proportion of 1:1 (1 cement: 1 fine sand). When the socket is filled, a fillet shall be formed round the joint with a trowel forming an angle of 45 Degree with the barrel of the pipe. After a day's work any extraneous material shall be removed from the inside of the pipe. The newly made joints shall be cured.

ii) Jointing of RCC pipes

IS : 783 provisions shall be followed for jointing of pipes; and every possible care shall be taken to ensure that the joints made are leak proof. Curing of joints shall be done for a period of 10 days.

e) Testing of Joints

i) Stone Ware Pipes

Stone ware pipes used for sewers shall be subjected to test pressure of 1.5M head of water at the highest point of the section under test. The test shall be carried out by suitably plugging the low end of the drain and the ends of the connection if any and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head. Or this may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.

ii) RCC pipes

All RCC pipe joints shall be checked for water tightness as per relevant IS code.

27.03.00

Internal Work

a) All water supply pipes for internal plumbing of buildings shall be of GI pipe of medium class conforming to IS : 1239 of approved make. Galvanizing of pipes shall conform to IS : 4736.

b) The pipes and sockets shall be cleanly finished, well galvanized in and out and free from cracks, surface flaws, laminations and other defects; all screw threads shall be clean and well cut. The ends shall be cut cleanly, and square with the axis of the tube. The thickness and weight of pipes and sockets shall be in accordance with IS : 1239.

All screwed tubes and sockets shall have pipe threads conforming to latest IS:554. Screwed tubes shall have taper threads while the sockets shall have parallel threads.

c) The pipe fittings shall be of malleable cast iron or mild steel tubes complying with all the appropriate requirements of clause No.3 or as specified. The fittings shall be designated by the respective nominal bores of the pipes for which they are intended. The fittings shall have screw threads at the ends conforming to IS: 554 (latest edition).

Female threads on fittings shall be parallel and male threads (except on running sipples and collars of unions) shall be taper.

d) Cutting, Laying and Jointing

Where the pipes have to be cut or rethreaded, the ends shall be carefully filled out so that no obstruction to bore is offered. The ends of the pipes shall then be threaded conforming to IS: 554 (latest edition) with pipe dies and tapes carefully in such a manner as well not result in slackness of joints when the two pieces are screwed together. The tapes and dies shall be used only for straightening screw threads which have become bent or damaged and shall not be used for turning of the threads so as to make them slack, as the later procedure may not result in a water tight joints. The screw threads of pipes and fittings shall be protected from the damage until they are fitted.

The pipes shall be cleaned and cleared of all foreign matter before being laid. In joining the pipes, the inside of the sockets and the screwed end of the pipes shall be oiled and rubbed over with white lead; and a few turns of spun yarn wrapped round the screwed end of the pipe. The end shall then be screwed in the sockets, tee etc. with the pipe wrench. Care should be taken that all the pipes and fittings are properly jointed so as to make the joints completely water-tight; and pipes are kept at all times free from dust and dirt during fixing. Bore from the joint shall be removed after screwing. After laying, the open ends of the pipes shall be temporarily plugged to prevent access of water, soil or any other foreign matter.

Any threads exposed after joining shall be painted or in case of underground piping thickly coated with approved anticorrosive paint to prevent corrosion.

e) Fitting

- (i) For internal work, the galvanized pipes fittings shall be done by means of standard pattern holder bat clamps, keeping the pipes about 1.5 cm. clear of the wall. When it is found necessary to conceal the pipes chasing may be adopted or pipes fixed in the ducts or recesses etc. provided there is sufficient space to work on the pipes with the usual tools. The pipes shall not be buried in walls or solid floors, where unavoidable pipes may be buried for short distances provided adequate protection is given against damage and where so required joints are not buried. Where directed by the Engineer, a steel tube sleeve shall be fixed at a place a pipe is passing through a wall or floor for reception of the pipe and to allow freedom for expansion and contraction and other movements. In case the pipe is embedded in wall or floors, it

should be painted with anticorrosive bitumastic paint of approved quality. The pipe should not come in contact with lime mortar or lime concrete as the pipe is affected by lime. Under the floors the pipes shall be laid in layer of sand filling done under concrete floors.

- ii) All pipes and fittings shall be fixed truly vertical and horizontal unless unavoidable. The pipes shall be fixed to walls with standard pattern holder bat clamps of required shape and size so as to fit tightly on the pipes when tightened with screw bolts. The clamps shall be embedded in brick work in cement mortar 1:3 (1 cement : 3 coarse sand) and shall be spaced at regular intervals in straight lengths as indicated below :-

Size of pipe (mm)	LENGTHS	
	Horizontal runs (m)	Vertical runs (m)
15	2	2.5
20	2.5	3
25	2.5	3
32	2.5	3
40	3	3.5
50	3.5	3.5
65	3.5	5
80	3.5	5

The clamps shall be fixed at shorter lengths near the fittings as directed by the Engineer.

- iii) For G.I. Pipes 15mm to 25 mm dia, the holes in the walls and floors shall be made by drilling with chisel or jumper and not by dismantling the brick work or concrete. However, for bigger dimension pipes, the holes shall be carefully made of the smallest size as directed by the Engineer. After fixing the pipes, the holes shall be made good with cement mortar 1:3 (1 cement and 3 coarse sand) and properly finished to match the adjacent surface.

27.04.00

Trenches and Other Excavations

Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to endanger the stability of the excavation. Spoil may be carted away and used for filling the trench behind the work.

Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement.

All excavation shall be properly timbered, where necessary.

Efficient arrangements for dewatering during excavation and keeping it dry till backfilling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

Where the excavation proceeds through roads necessary permissions shall be secured by the Contractors from the appropriate authorities.

Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe during handpacking with selected material. At least 300 mm over the pipe shall also be filled with soft earth or sand. Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All future settlements shall be made good regularly to minimise inconvenience of traffic where applicable.

27.05.00

Sanitary Appliances

a) Water Closet

- (i) **Water closet Pan** : The water closet shall be of Orissa pan/European type of approved make, Vitreous China conforming to IS: 2556 Part- III. The closet shall be of size as specified. The flushing rim shall be integral with the pan and shall be Self draining type. The closet shall be provided with a self cleaning trap of the same material as the pan. The trap shall be either a “P” or “S” outlet and with a vent hole. The effective depth of the water Seal shall not be less than 50 mm.

- (ii) The pan shall be fixed in position as shown on the drawing. It shall be embedded on a suitably prepared surface rendered smooth with neat cement or cement plaster so that uniform support is provided to the pan. The pan shall normally be at the floor level unless otherwise specified. The WC pan shall be fixed to the trap by means of a cement mortar joint as in the case of SW pipes; and the entire job carried out so that the effective seal is always kept maintained the vent of the trap being connected to Anti siphonage pipe.
- (iii) While laying flooring, a section about 1 x 1.5 m or less of the part of the floor where WC is to be fixed shall be left out. This shall be finished only after the pan has been fixed and laid in position. The pan shall be kept suitably protected against all damages. It shall include both pan and trap, as well as fixing materials as needed.

b) Flushing Cisterns for Water Closets

The flushing cistern for water closet shall be PVC low level type of 10 Ltr. capacity (IS 2556 mark) with PVC bend of approved make. The cistern shall be secured on wall or supported on steel brackets which shall be well embedded in the wall. The height of the bottom of the cistern from the top of the pan shall be 30 cm for low level cistern. The cistern shall be provided with brass balcock with ball to IS:1703. It shall include brackets, screw, flush pipes, brass ball cock with ball as needed.

- c) The Urinal shall be of first quality, WVC flat back (Large) or half shall type IS 2556 of size as specified of approved make. The urinal shall be fixed in position by means of four plugs embedded in wall and screws, the top of urinal lip being 65 cm from the floor level. Urinal bring a soil fitment should be connected to soil pipe. Each urinal shall be provided with 25 mm dia B Class GI Waste pipe connected to the pan by suitable joint and shall discharge in to a drain connected to a soil pipe through a trap. The flushing of urinal shall be with all fittings including voltaic control flushing system as per IS:2556 (Part-6 Section-1).
- d) The wash basin (oval shape) with all fittings as per IS:2556 made of vitreous China clay to be fixed on a concrete plat form finished with 12 mm thick polished granite stone. The basin shall be provided with single tap connection. The washbasin shall have an integral soap holder recess or recesses which shall drain into the bowl.

Each Wash Basin shall be provided with :

- i) 32 mm ø CP brass waste fitting with CP brass chain and 32 mm dia plug.
- ii) 25 mm ø galvanized waste pipe “B” class discharging into a drain suitably connected to waste fitting by means of brass check nuts.
- iii) 15 mm ø CP pillar taps of superior quality to IS-8994 of approved make.

The basin shall be connected to the waste pipe discharge in to drain, by means of the waste fittings and check nuts, the join being completely leak proof. The tap shall be connected to the water supply system by means of a lead connection. A stop cock shall be provided to regulate supply to the wash basin. It shall include fixing material complete with brackets, waste coupling, waste pipe, NP pillar tap, CC chamber and grating.

- e) Wall to wall bath room mirror (5.5MM thick) float glass with beveled edges including all fittings shall be provided.
- f) All toilets shall have at least one No. of exhaust fan. The No. of exhaust fan shall be decided as per ventilation requirements to maintain the high hygienic conditions in the toilet.

28.00.00**SWITCHYARD CIVIL WORKS****28.01.00**

The structural and civil works associated with erection and commissioning of station switchyard shall be executed as detailed below. The scope covers design, engineering, fabrication, galvanizing, supply and erection of:

- a) Lighting mast, towers, beams, equipment lattice support, equipment pipe support inclusive of all fixtures such as nuts, bolts, hangers, shackles, clamps, anti-climbing devices, bird guards, step bolts/ladders, number plates, danger and phase plates, inserts in concrete, foundation bolts, base plates, stiffeners, dampers, fixtures for supporting and operating mechanism boxes, control cubicles etc.
- b) Framed RCC switch yard building with brick cladding shall be provided to accommodate various equipments including GIS as per electrical drawing. Roof shall be of RCC. Size of building shall meet electrical requirements.
- c) Cable tray supports, cable trays, embedments in cable trenches, bolts and nuts and any other accessories etc.
- d) R.C.C. cable trench and pipe trenches with necessary precast R.C.C. covers with lifting facilities, sump pit, cable trays, supports etc. [wherever trenches cross road, the section below such crossings shall be designed as per Indian Road Congress Drainage of these trenches shall be suitably designed]. All precast slabs for trenches shall be provided with MS edge protection angle on all sides (min. size of angle 50x50x6 mm). The RCC trench edges shall be provided with MS angle protection (min. size of angle 50x50x6 mm)
- e) Drainage and lighting of the area [cable trench should not be used for drainage purpose]. An approved system for draining the transformer and oil collection, and disposal system shall be provided.
- f) For prevention of vegetation, the graded ground shall be covered with fly ash brick pavement over 300 mm ash filling is to be provided in the switchyard area. Each fly ash layer shall be compacted/ consolidated by using ½ ton roller with 4 to 5 passes and suitable water sprinkling. The method of application of chemicals used for soil sterilization/anti-weed treatment shall be as per manufacturer's recommendations. Also, the RCC pathway shall be provided in switchyard as per the requirement.

- g) Transformer foundations; RCC roads within switchyard, fire protection walls and chain link fencing for switchyard. RCC paving shall be provided in Transformer yard.

28.02.00

General Requirements

28.02.01

Steel shall conform to IS:226/IS2062. Where plate cut pieces are used to form a part of either flange plates or web plates of fabricated columns with butt joints, length of such pieces shall not be less than 3 (three) meters. When cut pieces out of rolled sections are to be joined by butt welding, the length of such pieces shall not be less than 3 (three) meters and the total number of pieces of any member shall not exceed three. The steel structures for the switchyard shall be double dip galvanized with zinc coating not less than 0.91 kg/m².

All foundations for the switchyard structures (except transformer) shall be designed as per relevant IS:4091 "Code of practice for design and construction of foundations for transmission line towers and poles" and IS-456 (latest) "Code of practice for plain and reinforced concrete". All the foundations shall be protected by as per clause 6.11 of this specification.

28.02.02

Transformer/shunt reactor foundations

The transformer/shunt reactor foundations shall be designed as per relevant IS Code. This shall include collection of oil, drainage of oil along with rain water collected in such foundation; as well as necessary cable connection works.

28.02.03

- a) The steel girders shall be designed for static tension dead load of conductors, insulators, and accessories, erection load, short circuit forces, wind/seismic loads and secondary stresses. The girders shall be connected with lattice columns by bolted joints.
- b) The fabrication and erection of the works shall be carried out generally as per IS:802 Part-II, IS:800. All materials shall be completely shop fabricated. Towers, beams etc. shall be trial assembled at shop keeping in view the actual site condition for convenient pre-assembly during erection. Necessary match marks shall be made on these components before dismantling in the shop.

28.02.04

Bolting

Every bolt shall be provided with a steel washer under the nut so that no part of the threaded portion of the bolt is within the thickness of the parts bolted together. Notwithstanding anything to the contrary contained in IS:1363, IS:1364 and IS:1367 the unthreaded length of

the bolt shank shall be equal to total thickness of metal being bolted together plus 2 mm. The threaded length shall be equal to at least the diameter of bolt plus 6 mm.

- a) Cable and pipe trenches shall be in R.C.C. with removable R.C.C. covers. (The top of trench shall be kept 150 mm above the grade level). The bed of trenches shall be slope 1 in 200 to drain water into a collection sump suitably. All trenches shall be given a slope of 1 in 500 along run of the trench. Cable trenches crossing the road shall be designed for class “AA” loading as per IRC standard. However, the design shall also be checked for class “A” loading as per IRC standard. All precast slabs for trenches shall be provided with MS edge protection angle on all sides (min. size of angle 50x50x6 mm). The RCC trench edges shall be provided with MS angle protection (min. size of angle 50x50x6 mm) Surcharge load of 2T /sqm. Shall be considered in design of trenches in switchyard area.
- b) The design of foundation and all trenches should take care of sub-soil water pressure as per relevant IS Codes. If the ground water table is above the base level of the trench, PVC water stops (minimum 230 mm wide and 5 mm thick) should be provided at all construction and expansion joints to the approval of the Engineer.

28.02.05 All anchors, anchor bolts, insert pipes, conduits, sleeves, bolts, etc. required to be embedded in concrete shall be placed in position before concreting. These inserts shall be welded to the nearest reinforcement to keep them in position.

28.02.06 a) The fence around switchyard area shall comprise of 12 gauge G.I. chain link fencing of mesh size 75 mm to a height of 2.4 m above the toe wall with a 600 mm high galvanized concertina at the top such that total fence height of 3.0m above toe wall level is achieved. Toe wall shall be minimum 200 mm above the formation level.

- b) The chainlink fencing shall comprise of size 2400x2000 mm size panel made from 75x75mm & 8 gauge GI chainlinks (including PVC coatings) and 50x50x6 mm angle including fixing the chainlink in angle frame by means of 40x3mm. MS flat welded to angle frame drilling to holes in angle frame & flat and fixing the same with angle post in the level and plumb by means of 10 mm dia bolts frames and flat & nuts, 3 coats of epoxy base paint to achieve required 250 DT to angle iron etc. completed.

This chainlink fencing panel shall be fixed with the fence posts of 65x65x6 MS angles spaced as per requirement.

- c) Above the chain link fencing panel 3 horizontal rows of barbed wire of gauge 12/14 with 3 diagonal rows shall be fixed as per drawing.
- d) All fence posts shall be 65 x 65 x 6 MS angles spaced at 2.5 m c/c distance. All straining posts i.e. end posts shall be 65 x 65 x 6 angles. Suitable concrete foundations for the angle iron posts and stays shall be provided based on the prevailing soil conditions. Toe walls either of bricks of minimum 50kg/cm² compressive shall be provided between the fence posts all along the run of the fence with suitable foundation. Toe wall shall be minimum 200 mm above the switchyard formation level with PCC coping (M-20) and minimum 300 mm below the switchyard formation level. All gates shall be of hot dipped galvanized structural steel as specified.
- e) All structural steel work for the fencing shall be painted with chlorinated rubber paint over a suitable primer or epoxy based paint (of total DFT 250 microns) to withstand severe marine/corrosive exposure condition for protection.

29.00.00**GALVANIZING**

- a) Structural steel works and pipe supports wherever required other than that of fencing shall be hot double dip galvanized after fabrication as per relevant IS codes. Galvanising of the towers shall be as per IS:4759 and 2633 and as given in the following paras. Zinc required for galvanizing shall be arranged by the contractor. Purity of zinc to used for galvanizing shall be 99.5% as per IS:209. All burrs and irregular edges shall be ground smooth before galvanizing.
- b) After completion of all shop work, structural material shall be punched with the erection marks and be hot dip galvanized including the portion to be embedded in concrete. Each grillage member including stubs shall also be fully galvanized. Before galvanizing, the steel section shall be thoroughly cleaned of any paint, grease, rust, scale, acid, alkali or such other foreign matters likely to interfere with the galvanizing process or with the quality and durability of the zinc coating. Pickling shall be carefully done and shall be proper.
- c) The weight of the zinc coating shall be at least 0.9 kg/ sq.m including stub members. The galvanized surfaces shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel, globules, spiky deposits, blistered surface, flaking or peeling off etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.
- d) There shall be no flaking or loosening when struck squarely with a chisel faced hammer. The galvanized steel member shall withstand in copper sulphate solution as per IS:2633. When the steel section is removed from the galvanizing kettle, excess spelter shall be removed by 'bumpng'. The process known as 'wiping' or 'scrapping' shall not be used for this purpose.

All bolts, nuts, washers etc. shall be hot dip galvanized. Excess spelter from bolts, nuts etc. shall be removed by centrifugal spinning of bolts and nuts. Threading after galvanizing, shall not be permitted. Nuts, however, may be tapped, but not to cause appreciable racking of the nuts on the bolts. Spring washers shall be electro-galvanised.
- e) Defects in certain members indicating presence of impurities in the galvanizing bath in quantities larger than that permitted by the specification or lack of quality control in any manner in the galvanizing plant shall render the entire production in the relevant shift liable to

rejection. All the towers, pipe supports and accessories shall be treated with sodium dichromate or an approved equivalent solution after galvanizing, so as to prevent white storage stains.

- f)** Similar If the galvanizing of any member is damaged, the galvanizing shall be redone in the manner as stated above to Engineer's approval. The contractor shall also furnish sufficient quantity of appropriate paint, for repairing galvanized surfaces, damaged in transit.

30.00.00**PILING****30.01.00**

The detailed design, preparation of construction drawings, installation and testing of piles forming foundations to buildings and structures are detailed below conforming to the latest IS:2911 – Code of Practice for Design and Construction of Pile Foundations : Part I Concrete Piles and IS:2911 Part : IV Load test on piles and to this Specification. The contractor shall be responsible for all aspects of the pile performance installed including demonstration of the adequacy of his design by testing. During detailed design the contractor shall submit the proposed firm to undertake piling work with details piling system, method of installation, summary of design basis, number, type and size of construction plant items to be employed for the work including crane, piling equipment, concreting equipment and proposal for installation & testing of trial piles and tests on work piles.

30.02.00

Prior to installation of trial piles, the contractor shall submit final details of the trial piling installation including specifications, detailed design calculations and construction drawings for the trial piling together with associated equipment to be provided for construction and testing of the same. Design report discussing the overall results of the tests on trial piles and concluding with and justifying the proposed definition of reference piles; specification, with fully detailed construction drawings, supporting calculations for the final design of the working piles, and the field control procedures the contractor intends to use to verify that pile installation satisfies the requirements of his design should also be submitted.

30.03.00**Design Criteria**

The following shall be the design criteria for the working piles :

- a) Piles shall be designed in line with approved soil investigation report as single vertical piles acting under a design load as deemed fit.
- b) Driving formula (where relevant) may be adopted inter alia as a criteria for acceptance. But the minimum founding requirements shall be based on recognized methods of soil mechanics design, appropriate to the type of pile.
- c) The piles shall be designed for a minimum factor of safety of 2.5 against failure under the design load specified.
- d) Piles shall be designed for a limiting settlement of a single pile under vertical design load of 8 mm at the head.

- e) Piles shall be designed to resist a maximum force due to critical load combination in any direction applied to the head of the pile at cut-off level. For this design condition it shall be assumed that the pile head is effectively as a fixed-end by the pile-cap.

30.04.00

Tolerance

Setting out shall be carried out from the main grid lines of the proposed structure. Immediately before installation of the pile, the pile position shall be marked with suitable identifiable pins or markers. For a pile head cut-off, at or above ground level, the maximum permitted deviation of the pile head cut off center from the center point, shown on the setting out drawing shall be 75 mm in any direction. For a pile head cut-off below ground level, an additional tolerance will be permitted as below on the assumption that the pile head would have been within tolerance if the cut-off had been at ground level. The maximum permitted deviation of the finished pile from the vertical is 1 in 75. Forcible corrections to concrete piles shall not be made.

30.05.00

The contractor shall carry out the work to minimize noise and disturbance.

If during the execution of the work, damage is likely to be, caused to mains, services or adjacent structures, the contractor shall submit proposal for repair or avoidance of such damage. The contractor shall ensure that damage does not occur to completed piles.

30.06.00

Records

The contractor shall keep records as below of the installation of each pile and shall submit record to the Engineer.

Table 1.0

a)	Piles reference number (location)	*
b)	Piles cut off level	*
c)	Pile type	*
d)	Nominal cross-sectional dimensions or diameter	*
e)	Pile design capacity	*
f)	Standing groundwater level	*
g)	Date and time of driving, red riving or boring	*
h)	Date of concreting	*
i)	Ground level at commencement of installation of piles	*
j)	Working level	*
k)	Depth from working level to pile toe	*
l)	Toe level	*
m)	Depth from working level to pile head level	*
n)	Length of temporary / permanent casing	*
o)	Type weight, drop and mechanical condition of hammer	*

p)	Number of type of packings used and type and condition of	*
q)	Record of blows per 300 mm over complete drive	*
r)	Set of pile or pile tube in mm per 10 blows or number of	*
s)	Temporary compression of ground and pile from time of	*
t)	Length and details of reinforcement	*
u)	Grade and slump of Concrete mix and control test	*
v)	Volume of concrete installed in pile	*
w)	Method of placing concrete	*
x)	Number of blows to form bulb where appropriate	*
y)	Level of water or drilling fluid at commencement of	*
z)	All information regarding obstructions delays and other	*

30.07.00**Driven Cast-in-situ Concrete Piles**

- a)** Installation of piles shall be carried out as per layout construction drawings in accordance with latest IS codes as below:
- i) IS:456-2000 : Code of practice for plain and Reinforced Concrete
 - ii) IS:2911-Part I : Code of Practice for Design and Section-I Construction of pipe foundation
 - iii) IS:2911-Part IV : Test load on piles
- b)** The sequence of installation of piles shall be to the approval of the Engineer.
- c)** The equipment and accessories required for the pile driving shall be standard type. The capacity of the pile frame shall be selected after considering the size and weight of the casing to be handled, the location of the work and the hardness of driving. The steel casing used for installing the piles shall be straight and shall have sufficient wall thickness and strength to prevent damage, distortion etc. Detachable shoes used with the temporary steel casing shall be fabricated steel or cast iron, double rimmed and of requisite strength, and of the standard sizes used with the respective steel casing. The shoe shall be co-axial with the steel casing. Casings distorted from true uniform shape whether caused by driving or earth and water pressure resulting in a reduction of the cross sectional area of the pile in excess of 10 percent shall not be used in the works. The nominal casing size shall be 500 mm diameter.

- d) The pile shall be driven to a set proposed by the contractor. The final set values shall be repeated thrice before terminating the pile at that level. All relevant data with back up, computations pertaining to “set” shall be submitted before commencing piling work for Purchasers approval. Any sudden change in rate of penetration shall be brought to the notice of the Engineer.

e) Control of Pile Driving

Protection of pile heads and selection of pile hammer shall be as per IS:2911 Part I. The pile shall be driven as accurately as possible to the vertical. Piles shall be installed with due consideration for the safety of adjacent structures by a method leaving their strength unimpaired and which develops and retains the required load bearing capacity. In the case of piles close to existing plant and structures, the Engineer may specify suitable precautions which may call for additional working hours for the rig. The quipment and methods for installing piles shall be such that the loss of energy is limited to a minimum. Should the deviation of the installed pile be greater than the specified tolerances, the Engineer may at his discretion order the installation of additional piles after checking the design load on the pile group of which the particular pile forms part. Care shall be taken not to damage the piles by over driving. Any sudden change in the rate of penetration shall be noted and informed to the Engineer. Jetting of Pile by means of water shall not be permitted.

- f) After complete installation of the casing before concreting, the contractor shall inform the Engineer to inspect the casing for proper plumb location and other conditions. Only after approval concreting should proceed. Level readings shall be taken on each pile after driving and again after all the piles in a group are driven. Piles which are found to have resin shall be driven to the original depth and set.

- g) The main longitudinal reinforcing bars in piles shall be in one continuous length. In long piles, joints shall be permitted in main longitudinal bars but these shall be kept to a minimum. Joints in adjacent bars shall be staggered at least 1 meter part along the length of the pile. Joints in reinforcement shall be such that the full strength of the bar is effective across the joint.

Longitudinal reinforcement shall be provided for the full length of the pile extending above pile cut off level to provide adequate bond length into the pile cap. The minimum area of longitudinal reinforcement within the pile shaft shall be 0.4 percent of cross-sectional area of the pile on the basis of the nominal casing diameter. Longitudinal reinforcement shall be formed into a rigid cage to resist deformation during handling and installation by the use of links or helical reinforcement. The minimum diameter of links

and helical reinforcement shall be 6 mm spaced at 150 mm and not more than 300 mm. The longitudinal reinforcement shall project 52 times its diameter; above the cut off level of the pile to ensure adequate bond length inside the pipe cap. Minimum 6 Nos. of longitudinal reinforcement shall be provided. Reinforcement provided in pile shall be symmetrical about any axis on the pile cross section. The diameter of longitudinal reinforcement shall not be less than 12 mm. Lap or splice joints shall be provided with sufficient link bars to resist eccentric forces. Minimum cover to main reinforcement in the pile shall be 75mm.

h) The method of placing and the workability of the concrete shall be such that continuous monolithic concrete shaft of the full cross-section is formed. Mechanical vibrators shall not be used to compact concrete. Concrete in piles shall be of design- mix with minimum grade M25 with minimum cement of 400 kg/cum water cement ratio within 0.45 to 0.55 using super plasticized Sikament 170 or equivalent. Generally the slump of the concrete shall be within the range 100 to 150 mm. The contractor shall ensure the minimum specified strength in accordance with IS:456, IS:10262 & SP. 23 shall be followed as guidance for mix design. Compaction of test cubes shall be done under same condition as followed for concreting of piles.

i) In soft clays or loose sands ,or where there is likelihood of danger to green concrete due to driving of adjacent piles, the designed reinforcement should be provided up to the full pile depth, regardless of whether or not it is required from uplift and lateral load considerations. Refer clause 5.11.2 of IS : 2911 (Part I / Sec-1)

j) Cleaning out of casing

Before placement of concrete ,it shall be ensured that the inside of the casing is free from sludge or any foreign matter. The contractor shall ensure that water does not enter the casing tube/pile shoe at the end of driving & during the concreting operations. The existence of water inside casing tube after driving and before executing the concrete operation, if any shall be checked by the contractor by suitable probe & concreting of pile work shall be allowed to proceed if water level is less than 15 cm measured above the inner surface at the top of the shoe. If the water level is more than 15 cm, contractor shall take remedial measures viz. bailing or pumping to reduce the depth of water before concreting & if it is not possible to do so then the contractor shall re-drive the casing at no extra cost to the Purchaser.

k) Concrete Level – finishing of pile head

The cut-off level shall be as shown on the construction drawings. Concrete shall be cast to minimum of 500 mm above the cut-off level, or local ground water level, whichever is higher. Withdrawal of temporary casing

shall be carried out in stages during the concrete placing operation with utmost care maintaining an adequate head of concrete above the bottom of casing at each stage of withdrawal so as to prevent the inflow of soil and water into the bore. Section of empty hole remaining above the head of the pile shall be temporarily backfilled with sand or other approved material prior to excavation for pile cap construction.

l) Trimming of pile heads

Following excavation subsequently for pile cap construction, the contractor shall carefully remove excess concrete above specified cut-off level, without damaging the remainder of the pile including the projection reinforcement. Any cracked or defective concrete occurring below specified cut-off level shall be cut away and made good with new concrete properly bonded to the old. Piles that are defective shall be pulled out or left in place as judged by Engineer without affecting performance of adjacent piles. Also the contractor shall be bound to install additional piles to substitute the defective ones as per the directions of the Engineer.

- m)** The dynamic cone penetration tests shall be carried out for a depth of at least 2 meters from the termination depth. The number of such tests shall be as follows
 - a. One number dynamic cone penetration test for each pile group consisting of more than four piles.
 - b. For TG and Chimney pile groups the number of dynamic cone penetration tests shall be one per cent of the total number of piles.

30.08.00

Load Tests on Piles

- a)** Load test shall be in accordance with IS:2911 Part IV (latest revision) Initial load tests on “Trial Piles” shall be executed in advance of works pile construction and shall comprise vertical load tests at locations as directed. Load test on trial piles shall also include lateral load test and uplift load tests as directed by the Engineer. 6 number of trial piles shall be tested from each capacity of the pile. Out of the six (6) nos. of piles to be tested for two (2) nos. each capacity shall be tested for vertical load, two (2) nos. for lateral load and two (2) nos. for uplift load.

Routine load tests on “Works Piles” shall be vertical load test and lateral load tests on piles as directed by the Engineer. Number of routine tests to be conducted on work piles shall be equal to one and half (1.5) percent of the total number of piles used in the work for vertical load tests as well as lateral load tests.

- b) Load tests shall not normally be undertaken by the contractor within 28 days after the installation of the piles in position. However, the contractor may be allowed by the Engineer to use rapid hardening cement or add necessary admixtures to enable him to conduct the tests within a lesser period. Before any load test is done, the proposed arrangement for carrying out the load tests including the preparation of the structure to receive the loads and the type of loading to be adopted shall be furnished by the contractor.

c) Vertical Load Test on Trial Piles

Load tests to verify the contractor's design shall be carried out on piles of different capacities proposed to be used. The contractor shall commence testing as early as possible after installing the piles. The test shall be carried out by applying series of loads on RC cap over single pile. The load shall be applied by means of standard hydraulic jack reacting against a loaded platform which shall be preloaded platform which shall be preloaded to three times the estimated safe load carrying capacity of the pile. Reading of settlement and rebound shall be recorded with four dial gauges of 0.01 mm sensitively and resting on diametrically opposite ends of the pile cap. The dial gauge shall be fixed to a datum bar whose ends rest-upon non-movable supports. The supports for datum bar with reference to which the settlement of the pile is measured shall be at least 5 times diameter of pile away from the pile.

The test shall be conducted by the cyclic loading method. The test load shall be applied in equal increments of about one-fifth of the estimated safe load. Each stage of loading or unloading shall be maintained till the rate of movement of the pile cap is not more than 0.02 mm per hour. However, load shall be maintained for longer periods at 1 to 1.5 times the assumed safe capacity, and at final loads as directed by Engineer. The safe load on pile shall be the least of the following :

- i Two third of the final load at which the total settlement attains the value of 12 mm.
- ii Two third of the final load at which the net settlement attains a value of 6 mm.
- iii 50 per cent of the final load at which the total settlement equals one-tenth of the pile diameter.

d) Lateral Load Test on Trial Piles

The test pile shall be decided by the Engineer. The test pile shall be cut off at the proper level and provided with a cap with vertical plane sides having

an adequate area for proper seating of the jack and dial gauge. The lateral load shall be applied on the pile at or approximately at cut off level and the deflection shall be measured at a point diametrically opposite to the point of load application. The loading shall be applied by the hydraulic jack of adequate capacity, abutting the pile horizontally and reacting against a suitable system. The reaction may be provided by the well of the excavated pit when the test is being conducted below ground level or by a neighbouring pile in which case thrust pieces shall be inserted on either end of the jack to make up the gap. Lateral load applied on the pile shall be measured by a calibrated pressure gauge mounted on the jack, having a least count of 500 kg. Deflection of the pile head shall be measured by four dial gauges, fixed to datum bars & having a least count of 0.01 mm. The datum bars shall be provided with rigid supports. Loading shall be applied in increments of 500 kg. Each stage shall be maintained for a period till the rate of movement of the pile head is not more than 0.02 mm/hour or 1 hour whichever is greater .

Loading shall be continued till one of the following occurs :

- i. Deflection of pile head exceeds 12 mm.
- ii. The applied load on the pile is three times the assumed lateral load capacity of the pile.

The safe load shall be smaller of the following :

- i. Half the final load for which the total deflection is 12 mm.
- ii. Load at which the total displacement corresponds to 5 mm.

e) Pull-out Test

The test piles shall be decided by the Engineer. The test pile shall be built upto the proper length and the head provided with suitable arrangements for anchoring the load applying system. Loads shall be applied using a approved reaction system, uplift forces on the pile shall be applied directly to the test pile or through a lever system. The reaction shall be provided by neighbouring piles or blocks may be constructed for the purpose. Hydraulic jacks shall be used for load application. Load applied by the hydraulic jack shall be measured by a calibrated gauge with a least count of 100 Kg. Movement of the pile shall be measured by dial gauges, fixed to datum bar and having a least count of 0.01 mm. Four dial gauges placed diametrically opposite shall be used. Datum bars shall be provided with rigid supports. The load shall be applied along the longitudinal axis of the pile using method approved by the Engineer. Loading shall be applied to the pile top in increment of one-fifth of the expected safe capacity. Each stage shall be

maintained for a period till the rate of movement of the pile head is not more than 0.02 mm per hour or four hours whichever is greater. Loading shall be continued till one of the following occurs :

- i. Yield of soil pile system occurs causing progressive movement of pile exceeding 12 mm.
- ii. The loading on the pile top equals three times the estimated safe load or as specified in the case of separate test pile.

The safe capacity of the pile should be least of the following :

- i. Two third of the load at which the total displacement is 12 mm or the load corresponding to a specified permissible uplift, and
- ii Half of the load at which the load displacement curve shows a clear break (downward trend)

f) Routine Test on Working Piles

Three tests shall be carried out on working piles upto one and half times the design load and the maximum settlement of test loading in position being not exceeding 12 mm as per IS:2911 (Part IV). In case a pile fails under or during the load test, the Engineer shall select two additional piles in lieu of each of such failed pile and the contractor shall carryout load tests on such additional piles.

30.09.00

Cast-In-Situ Piling Bored

The following specification deals with the requirements of materials, workmanship and installation of Bore Cast-in-situ reinforced concrete piles.

The materials and workmanship shall conform with the provision of the latest IS:456, IS:2911 (Part I, Section 2) & IS:2911 (Part 4).

Care shall be taken while boring piles so that no existing foundations / sub-structures are disturbed by providing suitable arrangements like shoring etc.

a) Sequence of Piling

The sequence of piles installed shall be such that the adjacent piles already installed are not disturbed nor their carrying capacity reduced by subsequent boring operation. In a group the installation of the piles shall normally proceed from the center of the group towards the periphery.

b) Control of Alignment

Piles shall be installed as accurately as possible as per the designs and drawings either vertically or to the specified batter. Great care should be exercised in respect of installation of single pile or piles in two pile group. For vertical piles a deviation of 1.5 percent should not normally be exceeded. Piles should not deviate more than 75 mm or $D/10$ whichever is more in case of piles having diameter more than 600 mm from their designed positions at the working level of the piling rig. In the case of a single pile in a column, positional tolerance should not be more than 50 mm (100 mm in case of piles having diameter more than 600 mm).

For piles carried to substantial depth, the design should provide for the worst combination of the above tolerance in position and inclination. In case of piles deviating beyond these limits and to such an extent that the resulting eccentricity cannot be taken care of by a redesign of the pile cap and ties, the piles shall be replaced or supplemented by one or more additional piles, as directed by the Engineer, at no extra cost.

Any deviation from the designed location, alignment or load capacity of any piles shall be noted and brought to the attention of the Engineer and rectification and supplemental works carried out to the satisfaction of the Engineer at no extra cost.

A minimum length of one meter of temporary casing shall be inserted in each bored pile unless otherwise specifically desired. Additional length of temporary casing may be used depending on the condition of the strata etc.

Drilling mud of suitable consistency may also be used instead of temporary casings for stabilizing sides of the holes.

In case, a bored pile is stabilized by drilling mud the bottom of the hole shall be cleaned very carefully before concreting work is taken upon. The cleaning of the hole shall be ensured by careful operation of boring tool and / or flushing of the drilling mud thorough the bottom of the hole. Flushing of bore holes before concreting with fresh drilling fluid/ mud is preferred.

In case a holes is bored by use of drilling mud, the specific gravity of the mud suspension near about the bottom of the hole shall, wherever practicable, be determined by suitable interval of piles and recorded. Consistency of the drilling mus suspension shall be controlled throughout the boring as well as concreting operations in order to keep the hole stabilized as well as to avoid concrete getting mixed up with the thicker suspension of the mud.

The concreting operatings should not be taken up when the specific gravity of bottom slurry is more than 1.2. Concreting shall be done by tremie method in all such cases.

The top of concrete in a pile shall be brought above the cut-off level as per cl. 7.8 of IS: 2911 (Part 1/sec.2).

In case, defective piles are formed, they shall be removed or left in place, if so directed by the Engineer, if these do not affect the performance of the adjacent piles or the cap as a whole. Additional piles shall be provided to replace them as directed by the Engineer.

Any deviation from the designed location alignment or load capacity of any pile shall be noted and adequate measures taken well before the concreting, of the pile cap and plinth beam if the deviations are beyond the permissible limit.

During chipping of the pile top manual chipping may be permitted after three days of pile casting, pneumatic tools for chipping shall not be used before seven days after pile casting.

After concreting the actual quantity of concrete shall be compared with the average obtained from observations actually made in the case of a few piles initially cast. If the actual quantity is found to be considerably less, special investigations shall be conducted and appropriate measures taken.

The bentonite suspension used for piling work shall satisfy the following requirements:

- i. The liquid limit of bentonite when tested in accordance with IS:2720 (Part V) shall be more than 300 percent and less than 450 percent.
- ii. The sand content of the bentonite powder shall not be greater than 7 percent.
- iii. Bentonite solution should be made by mixing it with fresh water using pump for circulation. The density of the freshly prepared Bentonite solution should be between 1.034 and 1.10 gm/ml depending upon pile dimensions and type of soil in which the pile is to be installed. However, the density of bentonite solution after mixing with deleterious materials in the pile bore may be up to 1.25 gm/ml.
- iv. The marsh velocity when tested by a Marsh cone should be about 37 seconds.
- v. The differential free swell shall be more than 540 percent.
- vi. The PH value of the bentonite suspension shall be between 9 & 11.5.

30.10.00**Codes and Standards**

The following Indian Codes and Standards (Latest) shall be used for design of the structural elements:

IS:456 : Code of Practice for plain and Reinforced concrete

IS:875 : Code of Practice for Design loads (other than earthquake) for Buildings and structures.

IS:2911: Code of Practice for Design and Construction of Pile Foundations – Bored Cast-in-situ Piles (Part 1/sec. 2)

IS:2911 : Code of Practice for Design and Construction of Pile Foundation – Load Test on Piles (Part 4)

IS:1786 : Code of Practice for HYSD bars

IS:2751 : Code of Practice for welding of mild steel bars used for reinforced concrete construction

IS:2062 : Steel for general structural purposes

SP:16 : Design Aids for Reinforced Concrete to IS:456.

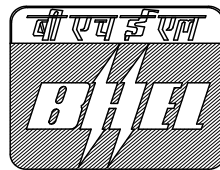
	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE		SPECIFICATION NO. PE-TS-412-600-C002	
			VOLUME	II B
			SECTION	D SUB-SECTION – C7
			REV.NO.	00
			SHEET	1 OF 36

**VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS**

SPECIFICATION NO. PE-TS-412-600-C002

**SECTION - D
*GENERAL TECHNICAL SPECIFICATION***

ROAD AND DRAINAGE



Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002			
		VOLUME		II B	
		SECTION		D SUB-SECTION – C7	
		REV.NO.		00	
		SHEET		2	OF
C O N T E N T					
CLAUSE NO.	DESCRIPTION	SHEET NO.			
1.00.00	SCOPE	3			
2.00.00	CODES AND STANDARDS	4			
a.	EXECUTION	7			
4.00.00	TESTING AND ACCEPTANCE CRITERIA	37			
5.00.00	MEASUREMENT	37			

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002	
		VOLUME	II B
		SECTION	D SUB-SECTION – C7
		REV.NO.	00
		SHEET	3 OF 36

General Standard Technical Specification For Road And Drainage

1.00.00

Scope

The scope include all works required for the construction of road including construction of embankment, sub-base course, base course, tack coat, bituminous macadam, wearing course, liquid seal coat, shoulder and all incidental items of work specified or not shown but reasonably implied or necessary for the completion of the work etc.

The scope also include all works required for the construction of drainage including construction of road side drains, RCC culverts, pipe culverts, drainage pipes, manholes and all other incidental items necessary for the completion of the work etc.

1.01.00

Works To Be Provided By The Contractor

The works to be provided by the contractor unless specified otherwise shall include but not be limited to the following.

a) Construction of roads including providing all materials, labour, supervision, services, equipments, tools and plants, transportation etc all required for the completion of the work.

b) Submission of detailed scheme of all operations required for executing the work (e.g. material handling, placement, services, approaches etc) to the engineer for approval.

c) Carrying out tests whenever required by the engineer to assess the quality of work and submission of the test results to the engineer after completion of the same etc.

1.02.00

Work To Be Provided By Others

No work under this specification will be provided for by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

1.03.00

Conformity With Designs

The contractor shall carryout the work as per the construction drawings, specification and as directed by the engineer.

1.04.00

Materials To Be Used

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002		
		VOLUME	II B	
		SECTION	D	SUB-SECTION – C7
		REV.NO.	00	
		SHEET	4	OF 36
		All materials required for the work shall be the best commercial variety and as approved by the engineer. 2.00.00 Codes and Standards All works under this specification shall conform to the latest revision and/or replacement of the following or any other IRC/IS Codes and Standard Practices unless specified otherwise. - Specification for road and bridge works of Ministry of Shipping & Transport (Road Wing) Published by the IRC - IRC: 19 - Standard specification and code of practice for Water bound Macadam - IRC :SP 11 - Hand Book of Quality Control for Construction of Roads and Runways - IS:456 - Indian Standard Code of Practice for Plain and Reinforced Concrete. - IS:2212 - Code of Practice for Brick work - IS: 783 - Code of Practice for Laying of Concrete Pipes - IS: 1201 - Methods of testing tar and bituminous materials to 1220 - IS: 73 - Specification for paving bitumen - IS: 215 - Specification for Road tar - IS: 216 - Coal tar pitch - IS: 217 - Specification for cut-back bitumen - IS: 454 - Specification for cut-back bitumen from waxy crude - IS: 1834 - Specification for hot applied sealing compound for joint in concrete - IS: 1838 - Specification for performed fillers for expansion joints in concrete, non extruding and resilient type Part I Bitumen impregnated fibre		

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002			
		VOLUME		II B	
		SECTION		D SUB-SECTION – C7	
		REV.NO.		00	
		SHEET		5	OF

Part II

CNSL Aldehyde resin and coconut pith

o)

IS : 334 -

Glossary of terms relating to bitumen and tar

p)

IS: 1077 -

Common burnt clay building bricks

q)

IS : 3117 -

Specification for bitumen emulsion roads (anionic type)

r)

IS : 1200 -

Method of measurement of building and civil engineering work (Part-17)- Road work including airfield pavements

s)

Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by the specification/Indian Standard Code of practices, any other standard practice as may be specified by the engineer shall be followed.

2.01.00

Quality Control

The Contractor shall establish and maintain quality control for all materials, procedures, workmanship and equipments used. All works shall conform to the lines, grades, cross sections and dimensions shown on the drawings, specification and as directed by the engineer. Permitted tolerances for road works are described hereinafter.

a) Horizontal Alignment

Horizontal alignment shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of ± 25mm therefrom. The corresponding tolerance for edges of the roadway and lower layers of the pavement shall be ± 40mm.

b) Longitudinal Profile

The finished levels of the sub-grade and different pavement courses as constructed shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the engineer and shall not exceed the tolerances as mentioned below.

Sub-grade	± 25 mm
Sub-base	± 20 mm
Base course	± 15 mm

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002					
		VOLUME II B					
		SECTION D SUB-SECTION – C7					
		REV.NO. 00					
		SHEET 6 OF 36					

Wearing course ± 10 mm

Tolerance in wearing course shall not be permitted in conjunction with the positive tolerance on base course if the thickness of the wearing course is thereby reduced by more than 6 mm.

c) Surface Regularity of Sub-grade and Pavement Courses

The surface regularity of the completed sub-base, base course and wearing surfaces in the longitudinal and transverse directions shall be within the tolerances indicated in Table - I. The longitudinal profile shall be checked with a 3m long straight edge at the middle of each traffic lane along a line parallel to the centre of the road. The transverse profile shall be checked with a set of three camber boards at intervals of 10m.

TABLE –I

PERMITTED TOLERANCE OF SURFACE REGULARITY FOR PAVEMENT COURSES

Sl. No.	Type of Construction	Longitudinal profile with 3m straight edge					Cross Profile
		Maximum permissible Undulation (mm)	Maximum number of undulations permitted in any 300m length with undulation exceeding (mm)				Maximum permissible variation from specified profile under camber template (mm)
			18	12	10	6	
1	2	3	4	5	6	7	8
1.	Earthen sub-grade	25	30	-	-	-	15
2.	Granular sub-base	15	-	30	-	-	12
3.	Water Bound Macadam with oversize metal (40-90 mm size)	15	-	30	-	-	12
4.	Water Bound Macadam with normal size metal (20-50 mm and 40-63 mm size), Bituminous Penetration Macadam	12	-	-	30	-	8
5.	Surface dressing** (two coat) over WBM (20-50 mm or 40-63 mm size metal), Bituminous penetration macadam	12	-	-	20	-	8

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE					SPECIFICATION NO. PE-TS-412-600-C002				
						VOLUME II B				
						SECTION D SUB-SECTION – C7				
						REV.NO. 00				
						SHEET 7 OF 36				
6.	Open graded premix carpet, mix seal Surfacing	10	-	-	-	30	6			
7.	Bituminous macadam	10	-	-	-	20***	6			
8.	Semi-dense carpet	10	-	-	-	20***	6			
9.	Asphaltic Concrete	8	-	-	-	10***	4			

Notes:

1. ** For surface dressing in all other cases, the standards of surface evenness will be the same as those for the surface receiving the surface dressing.

2. *** These are for machine laid surfaces. If laid manually due to unavoidable reasons, tolerance upto 50 percent above these values in this column may be permitted at the discretion of the Engineer. However this relaxation does not apply to the values of maximum undulation for longitudinal and cross profiles mentioned in columns 3 and 8 on the table.

3. Surface evenness requirements in respect of both the longitudinal and cross profiles should be simultaneously satisfied.

3.00.00 Execution

3.01.00 Setting Out

Within 15 days of the award of contract, the contractor shall prepare and submit to the Engineer detailed drawings/schemes of embankment filling and excavation works as proposed to be executed by him showing the dimensions as per construction drawings and specification adding his proposals of drainage and dewatering of pits, watering and compacting the embankment fill etc. On receiving the approval from the Engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the Engineer and fix permanent points and markers for ease of future checking. These permanent points and markers will be checked by the Engineer and certified by him after which the contractor shall proceed with the work. It should be noted that this checking by the Engineer prior to the start of the work will in no way absolve the contractor of his responsibility of carrying out the work to true lines and levels as per the approved drawings. If any errors are noticed in the Contractor’s work at any stage, the contractor at his own risk and cost shall rectify the same. Profiles of the embankment made with Bamboo, earth or other convenient materials and strings shall be set up at suitable intervals for the guidance of the workmen.

3.02.00 Clearing and Grubbing

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002			
		VOLUME II B			
		SECTION	D	SUB-SECTION – C7	
		REV.NO.	00		
		SHEET	8	OF	36

Before commencement of earthwork, the surface area of ground to be occupied shall be cleared of all fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Cutting of trees shall include trees having girth of any size and removing roots upto a depth of 600mm below ground level or 300mm below formation level whichever is deeper. After the removal of roots of trees, the pot holes formed shall be filled with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the Engineer. The trees shall be cut into suitable pieces as instructed by the Engineer. Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burnt or removed from the site to the approved disposal areas as may be specified. Useful materials, saleable timbers, firewood etc shall be the property of the Owner and shall be stacked properly at the work site in a manner as directed by the Engineer.

3.03.00 Filling in Embankment

3.03.01 General

The material used for constructing the embankment shall be earth, moorum, gravel or a mixture of the above or any other material approved by the Engineer. The material shall be free from lumps and clods, boulders and rock pieces, roots and vegetation, harmful salts and chemicals, organic materials, loose silts, fine sands and expansive clays in order to provide a stable embankment. The filling and compaction operation should be such that the best available materials are saved for the top portion and will result in an acceptable and uniform gradation of material and provide impermeability and stability to the embankment when compacted. The size of the coarse material in the mixture of earth shall ordinarily not exceed 75mm. However the Engineer may at his discretion permit the use of material coarser than the specified if he is satisfied that the same will not present any difficulty as regard to the placement and compaction of the fill material are concerned. Ordinarily, only the materials satisfying the density requirements as given below in Table-II shall be employed for embankment construction.

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002	
		VOLUME	II B
		SECTION	D SUB-SECTION – C7
		REV.NO.	00
		SHEET	9 OF 36

Table - II

Density Requirements of Embankment Materials

Sl. No.	Type of Work	Maximum laboratory dry density when tested as per IS: 2720 (Part - VII)
1.	Embankment upto 3m height	Not less than 1.44 gm/cc
2.	Embankment exceeding 3m height and embankment of any height subject to long period of inundation	Not less than 1.52 gm/cc
3.	Top 0.5m of the embankment below sub-base and shoulders (where earth shoulders are specified)	Not less than 1.65 gm/cc

Expansive clays exhibiting marked swell and shrinkage properties shall not be used for embankment construction.

The material for embankment construction shall be obtained from approved sources with preference given to the materials available from nearby road excavation or any other excavation under the same contract.

3.03.02 Setting Out

After the site clearance, the work shall be set out true to lines, curves, slopes, grades and sections as shown on the approved drawings or as directed by the Engineer. The contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboo, stones, lime, mortar, concrete etc required in connection with the setting out of the works and establishment of the bench marks. The limits of the embankment shall be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the earthwork. To ensure the safety, the pegs should normally be fixed about 500mm away from the actual limits of the fill and to be painted in a distinct colour. The centreline of the embankment shall be pegged at regular intervals of 25/30m and at all skews/curves. The actual profile of the embankment shall be made at every third centre line peg with bamboo posts and strings. Preferably prototype profiles developed with wooden planks need to be fixed at every 200m and at the intersection points at curves. The profile shall be about 3m long.

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002			
		VOLUME		II B	
		SECTION		D SUB-SECTION – C7	
		REV.NO.		00	
		SHEET		10	OF

3.03.03

Stripping and Storing top soil

The construction of the earthen embankment by filling shall conform to the dimensions, slopes and other details shown in the approved drawings. Before commencement of the embankment construction, the surface area of ground to be occupied after clearing and grubbing shall be stripped off to a minimum depth of 150mm or more as directed by the Engineer in order to remove all perishable materials and any soil which may become unstable on saturation or may interfere with the development or proper bonding between the foundation and embankment. It is not necessary to remove all the soil containing fine hair like roots but only the rather heavy mats are to be removed. In localities where most of the available embankment fill materials are not conducive to plant growth or when so directed by the Engineer, the top soil suitable for plant growth existing over the embankment foundation areas shall be stripped to specified depths not exceeding 150mm and stored for covering the embankment slopes where revegetation is desired.

3.03.04

Compacting Original Ground

In all cases, the original ground after stripping shall be compacted by rolling with a minimum six passes of 8-10 tonne roller and as directed by the Engineer.

Where the height of the proposed embankment is less than 0.5m and the original ground does not already have a relative compaction of atleast 95 percent of Standard Proctor density (maximum dry density), the same shall be loosened upto a depth of 0.5m and filled in layers not exceeding 250mm in loose thickness and each layer shall be watered and compacted to 100% maximum dry density of the fill material determined in accordance with IS:2720, Part-VII. However before relaying and compacting the loosened material, the surface below this level shall be suitably compacted as directed by the Engineer with a minimum six passes of 8 - 10 tonne roller.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation shall be removed and replaced with approved materials suitably compacted. Embankment work shall not proceed until the foundation soil of the embankment is inspected by the Engineer and approved.

3.03.05

Filling

The embankment material shall be spread uniformly over the entire width of the embankment in layers not exceeding 250mm in loose thickness. Successive layers of embankment shall not be placed until the layer under

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002		
		VOLUME	II B	
		SECTION	D	SUB-SECTION – C7
		REV.NO.	00	
		SHEET	11	OF 36

construction has been thoroughly compacted to the requirements set down hereunder. Moisture content of the fill material shall be checked at the source of supply and if found less than that specified for compaction, the same shall be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case water shall be sprinkled directly from a hose line or from a truck mounted water tank and flooding shall not be permitted under any circumstances. After adding required amount of water, the soil shall be processed by means of harrows, rotary mixers or by any other approved method until the layer is uniformly wet.

If the material delivered to the road bed is too wet, it shall be dried by aeration and exposure to the sun till the moisture content is acceptable for compaction. Should circumstances arise where owing to wet weather, the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended.

Moisture content of each layer shall be checked in accordance with IS:2720, Part-II and unless otherwise specified shall be so maintained making due allowance for evaporation losses that during compaction, the moisture content shall be in the range of 1 percent above to 2 percent below the optimum moisture content as determined in accordance with IS:2720, Part-VII.

Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the lower layers of the embankment and a maximum size of 60mm when being placed in the top 0.5m portion of the embankment below sub-base.

Hauling equipment shall be dispersed uniformly over the entire surface of the previously constructed layer to minimise rutting or uneven compaction.

Where the embankment is to be constructed across a low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed layer to a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

3.03.06 Compaction

Compaction equipment approved by the Engineer shall only be employed for construction. If directed by the Engineer, the Contractor shall demonstrate the efficiency of the plant he intends to use by carrying out compaction trials.

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002									
		VOLUME II B									
		SECTION D SUB-SECTION – C7									
		REV.NO. 00									
		SHEET 12 OF 36									
Each layer shall be thoroughly compacted to the density as specified in Table-III. Subsequent layers shall be placed only after the finished layer has been tested and accepted by the Engineer. Table - III Compaction Requirements For Embankment <table border="1"> <tr> <th>Sl. No.</th><th>Type of work/material</th><th>Field dry density as a percentage of maximum laboratory dry density as per IS : 2720, Part-VII</th></tr> <tr> <td>1.</td><td>Top 0.5m portion of embankment below sub-base and shoulders</td><td>Not less than 100</td></tr> <tr> <td>2.</td><td>Other portions of embankment</td><td>Not less than 95</td></tr> </table> When density measurements reveal any soft area in the embankment, further compaction shall be carried out as directed by the Engineer. If in spite of that the specified compaction is not achieved, the material in the soft area shall be removed and replaced with approved material and compacted to the density requirements and satisfaction of the Engineer. 3.03.07 Drainage The surface of the embankment at all times during construction shall be maintained at such a cross fall as will shed water and prevent ponding. 3.03.08 Finishing Operations Finishing operations shall include the work of shaping and dressing the shoulders, road bed and side slopes to conform the alignment, levels, cross sections and dimensions as shown on the drawings or as directed by the Engineer. Both the upper and lower ends of the side slopes shall be rounded off to improve the appearance and merge the embankment with the adjacent terrain. 3.04.00 Turfing With Sods 3.04.01 General This work shall consist of furnishing and laying live sod of perennial turf forming grass on embankment slopes, shoulders or other locations as			Sl. No.	Type of work/material	Field dry density as a percentage of maximum laboratory dry density as per IS : 2720, Part-VII	1.	Top 0.5m portion of embankment below sub-base and shoulders	Not less than 100	2.	Other portions of embankment	Not less than 95
Sl. No.	Type of work/material	Field dry density as a percentage of maximum laboratory dry density as per IS : 2720, Part-VII									
1.	Top 0.5m portion of embankment below sub-base and shoulders	Not less than 100									
2.	Other portions of embankment	Not less than 95									

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002		
		VOLUME		II B
		SECTION		D SUB-SECTION – C7
		REV.NO.		00
		SHEET		13 OF 36
		shown on the drawings or as directed by the Engineer. Unless otherwise specified the work shall be taken up following the construction of embankment provided the season is favourable for establishment of the sod. 3.04.02 Materials The sod shall consist of dense, well rooted growth of permanent and desirable grasses indigenous to the locality where it is to be used and shall be practically free from weeds and other undesirable matters. At the time the sod is cut, the grass shall have a length of approximately 50mm and the sod shall be free from any debris. Thickness of the sod shall be as uniform as possible with about 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that practically all the dense root system of the grass are retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than 250mm x 300mm in size but not so large so that it is convenient to handle and transport without damage. During wet weather the sod shall be allowed to dry sufficiently to prevent rearing during handling and during dry weather it shall be watered before lifting to ensure its vitality and to prevent dropping of soil during handling. 3.04.03 Placing The Sods The area to be sodded shall be previously constructed to the required slope and cross section. Soil in the area shall be loosened, freed from all stones larger than 50mm size, sticks, stumps and any other undesirable foreign matters etc and brought to a reasonably granular texture to a depth not less than 25mm for receiving the sod. Where required, top soil shall be spread over the slopes. Prior to placing the top soil, the slopes shall be roughened and wetted in order to have a satisfactory bond. The depth of top soil (to be spread) shall be 75mm. Following soil preparation and top soiling (if required), fertilizer and ground limestone when specified shall be spread uniformly. After spreading, the materials shall be incorporated in the soil by discing or other means. The prepared sod bed shall be moistened if not already sufficiently moist and the sod shall be placed thereon within 24 hours after the same has been cut. Each sod strip shall be laid in close contact with each other and shall be lightly tamped with suitable wooden or metal tampers so as to eliminate air pockets and to press it into the underlying soil. At points where water may flow over the sod, the upper edges of the sod strips shall be turned into the soil below the adjacent area and a layer of earth shall be placed over it followed by thorough compaction.		

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002		
		VOLUME		II B
		SECTION	D	SUB-SECTION – C7
		REV.NO.	00	
		SHEET	14	OF 36
3.04.04	Staking the Sods Where the side slope is 2 to 1 or steeper and the distance along the slope is more than 2m, the sods shall be staked with pegs or nails spaced approximately 500 to 1000mm along the longitudinal axis of the sod strips. Stakes shall be driven approximately plumb through the sods and to be almost flushed with them.			
3.04.05	Top Dressing After the sods have been laid in position, the surface shall be cleaned of any loose sod, excess soil and other foreign materials. Thereafter a thin layer of top soil shall be scattered over the top dressed surface and the area shall be thoroughly moistened by sprinkling water.			
3.04.06	Watering and Maintenance The turfing so laid shall be well watered and protected until final acceptance. Watering shall be done in such a way that no erosion or damage to the sodded areas/embankment occur. The Contractor shall erect necessary warning signs and barriers, repair or replace the sods which are failing to show uniform growth of grass or damaged by his operation and shall maintain the sod at his own cost until final acceptance.			
3.05.00	Shoulder Construction			
3.05.01	Description This work shall consist of constructing shoulder on either side of the pavement in accordance with the requirements of this specification and in conformity with the lines, grades and cross sections shown on the approved drawings and as directed by the Engineer.			
3.05.02	Materials Shoulder shall be made of selected earth or granular material as specified conforming to relevant IRC standards.			
3.05.03	Construction Operations Except in the case of bituminous pavements, the shoulders shall be constructed in advance to the laying of pavement courses. The compacted thickness of each layer of shoulder shall correspond to the compacted layer of pavement course to be laid adjacent to it. After compaction, the inside			

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002			
		VOLUME		II B	
		SECTION		D SUB-SECTION – C7	
		REV.NO.		00	
		SHEET		15	OF

edges of shoulders shall be trimmed vertical and the area enclosed between the shoulders shall be cleaned of all spilled materials before proceeding with the construction of the pavement layer.

In the case of bituminous pavements, shoulder shall be constructed only after the pavement courses have been laid and compacted.

Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed without any damage to the pavement and the area so affected shall be thoroughly cleaned. During all stages of shoulder construction, the required crossfall shall be maintained to drain off surface water.

3.06.00 Kerb

3.06.01 Material

Kerb if required for the construction of footpath shall consist of precast concrete blocks with concrete grade of M-20. The blocks shall be of 100mm thick and of suitable length. The depth of blocks unless otherwise mentioned elsewhere shall be 375mm considering 225mm height of footpath above the road level.

3.06.02 Laying

The kerb shall be laid by cutting trenches of 150mm deep. The width of the trench shall be minimum and just sufficient to insert the kerbs. The inside faces of the kerbs shall be in plumb and the gap between the block shall not be more than 10mm. The gap shall be filled with cement mortar as specified.

The kerbs shall be thoroughly packed with a mixture of stone chips (50%) and moorum (50%) at the outside face. The laying and packing shall be done in a proper workmanlike manner acceptable to the Engineer.

3.07.00 Sub-base (Granular Sub-base)

3.07.01 Description

This work shall consist of laying and compacting well graded material on the prepared sub-grade in accordance with the specification. The material shall be laid in one or more layers as shown on the drawings and shall conform to the lines, grades and cross sections shown on the drawings and as directed by the Engineer.

3.07.02 Materials

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE		SPECIFICATION NO. PE-TS-412-600-C002	
			VOLUME	II B
			SECTION	D SUB-SECTION – C7
			REV.NO.	00
			SHEET	16 OF 36

The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kankar etc or combinations thereof depending upon the grading required. The mixed materials shall be free from organic and other deleterious constituents and conform to one of the three grading given in Table - IV below.

Table - IV
Grading for Granular Sub-base Material

Sieve designation	Percent by weight passing the sieve		
	Grading 1	Grading 2	Grading 3
80 mm	100	100	100
63 mm	90 - 100	90 - 100	90 - 100
4.75 mm	35 - 70	40 - 90	50 - 100
75 micron	0 - 20	0 - 25	0 - 30
Minimum CBR value for the fraction of material passing 20 mm sieve.	30 %	25%	20%

Note : The materials passing 425micron sieve for all the three gradings when tested according to IS : 2720, Part V shall have liquid limit and plasticity index not more than 25 percent and 6 percent respectively.

3.07.03 Physical Requirements

The fraction of materials passing 20mm sieve shall give a CBR value as specified in Table – IV when tested in accordance with IS : 2720, Part XVI after preparing the samples at maximum dry density and optimum moisture content corresponding to IS : 2720, Part VII and soaking the same in water for 4 days.

3.07.04 Spreading and Compacting

Immediately prior to laying of sub-base, the sub-grade already finished shall be prepared by removing all vegetations and other extraneous matters, lightly sprinkled with water if necessary and rolled with one pass of 8 - 10 tonne smooth wheeled roller.

The sub-base material shall be spread on the sub-grade with the help of a drag spreader, motor grader or other approved means. The thickness of

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002		
		VOLUME	II B	
		SECTION	D	SUB-SECTION – C7
		REV.NO.	00	
		SHEET	17	OF 36
	loose layers shall be so regulated that the maximum thickness of each layer after compaction shall not exceed 150mm. Moisture content of the loose material shall be checked in accordance with IS : 2720, Part II and shall be suitably adjusted by sprinkling additional water from a hose line, truck mounted water tank or other approved means so that at the time of compaction it shall be from 1 percent above to 2 percent below the optimum moisture content. While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet. Immediately thereafter, rolling shall be done with 8 to 10 tonne smooth wheeled rollers or with any other approved plant. Rolling shall commence from the edges and progress towards the centre longitudinally except on super elevated portions where it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and camber shall be checked and any high spots or depressions which become apparent shall be corrected by removing or adding fresh material. Rolling shall be continued till the density achieved is at least 100% of the maximum dry density of the material determined as per IS : 2720, Part VII. The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction plant and from compaction planes, ridges, cracks or loose materials. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and recompacted.			
3.08.00	Water Bound Macadam Sub-base/Base Course			
3.08.01	Description Water bound macadam shall consist of clean crushed aggregates mechanically interlocked by rolling and bonded together with screenings, binding material wherever necessary and water, laid on the prepared sub-grade or sub-base as the case may be and finished in accordance with the specification and in conformity with the lines, grades and cross-sections shown on the approved drawings.			
3.08.02	Materials a) Coarse Aggregates - General Requirements			

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002	
		VOLUME	II B
		SECTION	D SUB-SECTION – C7
		REV.NO.	00
		SHEET	18 OF 36

Coarse aggregates shall be either crushed or broken stone. The aggregates shall conform to the physical requirements set forth in Table - V.

Table – V

Physical Requirements of Coarse Aggregates for Water Bound Macadam

Sl.No.	Type of Construction	Test	Test method	Requirements
1.	Sub-base	Los Angeles Abrasion Value * or Aggregate Impact Value	IS : 2386 (Part IV) IS : 2386 (Part IV) or IS : 5640**	50 percent maximum 40 percent maximum
2.	Base	a) Loss Angeles Abrasion value* or Aggregate Impact Value b) Flakiness Index ***	IS : 2386 (Part IV) IS : 2386 (Part IV) or IS : 5640 ** IS : 2386 (Part I)	50 percent maximum 40 percent maximum 15 percent maximum

* Aggregates shall satisfy requirements of either of the two tests.

** Aggregates like brick metal, kankar and laterite which get softened in presence of water shall be tested for impact value under conditions in accordance with IS : 5640.

*** The requirements of Flakiness Index shall be enforced only in case of crushed or broken stone and crushed slag.

b) Crushed or Broken Stone

Crushed or broken stone shall be hard, durable and free from excess flat, elongated, soft and disintegrated particles, dirt and other objectionable matters.

c) Grading Requirements of Coarse Aggregates

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002	
		VOLUME	II B
		SECTION	D SUB-SECTION – C7
		REV.NO.	00
		SHEET	19 OF 36

The coarse aggregates shall conform to one of the gradings given in Table – VI. However the use of Grading-1 shall be restricted to sub-base courses only.

**Table - VI
Grading Requirements of Coarse Aggregates**

Grading	Size range	Sieve designation	Percent by weight passing the sieve
1.	90mm to 40 mm	100 mm	100
		80 mm	65 - 85
		63 mm	25 - 60
		40 mm	0 - 15
		20 mm	0 - 5
2.	63 mm to 40 mm	80 mm	100
		63 mm	90 - 100
		50 mm	35 - 70
		40 mm	0 - 15
		20 mm	0 - 5
3.	50 mm to 20 mm	63 mm	100
		50 mm	95 - 100
		40 mm	35 - 70
		20 mm	0 - 10
		10 mm	0 - 5

d) Screenings

Screenings to fill the voids in the coarse aggregate shall generally consist of the same material as the coarse aggregates. However where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent.

As far as possible, screenings shall conform to the grading set forth in Table-VII. Screenings of Type-A in Table-VII shall be used with coarse aggregates of Grading-1 in Table-VI. Screenings of Type-A or B shall be used with coarse aggregates of Grading-2. Screenings of Type-B shall be used with coarse aggregates of Grading-3.

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002	
		VOLUME	II B
		SECTION	D SUB-SECTION – C7
		REV.NO.	00
		SHEET	20 OF 36

**Table - VII
Grading For Screenings**

Grading classification	Size of screenings	Sieve designation	Percent by weight passing the sieve
A	12.5 mm	12.5 mm 10.0 mm 4.75 mm 150 micron	100 90 - 100 10 - 30 0 - 8
B	10 mm	10 mm 4.75 mm 150 micron	100 85 - 100 10 - 30

e) Binding Material

Binding material to be used for water bound macadam construction shall comprise of a suitable material approved by the Engineer having plasticity index value less than 6 as determined in accordance with IS : 2720, Part V. Application of binding material may not be necessary when the screenings used are of crushable type such as moorum or gravel.

3.08.03

Construction Operations

a) The sub-grade/sub-base to receive the water bound macadam coarse shall be prepared to the specified grade and camber and made free of any dust and other extraneous materials. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm. Where water bound macadam is to be laid over an existing black topped surface, 50mm x 50mm furrows shall be cut at an angle of 45 degrees to the centre line of the road at 1m intervals in the latter before laying the coarse aggregates.

b) Inverted Choke

If water bound macadam is to be laid directly over the sub-grade without any other intervening pavement course, a 25mm course of screenings (Grading-B) shall be spread on the prepared sub-grade before application of coarse aggregates is taken up.

c) Spreading Coarse Aggregates

The coarse aggregates shall be spread uniformly over the prepared surface in such quantities that the thickness of each compacted layer is limited to 100mm for Grading-1 and 75 - 100mm for Grading-2 and 3. The spreading

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002			
		VOLUME		II B	
		SECTION		D SUB-SECTION – C7	
		REV.NO.		00	
		SHEET		21	OF

shall be done from stockpiles along the side of the roadway or directly from the vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregates nor shall hauling over permitted. The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregates as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregates as spread shall be of uniform gradation with no pockets of fine material. The coarse aggregates shall not normally be spread more than 3 days in advance of the subsequent construction operation.

d) Rolling

Immediately following the spreading of the coarse aggregates, rolling shall be started with three wheeled power rollers of 8 to 10 tonne capacity or with tandem or vibratory rollers of approved type. The weight of the roller shall depend upon the type of the aggregate and be indicated by the Engineer.

Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to the centre line of the road. Each pass of the roller shall uniformly overlap not less than one half the width of the track made in the preceding pass.

Rolling shall continue until the aggregates are thoroughly keyed and the creeping of aggregates ahead of the roller is no longer visible. During rolling slight sprinkling of water may be done if necessary. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wavelike motion in the sub-grade or sub-base course.

The rolled surface shall be checked transversely and longitudinally with templates and any irregularities found shall be corrected by loosening the surface, adding or removing necessary amount of aggregates and rerolled until the entire surface conform to the desired camber and grade. In no case shall the use of screenings be permitted to make up the depressions.

e) Application of Screenings

After the coarse aggregate has been rolled, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregates. The screenings shall not

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002			
		VOLUME		II B	
		SECTION		D SUB-SECTION – C7	
		REV.NO.		00	
		SHEET		22	OF

be dumped in piles but be spread uniformly in successive thin layers either by the spreading motion of hand shovels or by mechanical spreader or directly from trucks. Trucks operating for spreading the screenings shall be so driven as not to disturb the coarse aggregates.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms or hand brooms or with both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregates.

The spreading, rolling and brooming of screenings shall be carried out in only such lengths of road which could be completed within one day’s operation.

f) Sprinkling and Grouting

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to seep the wet screenings into the voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued with additional screenings applied as necessary until the coarse aggregates are thoroughly keyed, well bonded and firmly set to its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or sub-grade does not get damaged due to the addition of excess quantity of water during construction.

g) Application of Binding Material

After the application of screenings, the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water and the resulting slurry shall be swept in with hand brooms or mechanical brooms to fill the voids properly and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling the voids form a wave ahead of the wheels of the moving roller.

h) Setting and Drying

After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002
		VOLUME II B
		SECTION D SUB-SECTION – C7
		REV.NO. 00
		SHEET 23 OF 36
	with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam is set. The Engineer shall have the discretion to stop hauling traffic from using the complete water bound macadam course if in his opinion it would cause excessive damage to the surface. 3.09.00 Tack Coat 3.09.01 Description The work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction. 3.09.02 Materials The binder used for tack coat shall be bitumen of a suitable grade as approved by the Engineer and conforming to IS-73, IS-217 or IS-454 as applicable or any other approved cutback. 3.09.03 Construction Operations a) Preparation of Base The surface on which the tack coat is to be applied shall be thoroughly swept and scraped clean of dust and any other extraneous materials before the application of the binder. b) Application of Binder Binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Engineer and sprayed on the base at the rate specified below. The rate of spread in terms of straight run bitumen shall be 5 kg per 10 square metre area for an untreated water bound macadam surface. The binder shall be supplied uniformly with the aid of sprayers. The tack coat shall be applied just ahead of the oncoming bituminous construction. 3.10.00 Bituminous Macadam Binder Course 3.10.01 Description This work shall consist of construction in a single course of 50mm/75mm thickness of compacted crushed aggregates premixed with a bituminous binder laid immediately after mixing on a base prepared previously in	

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002	
		VOLUME	II B
		SECTION	D SUB-SECTION – C7
		REV.NO.	00
		SHEET	24 OF 36

accordance with the specification and in conformity with the lines, grades and cross sections shown on the approved drawings.

3.10.02 Materials

a) Binder

The Binder shall be straight run bitumen of a suitable grade as directed by the Engineer complying with IS : 73.

b) Aggregates

The aggregates shall consist of crushed stone, crushed gravel (shingle) or other stones. They shall be clean, strong, durable, fairly cubical in shape and free from any disintegrated pieces, organic and other deleterious matter and adherent coats. The aggregates shall preferably be hydrophobic and of low porosity.

The aggregates shall satisfy the physical requirements set forth in Table - VIII.

Table – VIII
Physical Requirements of Aggregates For Bituminous Macadam

Sl. No.	Test	Test method	Requirements
1.	Los Angeles Abrasion Value *	IS : 2386 (Part IV)	35 percent maximum
2.	Aggregate Impact Value *	IS : 2386 (Part IV)	30 percent maximum
3.	Flakiness Index	IS : 2386 (Part I)	35 percent maximum
4.	Stripping Value	IS : 6241 (Part IV)	25 percent maximum
5.	Water Absorption	IS : 2386 (Part III)	2 percent maximum

*Aggregates may satisfy requirements of either of the two tests.

The aggregates for bituminous macadam for different thickness shall conform to Grading- A or B as given in Table-IX or X as the case may be.

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002	
		VOLUME	II B
		SECTION	D SUB-SECTION – C7
		REV.NO.	00
		SHEET	25 OF 36

Table-IX
Aggregates Grading For 75mm Compacted Thickness Of Bituminous Macadam

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
63 mm	100	
50 mm	90 - 100	
40 mm	35 - 65	100
25 mm	20 - 40	70 - 100
20 mm	-	50 - 80
12.5 mm	5 - 20	-
4.75 mm	-	10 - 30
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

Table-X
Aggregates Grading For 50mm Compacted Thickness Of Bituminous Macadam

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
50 mm	100	
40 mm	90 - 100	
25 mm	50 - 80	100
20 mm	-	70 - 100
12.5 mm	10 - 30	-
10 mm	-	35 - 60
4.75 mm	-	15 - 35
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

c) Proportioning of Materials

The binder content for premixing shall be 3.5 and 4.0 percent by weight of the total mix for aggregate Grading-A and B respectively unless directed otherwise by the Engineer. The quantity of aggregates to be used shall be sufficient to yield the specified thickness after compaction.

d) Variation in Proportioning of Materials

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002
		VOLUME II B
		SECTION D SUB-SECTION – C7
		REV.NO. 00
		SHEET 26 OF 36
The Contractor shall have the responsibility for ensuring proper proportioning of materials and producing a uniform mix. A variation in binder content upto ± 0.3 percent by weight of total mix shall however be permissible for individual specimens taken for quality control tests. 3.10.03 Construction Operations a) Weather and Seasonal Limitations Bituminous macadam shall not be laid during rainy weather or when the base course is damp or wet. b) Preparation of Base The base on which the bituminous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross sections as shown on the drawings and as directed by the Engineer. The surface shall be thoroughly swept and scraped clean and free of any dust and foreign matter. c) Tack Coat A tack coat shall be applied over the base. d) Preparation and Transport of Mix Hot mix plant of adequate capacity shall be used for preparing the mix. The temperature of binder at the time of mixing shall be in the range 150 Deg. - 165 Deg. C and to that of aggregates shall be in the range 125 Deg. - 150 Deg. C provided the temperature difference between the binder and the aggregate at no time exceeds 25 Deg. C. Mixing shall be thorough to ensure that a homogenous mixture is obtained in which all particles of the aggregates are coated uniformly. The mixture shall be transported from the mixing plant to the point of use in a suitable vehicle. The vehicle employed for transport shall be clean and be covered over in transit if so directed by the Engineer. e) Spreading After mixing, the mix shall be spread immediately by means of a self propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix to the specified lines, grade and cross sections. However in restricted locations and in narrow widths where the available plants cannot operate in the opinion of the Engineer may permit		

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002		
		VOLUME	II B	
		SECTION	D	SUB-SECTION – C7
		REV.NO.	00	
		SHEET	27	OF 36
manual laying of the mix. The temperature of mix at the time of laying shall be in the range 110 Deg. - 135 Deg. C. In multilayer construction, the longitudinal joint in one layer shall offset into the layer below by about 150mm. However, the joint in the topmost layer shall be at the centre line of the pavement. Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material. f) Rolling After spreading of mix, the rolling shall be done with 8 to 10 tonne power roller or with any other approved plant. Rolling should start as soon as the materials are spread. Rolling shall be done with care to avoid any undulation in the pavement surface. Rolling on the longitudinal joint shall be done immediately after the paving operation. After this, the rolling shall commence at the edges and progress towards the centre longitudinally except on superelevated portions where it shall progress from the lower to the upper edge parallel to the centre line of the pavement. The initial or breakdown rolling shall be done as soon as it is possible to roll the mixture without cracking the surface and no mix pick up on the roller wheels. The second or intermediate rolling shall follow the break down rolling as early as possible and be done while the paving mix is still at a temperature that will result in maximum density. The final rolling shall be done while the material is still workable enough for removal of roller marks. When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding fresh materials. The rolling shall then be continued till the entire surface has been rolled to compaction and there is no crushing of aggregates and till all the roller marks are eliminated. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The roller wheels shall be kept damp if necessary to avoid the bituminous material from sticking on the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose.				

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002		
		VOLUME	II B	
		SECTION	D	SUB-SECTION – C7
		REV.NO.	00	
		SHEET	28	OF 36
		Rolling operation shall be completed in every respect before the temperature of the mix fall below 80 Deg. C. Rollers shall not stand on the newly laid material as it may lead to undue deformation. The edges along and transverse of the bituminous macadam laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it. The bituminous macadam shall be provided with a final surfacing without any delay. If there is to be any delay the course shall be covered by seal coat before allowing any traffic over it. 3.11.00 Open Graded Premix Carpet 3.11.01 Description This work shall consist of laying and compacting open graded carpet of specified thickness in a single course of suitable small sized aggregates premixed with bituminous binder on a previously prepared base to form wearing course in accordance with the specification. 3.11.02 Materials a) Binder The binder shall be bitumen of suitable grade as approved by the Engineer and satisfying the requirements of IS: 73, 217, 454 or any other approved cutback as applicable. b) Aggregates The aggregates shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be obtained by crushing rock, gravel or river shingle and be free of elongated and flaky pieces, soft and disintegrated materials, vegetable and any other deleterious matter etc. They shall preferably be hydrophobic type. The aggregates shall satisfy the quality requirements set forth in Table-VIII except that the flakiness Index shall be limited to a maximum of 30. c) Proportioning of Materials The materials shall be proportioned as per the quantities given in Table-XI for 20mm thick open graded premix carpet. Table - XI		

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002	
		VOLUME	II B
		SECTION	D SUB-SECTION – C7
		REV.NO.	00
		SHEET	29 OF 36

**Quantity of Materials Required For 10 Sq. M of Road Surface For 20mm Thick
Open Graded Premix Carpet**

Aggregates for Carpet

i)	Stone Chippings - 12mm size ; passing 20 mm sieve and retained on 10 mm sieve	0.18 Cu.m
ii)	Stone Chippings - 10 mm size; passing 12.5 mm sieve and retained on 6.3 mm sieve	0.09 Cu.m
	Total	<u>0. 27 Cu.m</u>

Binder for premixing (quantities in terms of straight run bitumen)

i)	For 0. 18 Cu.m of 12 mm size stone Chippings at 52 Kg per Cu.m	9.5 Kg
ii)	For 0.09 Cu. M of 10mm size stone Chippings at 56 Kg per Cu.m	5.1 Kg
	Total	<u>14.6 Kg</u>

3.11.03 Construction Operation

a) Weather and Seasonal Limitations

Open graded premix carpet shall not be laid during rainy weather or when the base course is damp or wet or when the atmospheric temperature in shade is 16 Deg. C or below.

b) Preparation of Base

The underlying base on which the bituminous carpet is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross section in accordance with the drawing, specification and as directed by the Engineer. The surface shall be well cleaned by removing caked earth and other foreign matters with wire brushes, sweeping with brooms and finally dusting with sacks as necessary.

c) Tack Coat

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002			
		VOLUME	II B		
		SECTION	D	SUB-SECTION – C7	
		REV.NO.	00		
		SHEET	30	OF	36

A tack coat complying with clause 3.09.00 shall be applied over the base preparatory to laying of the carpet. However application of tack coat shall not be necessary when the laying of carpet follows soon after laying the bituminous course.

d) Preparation of Premix

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer in boilers of suitable design avoiding local overheating and ensuring a continuous supply. The aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before these are placed in the mixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified. The mixing of binder with chipping shall be continued until the chippings are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheel barrows. The vehicles employed for transport shall be clean and be covered over in transit if so directed.

e) Spreading and Rolling

The premixed material shall be spread on the road surface with rakes to the required thickness and camber or distributed evenly with the help of a drag spreader without any undue loss of time. The camber shall be checked by means of camber boards and inequalities evened out. As soon as sufficient length of bituminous material are laid, rolling shall be commenced with 6 to 8 tonne power rollers preferably with smooth wheel tandem type or with any other approved plant. Rolling shall begin at the edges and progress toward the centre longitudinally except on the superelevated portions where it shall progress from the lower to upper edge parallel to the centre line of the pavement.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled to compaction and all the roller marks have been eliminated. In each pass of the roller, preceding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose. Rollers shall not stand on newly laid material as it may lead to undue deformations.

The edges along and transverse of the carpet laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002		
		VOLUME		II B
		SECTION	D	SUB-SECTION – C7
		REV.NO.	00	
		SHEET	31	OF 36
		painted with a thin surface coat of approved binder before the new mix is placed against it. f) Seal Coat A seal coat conforming to clause 3.12.00 shall be applied to the surface immediately after laying the carpet. No traffic shall be allowed on the road till the seal coat has been placed. 3.12.00 Seal Coat 3.12.01 Description This work shall consist of application of a seal coat as specified for sealing the voids in the bituminous surface laid to the specified levels, grade and camber. <u>Type-A</u> : Liquid seal coat comprising of an application of a layer of bituminous binder followed by a cover of stone chippings. <u>Type-B</u> : Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder. 3.12.02 Materials a) Binder The binder shall be bitumen of suitable grade as directed by the Engineer and conforming to the requirements of IS : 73, 217 or 454 as applicable or any other approved cutback. The quantity of binder to be adopted in terms of straight run bitumen shall be 9.8 Kg and 6.8 Kg per 10 square metre area for Type-A and Type-B seal coat respectively. b) Stone Chippings for Type A Seal Coat The stone chippings shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be free of elongated or flaky pieces, soft or disintegrated stone, vegetable or other deleterious matters etc. Stone chippings shall be of 6mm size defined as 100 percent passing through 10mm sieve and retained on 2.36mm sieve. The quantity used for spreading shall be 0.09 cu.m per 10 sq.m area. The chippings shall satisfy the quality requirements spelled out in Table- VIII except that the upper limit for flakiness Index shall be 30.		

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002
		VOLUME II B
		SECTION D SUB-SECTION – C7
		REV.NO. 00
		SHEET 32 OF 36
3.12.03 Construction Operations		
c) Fine Aggregate for Type B Seal Coat		
The fine aggregate shall be sand or fine grit and shall consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky material, organic matter or other deleterious substances. The aggregate shall pass 1.7 mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cubic metre per 10 square metre area.		
a) Preparation of Base		
The seal coat shall be applied immediately after laying the bituminous course which is required to be sealed. Before application of seal coat, the surface shall be cleaned free of any dust or other extraneous matters.		
b) Construction of Type-A Seal Coat		
The binder shall be heated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer and sprayed on the dry surface in a uniform manner preferably with the help of mechanical sprayers. Excessive deposits of binder caused by stopping or starting of the sprayer or through leakage or due to any other reason shall be suitably corrected before the stone chippings are spread.		
Immediately after the application of binder, stone chippings in a dry and clean state shall be spread uniformly on the surface preferably by means of a mechanical grittier or otherwise manually so as to cover the surface completely. If necessary the surface shall be broomed to ensure uniform spread of chippings. Immediately after the application of the cover material, the entire surface shall be rolled with a 8 - 10 tonne smooth wheeled roller. Rolling shall commence from the edges and progress towards the centre except in superelevated portions where it shall proceed from the inner edge to the outer. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. While rolling is in progress additional chippings shall be spread by hand in whatever quantities required to make up the irregularities. Rolling shall continue until all aggregate particles are firmly bedded in the binder and present an uniform closed surface.		
c) Construction of Type-B Seal Coat		
Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated in boilers of suitable		

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002		
		VOLUME		II B
		SECTION		D SUB-SECTION – C7
		REV.NO.		00
		SHEET		33 OF 36
		design to the temperature appropriate to the grade of bitumen approved by the Engineer. Also the aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before the same are placed in the mixer. Mixing of binder with aggregates to the specified proportions shall be continued till the latter is thoroughly coated with the former. The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed. As soon as sufficient length has been covered with the premixed material, the surface shall be rolled with 6 - 8 tonne smooth wheeled power rollers. Rolling shall be continued till the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained. 3.12.04 Opening to Traffic In case of Type-B Seal coat, traffic may be allowed soon after the final rolling when the premixed materials are cooled down to the surrounding temperature. However in case of Type- A seal coat, the traffic shall not be permitted until the following day. 3.13.00 Repair of Existing Water Bound Macadam Surfaces Pot holes or patches and ruts in the water bound macadam base or surface course which is to be surface treated shall be repaired by removing all loose materials by cutting in rectangular patches and replacing with suitable materials. The repair shall be done as under. Pot holes, patches and ruts shall be drained of any water and cut to regular shape with vertical sides and then be filled either with i) coarse aggregates and screenings conforming to the specification for water bound macadam and compacted with rollers or other approved rammer etc or with ii) premixed material conforming to the specification for open graded premix carpet and compacted with rollers or other approved means after painting the sides and bottom of the holes with a thin application of bitumen or a combination of both as directed by the Engineer. 3.14.00 Road Side Drains 3.14.01 Drains The road side drains shall be made in sizes and slopes as shown on the approved drawings. The sides and bottom shall be neatly dressed after excavation. Proper connections shall be made to the culverts outside the plant area as per the drawings and instructions of the Engineer. The excavated spoils other than that required for backfilling shall be transported and filled in low areas within the plant area or in embankments		

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002		
		VOLUME		II B
		SECTION		D SUB-SECTION – C7
		REV.NO.		00
		SHEET		34 OF 36
		as instructed by the Engineer. The lining for drains shall be as per the drawings. Lining of drains may be of bricks or cement concrete blocks of specified grade as shown on the approved drawing or as directed by the Engineer. If shown on approved drawing, drains shall be of R.C.C. construction with necessary slopes. 3.15.00 Culverts Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the drawings and instructions of the Engineer after clearing the site etc. As described in the “Specification for Earthwork in Excavation and Backfilling”, backfilling in layers with watering and compaction shall be done after the construction of foundations. The construction of culverts shall be done true to the lines and levels as shown on the drawings. The specification for Masonry and/or Plain and Reinforced Cement concrete shall be followed as applicable. 3.16.00 Pipe Culverts and Drainage Pipes 3.16.01 Materials The drainage pipes shall be made of R.C.C and shall be either class NP-2 or NP-3 as shown on the approved drawings. Pipe culverts shall be made of reinforced concrete pipe and shall be of class NP4 or RDSO class for railways as shown in the drawing. All pipes shall meet the requirements of IS : 458 and shall be procured from approved manufacturers with collars as per manufacturer’s specification. The tenderer shall specifically mention the particular manufacturer’s product he proposes to use. Cement shall be ordinary Portland Cement as per IS:269. Coarse Aggregates shall be as per IS:383. Maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller. Fine aggregates for concrete shall be as per IS:383. 3.16.02 Laying of Pipes Laying of concrete pipes shall correspond to IS:783 and as per the specification given below. a) The foundation bed for pipe shall be excavated true to lines and grades shown on the drawings and as directed by the Engineer. When trenching is involved, its width on either side of the pipe shall not be less than 150mm and not more than one third the diameter of pipe unless otherwise instructed/permitted by the Engineer. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, bailing out water etc as required shall be done by the Contractor.		

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002		
		VOLUME	II B	
		SECTION	D	SUB-SECTION – C7
		REV.NO.	00	
		SHEET	35	OF 36
Side slips if there be any shall be removed by the Contractor. After laying of the pipes are completed, backfilling of the trenches shall be done as per “Specification for Earthwork in Excavation and Backfilling” to the satisfaction of the Engineer. The surplus spoils shall be transported and filled in low areas within the plant area as instructed by the Engineer. When bedrock or boulder stratum is encountered during excavation, the excavation shall be taken down to at least 200mm below the bottom of the pipe with prior permission of the Engineer and all rock/boulders in the area shall be removed and space filled with approved earth free from stone or fragmented materials, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe. Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur and shall be done as per the “Specification for Earthwork in Excavation and Backfilling”. When two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm. Laying of pipes shall start from the outlet and proceed towards inlet. All pipes and fittings shall be gradually lowered into the trench or placed on the supports by approved means taking due care to avoid any damage. Under no circumstances the pipes shall be dropped into the trench or on supports from heights. b) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS : 783 having a projection ratio not greater than 0.70. The pipe shall be carefully laid on bedding made up of fine granular materials in an earth foundation; the bedding shall be carefully shaped to fit the lower part of the pipe exterior for at least ten percent of its overall height and in which the fill material is thoroughly compacted in layers not exceeding 150mm in depth around the pipe for the remainder of the pipe laid in trench. When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a cradle constructed of concrete having a mix not leaner than M-15. The shape and dimension of the cradle shall be as indicated on the drawing or as directed by the Engineer. The pipe shall be laid on the concrete bedding before the concrete is set. c) The drop walls shall be made with first class brickwork in 1:4 cement mortar. d) The pipe culverts shall be made with proper care with respect to the invert of the pipe, gradient if any etc as specified on the drawings and as instructed by the Engineer.				

	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002
		VOLUME II B
		SECTION D SUB-SECTION – C7
		REV.NO. 00
		SHEET 36 OF 36
	e) Where R.C.C pipes are encased in concrete at road crossings or at other places the pipes need be suitably supported avoiding reinforcements of concrete blocks, joints properly done before concreting is taken up. Concreting of total height of block may be done in a single operation or may be done upto some height for pipes to be properly laid in position and the balance height of the block shall be concreted subsequently. f) The R.C.C. pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part of cement and 2 part of clean sand with only enough water for workability. Procedure of jointing shall be as per IS : 783.	
3.16.03	Relation With Water Supply Pipeline	
	Unless specifically cleared by the Engineer, under no circumstances shall the drainage pipes be allowed to come close to water supply pipelines.	
3.17.00	Manholes and Inspection Chambers	
	The maximum distance between the manholes shall be 30m unless specifically permitted otherwise. In addition, at every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The distance between the manhole or inspection chamber and gully chamber shall not exceed 6 meters unless permitted otherwise. Manhole shall be constructed so as to be water tight under test. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide a smooth flow. Connection to the existing pipelines shall be through a manhole. Manholes shall be provided with standard covers usually of C.I. or as directed by the Engineer. The cover shall be closely fitted so as to prevent gases from coming out.	
4.00.00	Testing And Acceptance Criteria	
	All testing as mentioned in the specification and as mentioned in Clause No. 900 of the “Specification for Roads and Bridge Works, 1983” published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the Contractor as per the direction of the Engineer.	
5.00.00	MEASUREMENT	
	Method of measurement shall be as per the latest version of IS:1200, Part-17 and as directed by the Engineer.	



**TECHNICAL SPECIFICATION FOR
CARPENTRY & JOINERY**

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME - II B

SECTION - D | SUB-SECTION – C12

REV.NO. 00

SHEET 1 OF 6

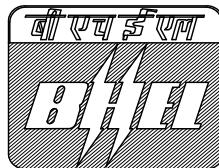
**VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS**

SPECIFICATION NO. PE-TS-412-600-C002

SECTION - D

GENERAL TECHNICAL SPECIFICATION

CARPENTRY & JOINERY



Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301



TECHNICAL SPECIFICATION FOR CARPENTRY & JOINERY

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME - II B

SECTION - D | SUB-SECTION – C12

REV.NO. 00

SHEET 2 OF 6

TABLE OF CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.0	SCOPE	3
2.0	FALSE FLOORING SYSTEM	3
3.0	ACCEPTANCE CRITERIA	5
4.0	I.S. CODES	6



TECHNICAL SPECIFICATION FOR CARPENTRY & JOINERY

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME - II B

SECTION - D | SUB-SECTION – C12

REV.NO. 00

SHEET 3 OF 6

TECHNICAL SPECIFICATION FOR CARPENTRY & JOINERY

1.0 SCOPE

This shall include supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, paneled or flush doors, windows, shutters, partitions, wall paneling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate. This shall also include the supply and fixing of all hardware and fixtures shown in drawing.

2.0 INSTALLATION

2.1 Materials

a) Timber

Unless otherwise specified, all timber shall be best quality well seasoned C P teakwood free from large or loose, knots cracks or other defects. Where specified, timber shall be treated with approved wood preservative before use. Before starting the carpenters work, the Tenderer shall have the rough timber approved by the Engineer.

b) Plywood

Plywood shall be commercial quality with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol-formaldehyde resin of B W R grade conforming to IS:848.

c) Decorative Laminated Plastic Sheets

The colour, pattern, finish and texture shall be approved by the Engineer and the bulk supply procured in sheet sizes which will ensure the least number of joints in one surface.

d) Flush Doors

Flush doors shall be hollow or solid core doors with commercial or decorative faces and hardwood edges. The core for solid core doors shall be of block board or wood particle board. Manufacturer's literature and test certificates shall be submitted for the approval of the Engineer.

	TECHNICAL SPECIFICATION FOR CARPENTRY & JOINERY	<table border="1"> <tr> <td colspan="3">SPECIFICATION NO. PE-TS-412-600-C002</td> </tr> <tr> <td colspan="3">VOLUME - II B</td> </tr> <tr> <td>SECTION - D</td> <td colspan="2">SUB-SECTION – C12</td> </tr> <tr> <td>REV.NO.</td> <td colspan="2">00</td> </tr> <tr> <td>SHEET</td> <td>4</td> <td>OF 6</td> </tr> </table>	SPECIFICATION NO. PE-TS-412-600-C002			VOLUME - II B			SECTION - D	SUB-SECTION – C12		REV.NO.	00		SHEET	4	OF 6
SPECIFICATION NO. PE-TS-412-600-C002																	
VOLUME - II B																	
SECTION - D	SUB-SECTION – C12																
REV.NO.	00																
SHEET	4	OF 6															
	The Contractor shall give a guarantee that the adhesive used is phenol formaldehyde of B W R grade, conforming to IS:848. The thickness shall be as specified in the drawing. e) Panel Doors Panel door shall be of teakwood shutter frame and panels of teakwood. Other considerations shall be as mentioned in item (d) above. f) Fixtures Fixtures for doors, windows, furniture, etc. shall be as shown on drawing. 2.2 Workmanship 2.2.1 General The work shall be done by skilled carpenters as per details shown on drawing or instructed by the Engineer. Framing timber and other work shall be close-fitting with proper wood joinery, accurately set to required lines or levels and rigidly secured in place. The surface of frames etc. which will come in contact with masonry after fixing, shall be given two coats of approved paint before fixing. Mastic caulking shall be done after fixing external door and window frames. Special care shall be taken to match the grain of timber or plywood which will be subsequently polished. Screwing or nailing will not be permitted to the edge of plywood and particle board. The edge of all plywood, blockboard and particle board shall be finished with teakwood lipping unless otherwise shown on drawings. Fixing for frames and partitions shall generally be with 40 mm x 6 mm x 300 mm long M S holdfasts bifurcated at end and grouted with 1:2:4 cement concrete. The gap between masonry and external door and window frame shall be caulked with polysulphide mastic. M S grills or guard bars shall be provided to windows where called for in the drawings. 2.2.2 Finish																



TECHNICAL SPECIFICATION FOR CARPENTRY & JOINERY

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME - II B

SECTION - D | SUB-SECTION – C12

REV.NO. 00

SHEET 5 OF 6

All carpentry work after finishing shall be sand papered smooth. A prime coat paint shall be given after inspection of the Engineer to all surfaces other than those which shall be subsequently polished or covered with laminated plastic sheet.

2.2.3 Surface Treatment

When shown on drawings decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of approved brand and brought to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer's instructions. The edge of sheets shall be protected by teak lipping or beveled as shown on drawings.

3.0 ACCEPTANCE CRITERIA

3.1 Door and Window Frames

All frames shall be square and flat at the time of delivery and shall be checked for dimensions and corner angles. After fixing they shall be on a fine vertical plane. All external door and window frames shall be caulked with mastic.

3.2 Door and Window Shutters

Shall be of proper size, shape and design and free of warp. When fixed to frames, these shall operate smoothly without jamming and all latching or locking devices shall engage properly without undue pressure.

3.3 Partitions, Paneling, Pelmet, Furniture, etc.

3.3.1 General

These shall conform to drawings in all details. No unsightly nailmarks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

	TECHNICAL SPECIFICATION FOR CARPENTRY & JOINERY	SPECIFICATION NO. PE-TS-412-600-C002			
		VOLUME - II B			
		SECTION - D		SUB-SECTION – C12	
		REV.NO. 00			
		SHEET	6	OF	6

3.3.2

Partition

Shall be checked for rigidity of fixing, plumb and horizontal as well as vertical alignment.

3.3.3

Pelmets

Shall be checked for rigidity of fixing and adequate clearance of fixture.

3.3.4

Cupboard Shutters

Shall operate smoothly without jamming and locks, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.3.5

Drawers

Shall operate smoothly and have back stops to prevent them from being pushed too far. Locks shall engage securely.

3.3.6

Loose Furniture

When placed on a level surface tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.0

I.S. CODES

Some of the important relevant Codes for the Section are:

IS:4021 - Timber door, window and ventilator frames.

IS: 1003 - Timber paneled and glazed shutters.

IS:2191 - Wooden flush door shutter (Cellular and hollow core type).

IS:2202 - Wooden flush door shutters (solid core type).



**TECHNICAL SPECIFICATION FOR
ROLLING STEEL
SHUTTERS/GRILLS**

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME - II B

SECTION - D | SUB-SECTION – C16

REV.NO. 00

SHEET 1 OF 5

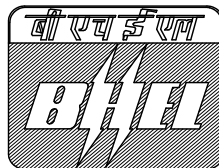
**VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS**

SPECIFICATION NO. PE-TS-412-600-C002

SECTION - D

GENERAL TECHNICAL SPECIFICATION

ROLLING STEEL SHUTTERS/GRILLS



**Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301**



**TECHNICAL SPECIFICATION FOR
ROLLING STEEL
SHUTTERS/GRILLS**

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME - II B

SECTION - D | SUB-SECTION – C16

REV.NO. 00

SHEET 2 OF 5

TABLE OF CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.0.0	SCOPE	3
2.0.0	INSTALLATION	3
3.0.0	ACCEPTANCE CRITERIA	5
4.0.0	I.S. CODES	5

	TECHNICAL SPECIFICATION FOR ROLLING STEEL SHUTTERS/GRILLS	SPECIFICATION NO. PE-TS-412-600-C002			
		VOLUME - II B			
		SECTION - D		SUB-SECTION – C16	
		REV.NO. 00			
		SHEET	3	OF	5

**TECHNICAL SPECIFICATION
FOR
ROLLING STEEL SHUTTERS/GRILLS**

1.0.0 SCOPE

This specification covers the design, supply of materials, fabrication, delivery and erection of Rolling Shutters/Grills with motor drive and/or manual operation including all accessories as hereinafter specified.

2.0.0 INSTALLATION

2.1.0 Components

a) Slats for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 4.5 M wide and not less than 2.25 mm thick for shutters 5.5 M wide and above, machine rolled at 75 mm rolling centres, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.

b) Rolling grills shall be constructed out of 6 mm dia. rods at 35 mm on centres running horizontally flexible connected with vertical links spaced not more than 200 mm centres. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6 mm dia rods.

c) End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats unless specified otherwise in the Schedule.

d) Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor.

e) Guides shall be of such depth as to retain the shutter under a wind pressure of 100 Kg/Sq.M or as specified in Schedule.

f) Shafts shall be of steel pipe of sufficient size to carry the torsion load with a maximum deflection of 1/360th of span.

Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.

g) Hoods shall be formed of not less than 20 gauge steel, suitable reinforced to prevent sag.

h) Locks shall be slide bolt and hasp, or cylinder lock operable from one or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc. shall be made as described

	TECHNICAL SPECIFICATION FOR ROLLING STEEL SHUTTERS/GRILLS	SPECIFICATION NO. PE-TS-412-600-C002 VOLUME - II B SECTION - D SUB-SECTION – C16 REV.NO. 00 SHEET 4 OF 5
	in Schedule or as described by the Engineer. i) Power unit shall be suitable for 3 phase, 50 cycle, 400 volt A.C. power supply and shall be either floor or wall mounted unit. The motor shall be of sufficient capacity to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building unless otherwise stated drawing. It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction. j) Operating chains shall be of tested quality, heavily galvanised and with all ends rounded to assure smooth operation and hand protection. k) Reduction gears shall be high strength gray cast iron, machine moulded from machine out patterns. 2.2.0 Manually Operated Shutters/Grills Manually operated shutters shall be easily operable by one person. The speed of operation shall be about 1.3 metres per second. In general, manually operated shutters shall be push pull type for openings upto 9 Sq.metre in area. Larger shutters shall be either chain and gear operated or crank and gear operated. The crank handle shall be removable. All shutters shall be lockable from one or both sides as described as desired by the Engineer. 2.3.0 Power Operated Shutters/Grills These shall be operable from a push button station conveniently located beside the door or as shown on drawings. One emergency hand chain/crank operation shall also be provided for use in case of failure of the electric system. Where called for in Schedule, externally mounted shutters shall be operated by control mechanism located inside the building. 2.4.0 Shop Coat Shutters shall be painted with one coat of red lead or zinc chromate primer. Where specified, doors shall be galvanized and subsequently painted one coat of zinc chromate for adhesion of field coat. 2.5.0 Erection Door shall be installed by the manufacturer or his authorised representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to concrete, masonry etc. shall be made good after erection of shutters and all abrasion to shop coat shall be touched up. All electrical work shall be in strict accordance with the latest Indian Electricity Rules.	

	TECHNICAL SPECIFICATION FOR ROLLING STEEL SHUTTERS/GRILLS	SPECIFICATION NO. PE-TS-412-600-C002			
		VOLUME - II B			
		SECTION - D		SUB-SECTION – C16	
		REV.NO.	00		
		SHEET	5	OF	5
3.0.0 ACCEPTANCE CRITERIA					
3.1.0 Shop Inspection					
After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.					
3.2.0 Field Inspection					
After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault-free performance.					
3.3.0 Guarantee					
The Contractor shall give one year's guarantee for the successful operation of the shutters. This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters.					
4.0.0 I.S. CODE					
IS : 6248 - Metal rolling shutters and rolling grills.					



**TECHNICAL SPECIFICATION FOR
MISCELLANEOUS METAL**

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME - II B

SECTION - D | SUB-SECTION – C17

REV.NO. 00

SHEET 1 OF 6

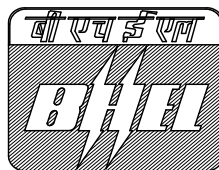
**VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS**

SPECIFICATION NO. PE-TS-412-600-C002

SECTION - D

GENERAL TECHNICAL SPECIFICATION

MISCELLANEOUS METAL



**Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301**

	TECHNICAL SPECIFICATION FOR MISCELLANEOUS METAL	SPECIFICATION NO. PE-TS-412-600-C002		
		VOLUME - II B		
		SECTION - D		SUB-SECTION – C17
		REV.NO. 00		
		SHEET 2	OF	6
TABLE OF CONTENT				
CLAUSE NO.	DESCRIPTION	PAGE NO.		
1.0.0	SCOPE	3		
2.0.0	INSTALLATION	3		
3.0.0	ACCEPTANCE CRITERIA	6		
4.0.0	I.S. CODES	6		

	TECHNICAL SPECIFICATION FOR MISCELLANEOUS METAL	<table> <tr> <td colspan="3">SPECIFICATION NO. PE-TS-412-600-C002</td></tr> <tr> <td colspan="3">VOLUME - II B</td></tr> <tr> <td>SECTION - D</td><td colspan="2">SUB-SECTION – C17</td></tr> <tr> <td>REV.NO.</td><td colspan="2">00</td></tr> <tr> <td>SHEET</td><td>3</td><td>OF 6</td></tr> </table>	SPECIFICATION NO. PE-TS-412-600-C002			VOLUME - II B			SECTION - D	SUB-SECTION – C17		REV.NO.	00		SHEET	3	OF 6
SPECIFICATION NO. PE-TS-412-600-C002																	
VOLUME - II B																	
SECTION - D	SUB-SECTION – C17																
REV.NO.	00																
SHEET	3	OF 6															
TECHNICAL SPECIFICATION FOR MISCELLANEOUS METAL 1.0.0 SCOPE This specification shall generally be read in conjunction with item nos. 6.01 & 6.03. This shall include supply, fabrication and erection of miscellaneous metal items of light nature in gates, grills, balcony and stair handrails particulars, structural mullions and transoms, ladders hangers masonry anchors, shelf angles, anchor bolts, fasteners, etc. as shown on drawing or as instructed by the Engineer. The above items shall be of fabricated or cast M.S/Aluminium/Brass, cast iron, M.S. and galvanised M.S. Sheets, aluminium sheets, expanded metal, wire mesh etc. as shown on drawings and/or described. 2.0.0 INSTALLATION 2.1.0 Fabrication/Casting 2.1.1 General All work shall be done according to approved shop drawings. All workmanship shall be equal to the best practice in modern structural or foundry shop. 2.1.2 Shop Connections - All shop connections shall be riveted or welded except when noted otherwise on drawings. - Welding of steel shall be done in accordance with the IS : 816. Use of metal arc welding for general construction in Mild Steel. - Welding of aluminium shall be done in accordance with IS: 2812, Arc welding of Aluminium and Alloys, Special care shall be taken to grind smooth all welded surface that shall remain exposed to view. Welds shall be electrically continuous if so required by the Engineer. 2.1.3 Shop Coat																	

	TECHNICAL SPECIFICATION FOR MISCELLANEOUS METAL	SPECIFICATION NO. PE-TS-412-600-C002 VOLUME - II B SECTION - D SUB-SECTION – C17 REV.NO. 00 SHEET 4 OF 6
	Before leaving the shop, all metal work shall be thoroughly cleaned by effective means of all loose mill/ scale, rust and foreign matter. Except where encased in concrete, all steelwork shall be given one coat of approved metal protective paint, applied by brush thoroughly and evenly, well worked into joints and other open spaces. All paint shall be applied to dry surfaces. Steel work shall be galvanised or galvanized and painted with a coat of zinc chromate primer. Aluminium surfaces which shall come in contact with masonry shall be given one coat of zinc chromate primer. 2.2.0 Erection 2.2.1 Bracing The Contractor shall provide all necessary temporary guys and braces to ensure alignment and stability of the members and to take care of all loads to which the structure may be subjected including erection of equipment and operation of the same. 2.2.2 Temporary Bolting-Up As erection proceeds the Contractor shall plumb up and level all members and shall securely bolt up to take care of all dead load, wind load and erection stresses. Wherever piles of materials, erection equipment or other loads are carried during erection, proper provision shall be made to take care of the stresses resulting from the same. 2.2.3 Turned Bolt For field connections where bolting is specified, holes for the turned bolts may be reamed in the field, if required. All drilling or reaming for turned bolts shall be done after the parts to be connected are assembled. 2.2.4 Welding Where specified on drawings, welding shall be done in accordance with IS : 816 for steel and IS: 2812 for Aluminium and Alloys. 2.2.5 Cutting and Fitting No cutting of sections, flanges, webs of angles shall be done without the approval of the Engineer. Where indicated on the drawings, holes, cuttings, etc. shall be provided as required for installation, to the work by the other Contractors. No additional holes or cuttings, than those shown on drawings, shall be made without the approval of the Engineer.	

	TECHNICAL SPECIFICATION FOR MISCELLANEOUS METAL	SPECIFICATION NO. PE-TS-412-600-C002			
		VOLUME - II B			
		SECTION - D		SUB-SECTION – C17	
		REV.NO.	00		
		SHEET	5	OF	6

2.2.6

Drifting

Correction of minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets may be permitted. For this, light drifting may be allowed to draw holes together. Twist drills shall be used to enlarge as necessary to make connections. Reaming that weakens the members or make it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins or a moderate amount of reaming and slight chipping and cutting shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of cutting torches to enlarge or alter rivet holes shall not be permitted.

2.2.7

Grouting

All bearing plates, loose lintels and beams, etc. shall be set to proper grade and level by the Contractor and the Engineer's approval obtained before proceeding with the grouting. Grouting shall be done in 1:1.5:3 or 1:1- 1/2:3 concrete with 6 mm down stone chips.

2.2.8

Anchor Bolting

When shown on drawings, the miscellaneous metal items shall be fixed to concrete by case hardened and drawn carbonizing steel expander nut and bolt. The Contractor shall submit the manufacturer's literature showing the average pull out and average shear values for bolts of various sizes. The bolts shall be fixed strictly as per the manufacturer's instructions.

2.2.9

Pipe Joints

M.S. Pipes shall be joined by threaded sockets or by welding. Cast iron pipes shall be socket and spigot jointed and caulked with hemp and molten lead.

2.2.10

Spot Painting

All field rivets and bolts and also any serious abrasion to shop paint shall be spot painted with the same materials as used for the shop paint.

2.2.11

Making Good

All cutting to concrete or masonry shall be made good to the satisfaction of the Engineer.

	TECHNICAL SPECIFICATION FOR MISCELLANEOUS METAL	SPECIFICATION NO. PE-TS-412-600-C002			
		VOLUME - II B			
		SECTION - D		SUB-SECTION – C17	
		REV.NO.	00		
		SHEET	6	OF	6

3.0.0

ACCEPTANCE CRITERIA

a)

All items shall be of correct shape, size, weight etc. shown on drawings.

b)

For installed items, the tolerances shall be follows :

i)

Permissible deviation from straightness - 1 in 1000.

ii)

Seats, stiffener connections etc. shall be as per approved drawings and shall not interfere with architectural clearances.

c)

All castings shall be free from blow holes, cracks and other blemishes.

4.0.0

I.S. CODES

IS : 226

-

Structural Steel (Standard Quality)

IS:800

-

Code of practice for use of structural steel in general building construction.

IS : 816

-

Use of metal arc welding for general construction in mild steel.

IS : 2812

-

Arc welding of Aluminium and Alloys

IS : 3150

-

Hexagonal Wire Netting

IS : 4948

-

Welded steel wire fabric for general use.



TECHNICAL SPECIFICATION FOR
ROOF WATER PROOFING, INSULATION
AND ALLIED WORKS

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME - II B

SECTION - D | SUB-SECTION – C19

REV.NO. 00

SHEET 1 OF 7

VOLUME – II B

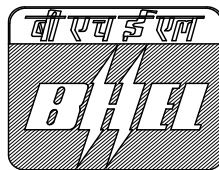
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

SPECIFICATION NO. PE-TS-412-600-C002

SECTION - D

GENERAL TECHNICAL SPECIFICATION

ROOF WATER PROOFING, INSULATION AND ALLIED WORKS



Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301



**TECHNICAL SPECIFICATION FOR
ROOF WATER PROOFING, INSULATION
AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME - II B

SECTION - D | SUB-SECTION – C19

REV.NO. 00

SHEET 2 OF 7

TABLE OF CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.0.0	SCOPE	3
2.0.0	INSTALLATION	3
3.0.0	ACCEPTANCE CRITERIA	7
4.0.0	I.S. CODES & STANDARDS	7

	TECHNICAL SPECIFICATION FOR ROOF WATER PROOFING, INSULATION AND ALLIED WORKS	<table border="1"> <tr> <td colspan="3">SPECIFICATION NO. PE-TS-412-600-C002</td> </tr> <tr> <td colspan="3">VOLUME - II B</td> </tr> <tr> <td>SECTION - D</td> <td colspan="2">SUB-SECTION – C19</td> </tr> <tr> <td>REV.NO.</td> <td colspan="2">00</td> </tr> <tr> <td>SHEET</td> <td>3</td> <td>OF 7</td> </tr> </table>	SPECIFICATION NO. PE-TS-412-600-C002			VOLUME - II B			SECTION - D	SUB-SECTION – C19		REV.NO.	00		SHEET	3	OF 7
SPECIFICATION NO. PE-TS-412-600-C002																	
VOLUME - II B																	
SECTION - D	SUB-SECTION – C19																
REV.NO.	00																
SHEET	3	OF 7															
TECHNICAL SPECIFICATION FOR ROOF WATER PROOFING, INSULATION AND ALLIED WORKS 1.0.0 SCOPE This specification covers furnishing, installation, repairing, finishing, curing, testing,, protection, maintenance till handing over of roof water-proofing, insulation and allied work for buildings and at locations covered under the scope of the Contract. 2.0.0 INSTALLATION 2.1.0 Grading Underbed The surface to receive the underbed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed. The underbed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water for at least 7 days. The underbed shall be laid to provide an ultimate run off gradient not less than 1 in 120 and as directed by the Engineer. Upto an average thickness of 25 mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete. The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be. 2.1.1 The grading plaster shall be average 25mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The same and cement shall be thoroughly mixed dry and then water added. Each batch of mix shall be consumed before the initial set starts. The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth. 2.2.0 Concrete The concrete shall be used where the subgrade is more than average 25mm thick. It shall consist of cement concrete 1:2:4 nominal mix by volume with 12mm down stone chips and coarse sand. The aggregate shall be mixed dry and minimum quantity of water shall be added to make the mix workable. The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.																	

	TECHNICAL SPECIFICATION FOR ROOF WATER PROOFING, INSULATION AND ALLIED WORKS	SPECIFICATION NO. PE-TS-412-600-C002 VOLUME - II B SECTION - D SUB-SECTION – C19 REV.NO. 00 SHEET 4 OF 7
2.3.0	Insulation The Tenderer shall along with the tender send specification of insulating materials he proposes to use and the proposed method of laying. Before bulk supply, the contractor shall send samples of insulating material to the Engineer, and after approval of the samples, the Contractor shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Contractor shall furnish test certificates from testing laboratory on the insulating and other properties of the materials. After laying the insulation the surface shall be made ready as required to receive the waterproofing treatment. If any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12mm and it shall be cured for seven days. 2.3.1 Foam Concrete This shall be of light weight foam concrete of average 50 mm thickness or as specified or as shown on drawings. This may be laid in situ in suitable panels or in precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl m/m degree C. The weight of the insulating material shall be from 0.3 to 0.5 gm/cm. Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer. The foam concrete laid shall be sufficiently strong to make the usual work load and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation. While laying the foam concrete, samples from each batch of the mix shall be kept for test if so desired by the Engineer. 2.3.2 Expanded Polystyrene Blocks The expanded polystyrene block insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 KCl m/m degree C. It must be strong enough to withstand without deformation the workload and standard loads expected on the roof. The Contractor shall lay the expanded polystyrene block as per manufacturer's approved specification. Only specifically experienced workers shall be used for this work. If the Engineer is not satisfied about the efficiency of the workers the Contractor shall have to secure manufacturer's supervision. Either of above items (cl. No. 2.03.01 or 2.03.02) can be adopted subject to approval of engineer. 2.4.0 Fillets	



TECHNICAL SPECIFICATION FOR ROOF WATER PROOFING, INSULATION AND ALLIED WORKS

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME - II B

SECTION - D | SUB-SECTION - C19

REV.NO. 00

SHEET 5 OF 7

Fillets at junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix by volume.

2.5.0 **Water proofing by epoxy resin based application**

Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin based application shall be thoroughly cleaned and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration from fire, sun, light traffic. The application shall be resistant to growth of fungus and proof against saltpetre action. If desired by the Engineer, a sample shall be prepared in advance and tested for waterproofness for 48 hours under 300 mm depth of standing water. The Contractor shall arrange the demonstration by providing free the materials and labours for the application.

2.6.0 **Flashing**

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer, instead of being finished with pea-sized gravel, shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at least 65 mm deep and caulked with waterproof mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

Where specified on drawings or directed by the Engineer, metal flashing shall be provided. The metal flashing shall be done as shown on the drawings. The materials shall be 18g or 22g G.I. sheets, as specified on the drawings and/or as directed by the Engineer.

2.7.0 **Elastromeric Membrane**

2.7.1 **Primer Coat**

It shall consist of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush /spray with airless spray equipment over the prepared bed as an adhesion coat with an application rate of 6-8 sq.m per litre depending on the surface porosity.

	TECHNICAL SPECIFICATION FOR ROOF WATER PROOFING, INSULATION AND ALLIED WORKS	SPECIFICATION NO. PE-TS-412-600-C002		
		VOLUME - II B		
		SECTION - D		SUB-SECTION – C19
		REV.NO.	00	
		SHEET	6	OF 7

The primer shall be allowed to dry for a minimum period of 2 to 4 hours time before the successive finishing coats of P.U. liquid membrane are applied. In any case successive finishing coat shall be applied within 24 hours.

The substrate shall be properly prepared by removing all loose materials by vigorous brushings, fungal growth with proprietary fungicide as recommended. Priming coat shall not be applied to damp substrate.

2.7.2

Finishing Coats

The finishing coats shall consist of two successive liquid coatings of high solid content urethane pre-polymers material to form an elastomeric membrane. Application shall be with brush or spray to form an uniform jointless elastomeric membrane. The overall dry film thickness shall be 1.5 mm subject to minimum 750 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface should be dry and smooth before application.

The coating shall be continued up the parapets/walls for minimum of 150 mm over the finished roof surface or fillet with suitable tucking into the vertical wall surface. It shall be continued into rain water pipes by atleast 100 mm.

The final coat of PU liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a layer of polyscrim cloth/fabric are to be embedded between 2 finishing coats.

The entire work shall be carried out under the suspension of approved authorized agency.

2.7.3

Surface Finish

Areas of roof treatment shall be provided with wearing course consisting of minimum 25 mm thick PCC 1:11/2:3(using 12.5 mm size aggregate) cast in panel of maximum size of 1.20 m x 1.20 m and reinforced with 0.56 mm diameter galvanized chicken wire mesh and sealing of joints using sealant or elastomeric compound.

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS:13801 shall be provided. The tiles shall be laid as per IS 1443.

3.0.0

ACCEPTANCE CRITERIA

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and

	TECHNICAL SPECIFICATION FOR ROOF WATER PROOFING, INSULATION AND ALLIED WORKS	SPECIFICATION NO. PE-TS-412-600-C002 VOLUME - II B SECTION - D SUB-SECTION – C19 REV.NO. 00 SHEET 7 OF 7
4.0.0	shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed. The Contractor shall give a guarantee in writing for all work executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof water-proofing treatment work. The guarantee shall be for materials and workmanship for a period of minimum 10 years. The mode of execution of the guarantee shall be acceptable to the Owner. I.S. CODES AND STANDARDS a) IS:73 : Paving Bitumen b) IS:702 : Industrial Bitumen c) IS:1203 : Methods of testing tar and bitumen d) IS:1322 : Bitumen felts for waterproofing and damp proofing e) IS:1346 : Code of Practice for waterproofing of roofs with bitumen felts f) IS:3384 : Bitumen primer for use in waterproofing and damp proofing.	



**TECHNICAL SPECIFICATION FOR
ANTI-TERMITE TREATMENT**

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME - II B

SECTION - D | SUB-SECTION – C23

REV.NO. 00

SHEET 1 OF 5

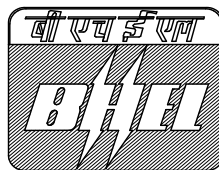
**VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS**

SPECIFICATION NO. PE-TS-412-600-C002

SECTION - D

GENERAL TECHNICAL SPECIFICATION

ANTI-TERMITE TREATMENT



**Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301**



TECHNICAL SPECIFICATION FOR ANTI-TERMITE TREATMENT

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME - II B

SECTION - D | SUB-SECTION – C23

REV.NO. 00

SHEET 2 OF 5

TABLE OF CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	3
2.00.00	EXECUTION	3
3.00.00	ACCEPTANCE CRITERIA	4
4.00.00	RATES	5
5.00.00	METHOD OF MEASUREMENT	5
6.00.00	I.S. CODES	5

	TECHNICAL SPECIFICATION FOR ANTI-TERMITE TREATMENT	SPECIFICATION NO. PE-TS-412-600-C002			
		VOLUME - II B			
		SECTION - D	SUB-SECTION – C23		
		REV.NO.	00		
		SHEET	3	OF	5

**TECHNICAL SPECIFICATION
FOR
ANTI-TERMITE TREATMENT**

1.00.00 SCOPE

The scope of work is to set up a chemical barrier against attack by subterranean termites while the building is under construction.

2.00.00 EXECUTION

2.01.00 General

All work shall in general be executed as specified in IS: 6313 Part II-1981 and as per approved specification of the agency having special know-how for the job.

All necessary work to ensure uniform distribution and proper penetration of treatment of treating solution shall be done according to the instruction of the Engineer.

Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

2.02.00 Chemicals and Rate of Application

Any of the following chemicals (conforming to relevant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly over the area treated.

Chemicals	Concentration by Weight, Percentage
Chlorpyrifos Emulsifiable (IS 8944 - 1978)	: 1.0
Heptachlor Emulsifiable Concentrate (IS: 6439 - 1978)	: 0.5
Chlordane Emulsifiable Concentrate (IS: 2682 - 1984)	: 1.0

2.02.01 Treatment of Column Pits, Wall Trenches and Basement Excavations

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. The bottom surface and sides of excavation (upto a height of about 300 mm) for column pits, walls trenches and basements shall be treated with chemicals at the rate of 5 litres / M² of surface area. Backfills around columns, walls etc. shall be

	TECHNICAL SPECIFICATION FOR ANTI-TERMITE TREATMENT	SPECIFICATION NO. PE-TS-412-600-C002
		VOLUME - II B
		SECTION - D SUB-SECTION – C23
		REV.NO. 00 SHEET 4 OF 5
	treated at the rate of 7.5 litres / M ² of the vertical surface. Chemical treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by rodding the earth at 150 mm centres close to the wall surface and spraying the chemicals in the specified dose.	
2.02.02	Treatment of Top Surface of Plinth Filling Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crowbars on the surface of compacted plinth fill. Chemical emulsion at the rate of 5 litres / M ² of surface shall be applied prior to laying soling or sub-grade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.	
2.02.03	Treatment of Soil Surrounding Pipes, Wastes and Conduits Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building.	
2.02.04	Treatment of Expansion Joints These shall receive special attention and shall be treated in a manner approved by the Engineer.	
2.02.05	Treatment at Junction of the Wall and the Floor Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from ground level up to the level of the filled earth surface. A small channel 30 x 30 mm shall be made at all the junctions of wall and columns with the floor. Rod holes made in the channel up to the ground level 150 mm apart and the chemical emulsion poured along the channel at the rate of 7.5 litres per square meter of the vertical wall or column surface. The soil should be tamped back into place after this operation.	
3.00.00	ACCEPTANCE CRITERIA The Contractor shall give a 10-year service guarantee in writing supplemented by a separate and unilateral guarantee from the specialised agency for the job to keep the building free of termites for the specified period.	
4.00.00	RATES	

	TECHNICAL SPECIFICATION FOR ANTI-TERMITE TREATMENT	SPECIFICATION NO. PE-TS-412-600-C002
		VOLUME - II B
		SECTION - D SUB-SECTION – C23
		REV.NO. 00
		SHEET 5 OF 5
	Rates shall be of complete work per unit area as stated in the Schedule. 5.00.00 METHOD OF MEASUREMENT Complete work of anti-termite treatment shall be measured for plinth area treated. This includes treatment, to foundations, walls, trenches, basements, plinth, buried pipes, conduits etc. The extended portions of foundation and like beyond plinth limit shall be the part of complete work. 6.00.00 I.S. CODE Relevant code applicable for this Specification. IS: 6313 (Part-II) 1981 : Code of Practice of Anti-Termite Measures in Buildings Pre-constructional chemical treatment measures.	



**TECHNICAL SPECIFICATION FOR SITE
LEVELING AND GRADING**

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME IIB

SECTION D | SUB-SECTION – C25

REV.NO. 0

SHEET 1 OF 16

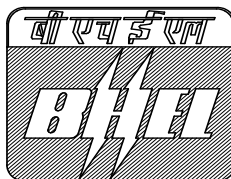
**VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS**

SPECIFICATION NO. PE-TS-412-600-C002

SECTION - D

GENERAL TECHNICAL SPECIFICATION

SITE LEVELING AND GRADING



Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

	TECHNICAL SPECIFICATION FOR SITE LEVELING AND GRADING	SPECIFICATION NO. PE-TS-412-600-C002																								
		VOLUME IIB																								
		SECTION	D	SUB-SECTION – C25																						
		REV.NO. 0																								
		SHEET	2	OF	16																					
C O N T E N T <table><tr><th>CLAUSE NO</th><th>DESCRIPTION</th><th>SHEET NO</th></tr><tr><td>1.00.00</td><td>GENERAL</td><td>3</td></tr><tr><td>2.00.00</td><td>SCOPE</td><td>3</td></tr><tr><td>3.00.00</td><td>MATERIALS</td><td>4</td></tr><tr><td>4.00.00</td><td>QUALITY CONTROL</td><td>6</td></tr><tr><td>5.00.00</td><td>EXECUTION</td><td>6</td></tr><tr><td>6.00.00</td><td>RATES AND MEASUREMENTS</td><td>15</td></tr></table>						CLAUSE NO	DESCRIPTION	SHEET NO	1.00.00	GENERAL	3	2.00.00	SCOPE	3	3.00.00	MATERIALS	4	4.00.00	QUALITY CONTROL	6	5.00.00	EXECUTION	6	6.00.00	RATES AND MEASUREMENTS	15
CLAUSE NO	DESCRIPTION	SHEET NO																								
1.00.00	GENERAL	3																								
2.00.00	SCOPE	3																								
3.00.00	MATERIALS	4																								
4.00.00	QUALITY CONTROL	6																								
5.00.00	EXECUTION	6																								
6.00.00	RATES AND MEASUREMENTS	15																								

	TECHNICAL SPECIFICATION FOR SITE LEVELING AND GRADING	SPECIFICATION NO. PE-TS-412-600-C002			
		VOLUME IIB			
		SECTION D SUB-SECTION – C25			
		REV.NO. 0			
		SHEET 3 OF 16			
GENERAL TECHNICAL SPECIFICATION FOR SITE LEVELLING AND GRADING					
1.00GENERAL This specification cover the works to be carried out for “Site Levelling and Grading Works including Slope Protection” etc for the entire plant and associated areas. The specified formation level(s) shall be achieved either by excavation or by raising with controlled fill with excavated/borrowed earth as the case may be.					
2.00SCOPE 2.01The scope include all works involved in levelling the site to the lines, grades, cross sections and dimensions as shown on the approved drawings and/or as directed by the engineer including site clearance, setting out, earth work in excavation, stacking, loading, transportation, unloading, dewatering, drainage, filling, watering, compaction, turfing on slopes (if required), lighting, disposal of residual/surplus earth etc. It also include supplying and providing all labour, materials, supervision, services, equipments, tools and plants, testing and all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work etc. 2.02All tools and plants, equipments and machineries to be used in this work shall be of standard quality and manufactured by reputed concerns conforming to Indian Standard (IS) codes or equivalent thereof. 2.03Work to be provided by the Contractor The works to be provided by the contractor unless specified otherwise shall include but not be limited to the following. a) Supplying and providing all labour, supervision, services including as required under statutory labour regulations, materials, equipments, tools and plants, approaches, transportation etc required for the completion of the work. b) Preparation and submission of detailed scheme of all operations required for executing the work (material handling, placement, services, approaches etc) to the engineer for approval. c) Carrying out sampling and testing on fill materials/fills to assess the quality/moisture content/degree of compaction and submission of the test results whenever required by the engineer. d) Design, construction and maintenance of Magazine of proper capacity for storage of explosives for blasting work and removal of the same after completion of the work etc.					

	TECHNICAL SPECIFICATION FOR SITE LEVELING AND GRADING	SPECIFICATION NO. PE-TS-412-600-C002			
		VOLUME		IIB	
		SECTION	D	SUB-SECTION – C25	
		REV.NO.		0	
		SHEET	4	OF	16
2.04 Work to be provided by others No work under this specification will be provided for by any agency other than the contractor unless specifically mentioned elsewhere in the contract.					
2.05 Codes and Standards All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) codes unless specified otherwise. IS: 1200 Methods of measurement of building and civil engineering works, Part-1: Earthwork IS: 2720 Method of test for soils (Relevant parts) IS: 3764 Excavation work- Code of safety IS: 4081 Safety code for blasting and related drilling operations IS: 4701 Code of practice for earthwork on canals IS: 6922 Criteria for safety and design of structures subject to underground blasts In case of conflict between this specification and those (IS codes) referred to herein, the former shall prevail. In case any particular aspect of work is not covered specifically by the specification or/and by the IS codes, any other standard practice as may be specified by the engineer shall be followed.					
2.06 Conformity with Designs The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.					
3.00 MATERIALS All materials required for the work shall be of best variety and approved by the engineer.					
3.01 Materials for Excavation For the purpose of identifying the various strata met during the course of excavation, the following classification is to be followed.					



TECHNICAL SPECIFICATION FOR SITE LEVELING AND GRADING

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME IIB

SECTION D | SUB-SECTION – C25

REV.NO. 0

SHEET 5 OF 16

a) Soil

It include all type of soil including laterite, moorum etc with/without any percentage of kankars which can be excavated by normal means such as shovel, pick axe, crow bar, spade etc and those which do not fall under **clause** 3.01 (b) and (c) etc.

b) Soft Rock

It include the rocks (including weathered rock) which are removable by splitting with the help of crow bar, pick axe, wedges, pavement breakers, pneumatic tools, hammers or such implements etc and not requiring blasting (for excavation) in the opinion of the engineer.

c) Hard Rock

It includes the rocks, which require blasting for excavation in the opinion of the engineer. Where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other method as approved by the engineer. The mere fact that the contractor resorts to blasting shall not classify the soft rock under hard rock.

However, the engineer's decision on the type of strata encountered during excavation shall be the final and binding on the contractor.

3.02

Materials for Filling

Any coarse grained or fine grained low plastic soil free from vegetation, roots, shingle, salts, organic matters, sod and any other harmful chemicals shall be used for filling. The contractor shall test the fill material to establish its suitability and submit the results to the engineer for approval. Fill material shall be got approved by the engineer. The following type of materials shall not be used for filling.

- a) Materials from swamps, marshes and bogs
- b) Expansive clays
- c) Peat, logs, sod and perishable materials
- d) Materials susceptible to combustion
- e) Any material or industrial and domestic produce which will adversely affect other materials of work
- f) Materials from prohibited areas

The earth available by cutting the high grounds within the project site and the materials (if) available from the road excavation or any other excavation under the same contract shall be used for filling depending upon its suitability as fill material. Filling with excavated rock (in the project site) shall be done only with



TECHNICAL SPECIFICATION FOR SITE LEVELING AND GRADING

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME IIB

SECTION D | SUB-SECTION – C25

REV.NO. 0

SHEET 6 OF 16

the written permission of the engineer in the following manner. The boulders shall be broken into pieces not exceeding 150mm size in any direction and mixed with fine materials consisting of decomposed rock, moorum or any approved earth to fill the voids as far as possible and the mixture shall then be used for filling. In case the earth required for filling is over and above the earth available from the compulsory excavations within the project area, then borrow areas for obtaining suitable fill material shall be arranged by the contractor himself from outside the plant boundary limits and all expenses including royalties, taxes, duties etc shall be borne by him. He shall obtain and submit the necessary clearances/permissions from the concerned authorities to the engineer for the borrow areas/materials acquired.

4.00 QUALITY CONTROL

All works shall conform to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments used etc. The quality control operation shall include but not be limited to the following.

Sl. No.	Activity	Check
1	Lines, levels & grades	a) By periodic surveys b) By establishing markers, boards etc
2	Filling	(a) On quality of fill material (b) On moisture content of fill material (c) On degree of compaction achieved

5.00 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of approaches, dewatering (if any), drainage and compaction etc within 15 days of award of the contract to the engineer for approval.

5.01 Site Clearance

Before the commencement of earthwork, the entire area of cutting and filling shall be cleared of all trees, stumps, bushes, grasses, vegetation etc with their roots, fences, logs, rubbish, water, slush etc. It is not necessary to remove all the soil containing fine hair like roots but only the rather heavy mats are to be removed. Cutting of trees shall include trees having girth of any size and removing roots upto a depth of 600mm below the existing ground level or 300mm below the formation level whichever is deeper. After the removal of roots of trees, the pot holes formed shall be filled with good earth in 250mm



TECHNICAL SPECIFICATION FOR SITE LEVELING AND GRADING

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME IIB

SECTION D | SUB-SECTION – C25

REV.NO. 0

SHEET 7 OF 16

layers (loose thickness) and compacted unless otherwise directed by the engineer. The trees shall be cut in to suitable pieces as instructed by the engineer. Before earthwork is started, all the spoils, unserviceable materials and rubbish shall be burnt or removed and disposed off to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timbers, fire woods etc shall be the property of owner and shall be stacked properly at the worksite in a manner as directed by the engineer.

5.02 Setting Out

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the engineer and fix permanent points and markers for the ease of periodic checking as the work proceeds. These permanent points and markers shall be fixed at the interval as prescribed by the engineer and shall be got checked and certified by the engineer after whom the contractor shall proceed with the work. It should be noted that this checking by the engineer prior to the start of the work will in no way relieve the contractor of his responsibility of carrying out the work to true lines, levels and grades as per the drawings and specification. If any errors are noticed in the contractor's work at any stage, the contractor at his own risk and cost shall rectify the same. The contractor shall take spot levels of the area (with respect to the bench mark/ available source as provided by the engineer) to be excavated or to be filled at an interval of not more than 10m or as directed by the engineer before starting any earth work and shall be submitted to the engineer for prior approval.

5.03 Excavation

Levelling by excavation shall be carried out where the existing ground levels are higher than the specified formation level. Excavation shall include removal of all materials whatever nature as may be and whether wet or dry shall be carried out exactly in accordance with the line, levels, grades and curves shown on the approved drawings and/or as directed by the engineer. All excavations shall be done to the minimum dimensions as required. The contractor shall obtain prior approval of the engineer for the method he proposes to adopt for excavation in different types of strata including dimensions, side slopes and dewatering if any, stacking or disposal etc. This approval however shall not in any way make the engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to any other activities in the area. **Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.**

The rough excavation may be carried up to a maximum depth of 150mm above the final formation level. The balance shall be excavated with special care and the final surface shall be compacted by rolling with 6 passes of 8 to 10 tonne



TECHNICAL SPECIFICATION FOR SITE LEVELING AND GRADING

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME IIB

SECTION D | SUB-SECTION – C25

REV.NO. 0

SHEET 8 OF 16

roller. If directed by the engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer. The contractor shall be paid for the extra excavation and filling at the appropriate items of work.

If the excavation is done to a depth greater than that shown on the drawing or as directed by the engineer due to the contractor's fault, the excess depth shall be filled up to the required level with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer at the own risk and cost of the contractor.

Suitable slope in cutting as per the requirements and as directed by the engineer shall be adopted to withhold the face of earth. The contractor shall be held responsible for any damage to any part of the work caused by the collapse of the side of excavations.

5.03.01 Excavation in Hard Rock

Excavation in hard rock shall normally be done with blasting. In case where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other approved method as directed by the engineer. Personnel deployed for rock excavation shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces.

5.03.02 Blasting

a) General

Storage, handing and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The contractor shall ensure that these rules/regulations are strictly adhere to. The following instructions are also to be strictly followed and the instructions wherever found in variance with the above said rules/regulations, the former (instructions) shall be superseded with the later (above said rules/regulations).

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives. The contractor shall obtain licence from the District Authorities for undertaking the blasting work as well as for obtaining and storing the explosives as per Explosives Rules, 1940 corrected upto date. The contractor shall purchase the explosives, fuses, detonators etc only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The engineer or his authorized representative shall have the access to check the contractor's store of explosives and his accounts at any time. It is the full responsibility of the contractor to



TECHNICAL SPECIFICATION FOR SITE LEVELING AND GRADING

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME IIB

SECTION D | SUB-SECTION – C25

REV.NO. 0

SHEET 9 OF 16

transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions to the contractor from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.

b) Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation shall have the prior approval of the engineer. Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used. The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

c) Storage of Explosives

The current Explosive Rules shall govern the storage of explosives. Explosives shall be stored in a clean, dry and well-ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400m of the actual work site or any source of fire. The space surrounding the magazine shall be fenced and the ground inside shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be through a single gate only and no person shall be allowed without the permission of the officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be well drained. Two lightning conductors, one at each end shall be provided to the magazine. The lightning conductors shall be tested once in every year.

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the magazine and the explosives in open cases shall not be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine but must be removed without delay to a safe distance and be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine.



TECHNICAL SPECIFICATION FOR SITE LEVELING AND GRADING

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME IIB

SECTION D | SUB-SECTION – C25

REV.NO. 0

SHEET 10 OF 16

Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine.

Magazine shoes without nails shall be used while entering the magazine. The persons entering the magazine must put on the magazine shoes which shall be provided at the magazine for this purpose and should be careful

* not to put their feet on the clean floor unless the magazine shoes on.

* not to touch the magazine shoes on ground outside the clean floor.

* not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.

The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

d) Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on the vehicle conveying explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

e) Use of Explosives



TECHNICAL SPECIFICATION FOR SITE LEVELING AND GRADING

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME IIB

SECTION D | SUB-SECTION – C25

REV.NO. 0

SHEET 11 OF 16

The contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with his responsibilities.

Holes for charging the explosives shall be drilled with pneumatic drills and the drilling pattern shall be so planned that the rock pieces after blasting will be suitable for handling. The hole diameter shall be of such a size that the cartridges can easily pass down through them and any undue force is not required during charging. Charging operation shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from the explosive cartridges. Only one cartridge at a time shall be inserted in a hole and wooden rods shall only be used for loading and stemming the shot holes. Only such quantities of explosives as are required for a particular work shall be brought to the work site. Should any surplus remain when all the holes have been charged shall be carefully removed to a point at least 300m away from the firing point.

The authorized shot firer himself shall make all the connections. The shot firing cable shall not be dragged along the ground to avoid any damage to the insulation. The shot firing cable shall be tested each time for its continuity and possible short circuiting. The shot firer shall always carry the exploder handle with him until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits. Before any blasting is carried out it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300m radius from the firing point or as required by the statutory regulations at least 10 minutes before the time of firing by sounding a warning siren and the area shall be encircled by red flags.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges, the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current etc and keep the lead wires short circuited until it is ready to fire. Any kink in the detonator leading wire shall be avoided. For simultaneous firing of a large number of shot holes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate cordtex connecting wire or string. Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the engineer.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations, the authorized shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all the charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be



TECHNICAL SPECIFICATION FOR SITE LEVELING AND GRADING

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME IIB

SECTION D | SUB-SECTION – C25

REV.NO. 0

SHEET 12 OF 16

present during the removal of debris as it may contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

Where blasting is to be carried out in proximity of other structures, controlled blasting by drilling shallow shot holes and proper muffling arrangements with steel plates loaded with sand bags etc shall be used on top of the blast holes to prevent the rock fragments from causing any damage to the adjacent structures and other properties. Adequate safety precautions as per building byelaws, safety codes, statutory regulations etc shall be taken during blasting operations.

5.03.04 Restrictions on Blasting

- a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.
- b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.
- c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.
- d) No large scale blasting operations will be resorted to when the excavation reaches the last one metre and only small charge preferably black powder may be allowed so as not to shatter the parent rock.
- e) The last blast shall not be more than 0.50 m in depth.
- f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and excavation shall be completed by chiselling or any other suitable method as approved by the engineer.

5.04 Sorting of Excavated Materials

The excavated material shall be carefully sorted for use in filling the areas in the project site by removing roots, grasses, organic matters and other objectionable materials and be sorted out into different types of materials for use and as directed by the engineer. The excavated material which is not considered fit for filling purpose shall be immediately removed and disposed at such a place and in such a manner as will be directed by the engineer. The material found unusable should be got approved by the engineer before actually disposing it off. The useful materials that cannot be used directly shall be heaped in separate area as stock piles. Stockpiles shall be of regular size as far as possible for ease of measurement. The materials heaped shall be utilised as and when required and as directed by the engineer. The cost of complete item of earthwork includes the cost of rehandling of the materials and temporarily heaped and reused.

5.05 Disposal of Surplus/ Waste Materials



TECHNICAL SPECIFICATION FOR SITE LEVELING AND GRADING

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME IIB

SECTION D | SUB-SECTION – C25

REV.NO. 0

SHEET 13 OF 16

Surplus and other waste materials shall be removed and disposed of from the construction site to the area demarcated by the engineer. No material shall be wasted unless approved by the engineer.

5.06 Earth Work in Filling

Levelling by raising with controlled fill of approved excavated/borrowed earth shall be carried out where the existing ground levels are lower than the specified formation level. After clearing site as per clause 5.01, the original ground shall be compacted by rolling subject to a minimum 6 passes of 8 to 10 tonne roller. The approved earth/fill material shall then be spread in horizontal layers not exceeding 300mm in compacted thickness. Each layer shall be watered and thoroughly compacted with proper moisture content and such equipments as may be required to obtain a minimum of 95% of its maximum dry density as determined by standard Proctor's test as per IS: 2720 part-VII or 85% of relative density as per IS:2720 part-XIV as specified. Moisture content of the fill material shall be controlled near optimum moisture content during compaction

The fill material shall be tested for its optimum moisture content and maximum dry density as per IS: 2720, part-VII. Moisture content shall be checked at the source of supply in accordance with IS:2720 part- II and if found less than that required for proper compaction, the same shall be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case, water shall be sprinkled directly from the hose line or from the truck-mounted water tank etc making due allowance for evaporation losses and the fill material be thoroughly mixed by means of harrows, rotary mixers or by any other suitable approved method until the layer is uniformly wet. **Flooding shall not be permitted for watering purpose under any circumstances.** If the material delivered is too wet, it shall then be dried by aeration and exposure to the sun till the moisture content is suitable for compaction. Should circumstances arise owing to wet weather the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended. Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the layers before compaction. For each of the above tests on the fill material, one sample for every 10,000cu.m shall be tested. Additional samples shall be tested whenever there is a change of source or type of material.

Before start of filling, the contractor shall submit the engineer his proposal for the methodology to be adopted for compaction. The compaction equipments as approved by the engineer shall only be employed to compact the different type materials encountered during construction. If directed by the engineer, the contractor shall demonstrate the efficacy of the plant he intends to use by carrying out compaction trials. Moisture content of the fill material shall be controlled near optimum moisture content during compaction.

The compacted layer shall be tested for its dry density as per IS:2720, part-XXVIII or XXIX as directed by the engineer. Samples shall be taken at the rate



TECHNICAL SPECIFICATION FOR SITE LEVELING AND GRADING

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME IIB

SECTION D | SUB-SECTION – C25

REV.NO. 0

SHEET 14 OF 16

of one sample for every 10,000sq.m area of each compacted layer. In addition random checks shall be carried out in compacted layers by means of Proctor needle penetration test. Contractor shall submit all the test results to the engineer immediately after completion of the tests. A sample shall be deemed to have passed the test when the dry density of the compacted fill is equal to or more than 95% of its maximum dry density. When field density measurements reveal any soft areas in the fills, further compaction shall be carried out as directed by the engineer. If in spite of that, the specified compaction is not achieved, the material in the soft areas shall be replaced with approved material compacted to the density requirements and satisfaction of the engineer.

Subsequent layers shall be placed only after the finished layer has been tested and accepted by the engineer.

Where the filling is to be done across low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed layer of a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

5.07 Dewatering and Drainage

It shall be ensured that the area to be excavated/filled shall be free from water. The contractor shall remove the water (if any) by pumping or by any other means as approved by the engineer. At all times, the surface of cutting/filling during execution shall be maintained at such a cross fall as will shed water and prevent ponding. All existing drains/channels (if any) in the work area shall be suitably diverted by the contractor before taking up any excavation or filling. These diversions shall be such that it shall ensure effective disposal of water without any accumulation or flooding within the project site and in adjoining areas.

5.08 Finishing Operations

Finishing operation shall include the work of shaping and dressing the excavated/filled ground to the required grades, levels, lines, side slopes, cross-sections and dimensions as shown on the approved drawings or as directed by the engineer.

5.09 Turfing

Turfing shall be provided at the slopes and other locations as shown on the drawings or as directed by the engineer. The turf shall be of approved quality of grass. The sod shall consist of dense, well rooted growth of permanent and desirable grasses indigenous to the locality where it is to be used and shall be practically free from weeds or other undesirable matter. The grass on the sod shall have a length of approximately 50mm and the sod shall be free of any

	TECHNICAL SPECIFICATION FOR SITE LEVELING AND GRADING	SPECIFICATION NO. PE-TS-412-600-C002			
		VOLUME IIB			
		SECTION D SUB-SECTION – C25			
		REV.NO. 0			
		SHEET 15 OF 16			
debris. Thickness of the sod shall be as uniform as possible with 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that all the dense root system of the grasses are retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than about 300mm x 250mm size but not so large so that it is convenient to handle and transport without damage. The area to be sodded shall be previously constructed to the required slope and cross section. Prior to placing the sods, the slopes shall be roughened and wetted in order to have a satisfactory bond. The strips of sod shall be laid in close contact with each other and be tamped firmly in place so as to fill and close the joints between them. The turfing so laid shall be well watered and protected until final acceptance. 5.10 Approaches The contractor shall provide proper approaches for workmen and inspection. 5.11 Lighting Full scale lighting are to be provided if night work is permitted or directed by the engineer. If no night work is in progress, red warning lights should be provided at the edges of excavations and fills. 6.00 RATES AND MEASUREMENTS 6.01 Rates a) The item of work in the schedule of quantities describe the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding sections in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder’s rate shall include all the activities covered in the description of the items as well as for all necessary operations in detail as described in the technical specification. b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way from those shown on the tender drawings. c) The unit rate quoted shall include minor details which are obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the work. a) The bidder’s quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.					



TECHNICAL SPECIFICATION FOR SITE LEVELING AND GRADING

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME IIB

SECTION D | SUB-SECTION – C25

REV.NO. 0

SHEET 16 OF 16

6.02 Measurements

Method of measurements are specified in the proceeding sections. Where not so specified, the latest version of IS:1200, Part-1 shall be applicable.

a) The length, breadth and depth shall be measured correct to the nearest centimetre if measurements are taken by tape. Rounding of numericals shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter correct to the nearest of two decimal places.

b) For earth work in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earth work in cutting shall be computed from these levels in cubic meter.

c) Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of excavation then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.

d) Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rocks so arrived shall be taken as soil.

e) For earth work in filling, the actual measurements of fill shall be calculated by taking levels of the original ground before start of the work but after site clearance and after compaction of fills. The quantity of earth work in filling shall be computed from these levels in cubic meter.

f) For turfing, the measurement shall be made on the finished work in square meter.



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-III

REV 00

SECTION - III

1. SCHEDULE OF PRE BID CLARIFICATIONS
2. COMPLIANCE CUM CONFIRMATION SCHEDULE
3. SCHEDULE OF DECLARATION
4. SCHEDULE OF DEVIATIONS
5. GUARANTEED AUXILIARY POWER CONSUMPTION FORMAT



TITLE

2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-III

REV 00

SCHEDULE OF PRE-BID CLARIFICATION

All clarification from the Technical Specification shall be filled in by the BIDDER clause by clause in this format only.

VOLUME	SECTION	CLAUSE NO.	PAGE NO.	SPECIFICATION REQUIREMENT	CLARIFICATION	REASONS FOR CLARIFICATION

	TITLE 2X660 MW, ENNORE SEZ STPP TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT	SPECIFICATION NO. PE-TS-412-158-A001
		SECTION-III
		REV 00

COMPLIANCE CUM CONFIRMATION SCHEDULE

The bidder shall confirm compliance with following by signing/ stamping this compliance certificate and furnishing same with the offer:

1. The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions/ deviations with regard to same.
2. QP/ test procedures shall be submitted in the event of order based on the guidelines given in the specification & QP enclosed therein.
3. QP will be subject to BHEL/Customer approval in the event of order & customer hold points for inspection/ testing shall be marked in the QP at the contract stage. Inspection/ testing shall be witnessed as per same apart from review of various test certificates/ Inspection records etc. The charges for 3rd party inspection (Lloyds, TUV or equivalent) for imported components shall be included in the base price of the equipment by the bidder.
4. All drawings/data – sheets etc. to be submitted during contract shall be subject to BHEL/Customer review/ approval. GA drawings, as submitted with offer at tender stage are for reference purpose only and shall be subject to approval during contract stage.
5. There are no other deviations with respect to specification other than those furnished in the 'Schedule of Deviations'.
6. The offered materials shall be either equivalent or superior to those specified. Also for components where material is not specified it shall be suitable for intended duty, materials shall be subject to approval in the event of order.
7. The commissioning spares (if any) are supplied on 'As Required Basis' & prices for same included in the base price (If bidders reply to this is "No commissioning spares are required" and if some spares are actually required during commissioning same shall be supplied by bidder without any cost to BHEL).
8. All sub vendors shall be subject to BHEL/CUSTOMER approval.
9. Any special tools & tackles, if required, shall be in bidder's scope.
10. Performance guarantee test parameters shall stand valid till the satisfactory completion of Performance guarantee test and its acceptance by BHEL/Customer.
11. Prices for recommended spares (if any) for three year operation shall be furnished separately and not to be included in the base price.

**TITLE**

**2X660 MW, ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-412-158-A001

SECTION-III

REV 00

DECLARATIONS

I certify that all the technical data and information pertaining to this specification are correct and are true representation of the equipment/system covered by our format proposal number Dated and there is no deviation to the specification.

I hereby certify that I am duly authorized representative of the Bidder's company whose name appears above my signature.

Bidders Company Name

Authorized representative's Signature

Name

Bidder's Name

The bidder hereby agrees to fully comply with the requirements and intent of this specification for the price indicated.

THIS IS A PART OF TENDER TECHNICAL SPECIFICATION PE-TS-411-158-11000-A001**SCHEDULE OF DEVIATIONS WITH COST OF WITHDRAWAL****PROJECT:- 2X660 MW, ENnore SEZ STPP****PRE- TREATMENT PACKAGES****TENDER ENQUIRY REFERENCE:-****NAME OF VENDOR:-**

SL NO	VOULME/ SECTION	PAGE NO.	CLAUSE NO.	TECHNICAL SPECIFICATION/ TENDER DOCUMENT	COMPLETE DESCRIPTION OF DEVIATION	COST OF withdrawal OF DEVIATION	REFERENCE OF PRICE SCHEDULE ON WHICH COST OF withdrawal OF DEVIATION IS APPLICABLE	NATURE OF COST OF withdrawal OF DEVIATION (POSITIVE/ NEGATIVE)	REASON FOR QUOTING DEVIATION

TECHNICAL DEVIATIONS

COMMERCIAL DEVIATIONS

PARTICULARS OF BIDDERS/ AUTHORISED REPRESENTATIVE

NAME	DESIGNATIONS	SIGN & DATE	

NOTES:

- For self manufactured items of bidder, cost of withdrawal of deviation will be applicable on the basic price (i.e. excluding taxes, duties & freight) only.
- For directly dispatchable items, cost of withdrawal of deviation will be applicable on the basic price including taxes, duties & freight.
- All the bidders have to list out all their Technical & Commercial Deviations (if any) in detail in the above format.
- Any deviation not mentioned above and shown separately or found hidden in offer, will not be taken cognizance of.
- Bidder shall submit duly filled unpriced copy of above format indicating "quoted" in "cost of withdrawal of deviation" column of the schedule above along with their Techno-commercial offer, wherever applicable.
- Bidder shall furnish price copy of above format along with price bid.
- The final decision of acceptance/ rejection of the deviations quoted by the bidder shall be at discretion of the Purchaser.
- Bidders to note that any deviation (technical/commercial) not listed in above and asked after Part-I opening shall not be considered.
- For deviations w.r.t. Payment terms, Liquidated damages, Firm prices and submission of E1/ E2 forms before claiming 10% payment, if a bidder chooses not to give any cost of withdrawal of deviation loading as per Annexure-VIII of GCC, Rev-06 will apply. For any other deviation mentioned in un-priced copy of this format submitted with Part-I bid but not mentioned in priced copy of this format submitted with Priced bid, the cost of withdrawal of deviation shall be taken as NIL.
- Any deviation mentioned in priced copy of this format, but not mentioned in the un-priced copy, shall not be accepted.
- All techno-commercial terms and conditions of NIT shall be deemed to have been accepted by the bidder, other than those listed in unpriced copy of this format.
- Cost of withdrawal is to be given separately for each deviation. In no event bidder should club cost of withdrawal of more than one deviation else cost of withdrawal of such deviations which have been clubbed together shall be considered as NIL.
- In case nature of cost of withdrawal (positive/negative) is not specified it shall be assumed as positive.
- In case of discrepancy in the nature of impact (positive/ negative), positive will be considered for evaluation and negative for ordering.

2x660 MW ENNORE TPS - PRE-TREATMENT PLANT					
GUARANTEED AUXILIARY POWER CONSUMPTION					
Sl.No.	Description / Item	Working	Standby	Power Consumption (KW) (at motor input terminal)	Total Power Consumption (KW)
1	2	3	4	5	6 = 3 x 5
1.1	Total power consumption for station of PT plant				
Notes					
1	If the actual power consumption exceeds the guaranteed power consumption, liquidated damages shall be payable by the bidder at the rate of Rs.3,56,607/- per KW (Rupees Three lacs fifty six thousand six hundred and seven per Kilowatt) excess power consumption, over the base guaranteed figure indicated by him in his bid. Such liquidated damages may be recovered by the BHEL by deduction from the contract price or by enforcing the contract performance guarantee or in any other manner deemed fit by the BHEL For this purpose, the drives of standby equipment shall not be considered.				
2	Power consumption (KW) of motors shall be measured at motor input terminals when operating at the rated capacity and pressure and performed on test rig at the vendor's works and actual motor shall be used for this purpose.				
3	Base aux power figure is given in ANNEXURE-III of the technical specification of Pre-treatment plant.				