# TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LTD.

## 2X660 MW ENNORE STPP

# *TECHNICAL SPECIFICATION*

# *FOR*

# *AIRCONDITIONING SYSTEM*

## SPECIFICATION NO.: - PE-TS-412-553-A001 (REV1)


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

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# SECTION - I

# SECTION-I

# SUB-SECTION-A

# INTENT OF SPECIFICATION

## 1.0 INTENT OF SPECIFICATION

1.1 The specification covers design, engineering, manufacture, supply / procurement, inspection and testing at vendor's / sub vendor's / manufacturer's works, painting, forwarding, proper packing and shipment and delivery at site, unloading, handling & transportation, storage, preservation , security / safety at site , Erection & Commissioning, minor civil & structural (as applicable) works as required on FOR site basis, Performance and guarantee testing / demonstration testing and handing over to BHEL's customer of **AIRCONDITIONING SYSTEM** as per details in different sections / volumes of this specification and various pre award agreements for **2x660MW ENNORE STPP at Kattupalli, Chennai, Tamil Nadu.**

1.2 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve the contractor of the responsibility of providing such facilities to complete the supply, erection and commissioning, performance and guarantee/demonstration testing of **AIRCONDITIONING SYSTEM.**

1.3 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to highest standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgement is not in full accordance herewith.

1.4 The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing. Similarly, the extent of supply also includes all tems required for completion of the system and not withstanding that they may have been omitted in drawings / specifications or schedules.

1.5 The general term and conditions, instructions to tenderers and other attachment referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification is subject to compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.

1.6 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL

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

1.7 The bidder's offer shall not carry any sections like clarification, interpretations and /or assumptions.

1.8 Deviations, if any, should be very clearly brought out clause by clause along with cost of withdrawal in the enclosed schedule (in Vol – III); otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification. If no cost of withdrawal is given against the deviation, it will be presumed that deviation can be withdrawn without any cost to BHEL/its customer.

1.9 In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, Section - C shall prevail over section – D, however more stringent requirement as per the interpretation of the owner shall apply.

1.10 In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.

1.11 For definition of word like Contractor, bidder, supplier, vendor, Customer/ Purchaser Employer, consultant, please referred relevant clause

# SECTION: I

# SUB-SECTION: B

# PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA

# CHAPTER 1

## PROJECT SYNOPSIS

### 1.0 GENERAL BACKGROUND AND SALIENT FEATURES

### 1.1 Introduction

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

### 1.2 Location

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

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

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

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

### 1.3 Type of Plant

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

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

### 1.4 PROJECT INFORMATION

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

Owner : **TAMIL N ADU GENERATION AND DI STRIBUTION CORPORATION (TANGEDCO)**

**LOCATION**

The site is located near Vayalur Village, Ennore

| | | |
|---|---|---|
| Latitude | : | $13^0$17' N to $13^0$18' N |
| Longitude | : | $80^0$18' E to $80^0$19' E |
| Distance from Chennai City | : | 35 km |
| Nearest Airport is at Chennai at a Distance of | : | 60 km |
| Nearest Seaport is | : | Ennore |
| Nearest Railway Station is | : | Athipattu Pudunagar (approx 5 kms) |

**Meteorological Condition**

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

Climatological data :

Ambient temp. ($^0$C)

| | |
|---|---|
| Annual Maximum Mean Temp | 41.5($^0$C) |
| Annual Minimum Mean Temp | 24($^0$C) |
| Design Ambient temperature | 35($^0$C) |

Relative Humidity

| | |
|---|---|
| Maximum | 100% |
| Minimum | 36% |
| Design | 75% |

Annual Rainfall

| | |
|---|---|
| Maximum | 2540 mm |
| Average | 1600 mm |
| Minimum | 1175 mm |

Prevailing Wind Direction

Nov to Jan – From NW & NE

Feb to Mar – From East & SE

Apr to May – From South & SE

June – From SW

July to Aug – From NW

Sept to Oct – From SE & SW

Wind Speed 11.8 kmph (avg)

50 kmph (max)

Seismic Zone III as per IS:1893-2002

## 1.5 Access to Site

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

## 1.6 Plant Rating, Capacity, Availability, PLF

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

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

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

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

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

## 1.7 Power Evacuation

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

## 1.8 Site Selection

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

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

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

## 1.9 Fuel

### 1.9.1 Source of Fuel

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

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

The steam generator shall be designed for the following conditions :

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

The analysis of fuel is given below :

### 1.9.2 Coal Analysis:

**Coal Quality Parameters**

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

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

**DOMESTIC COAL**

| Sr. No. | Particulars | Units | Parameters |
|---|---|---|---|
| A. | **Proximate Analysis** | | |
| 1. | Moisture | % | 16.00 |
| 2. | Volatile Matter | % | 19.00 |
| 3. | Ash | % | 45.00 |
| 4. | Fixed carbon | % | 20.00 |
| | Total | % | 100 |
| B. | **ULTIMATE ANALYSIS, % ( As received)** | | |
| 1. | Carbon | % | 27.70 |
| 2. | Hydrogen | % | 2.60 |
| 3. | Nitrogen | % | 0.52 |
| 4. | Oxygen | % | 7.26 |
| 5. | Sulphur | % | 0.50 |
| 6. | Ash | % | 45.00 |
| 7. | Moisture | % | 16.00 |
| 8. | Carbonates | % | 0.38 |
| 9. | Phosphorous | % | 0.04 |
| 10. | Others | % | - |
| | Total | % | 100.00 |
| C. | **Ash f usion temperature** | deg C | |
| 1. | Initial deformation, IT | deg C | 1100 |
| 2. | Spherical, ST | deg C | 1200 |
| 3. | Hemispherical, HT | deg C | 1300 |
| 4. | Fluid, FT | deg C | - |
| D. | **Ash Analysis, %** | | |
| 1. | Sio2 | **%** | 59.54 |
| 2. | Al 2 O3 | **%** | 29.00 |
| 3. | Fe2O3 | **%** | 6.42 |
| 4. | CaO | **%** | 1.50 |
| 5. | Na2O | **%** | 0.08 |

| Sr. No. | Particulars | Units | Parameters |
|---|---|---|---|
| 6. | K2O | % | - |
| 7. | TiO2 | % | 1.60 |
| 8. | SO3 | % | 0.25 |
| 9. | P2O5 | % | 0.51 |
| 10. | MgO | % | 0.50 |
| 11. | Others | % | 0.60 |
| 12. | Total | | 100.00 |
| E | **Resistivity of fly ash** | Ohm - cm | 1.73x 10^12 |

**IMPORTED COAL**

| Sr. No. | Particulars | Units | Parameters |
|---|---|---|---|
| A. | **Proximate Analysis (As received)** | | |
| 1. | Moisture | % | 16.50 |
| 2. | Volatile Matter | % | 36.45 |
| 3. | Ash | % | 6.62 |
| 4. | Fixed carbon | % | 40.43 |
| 5 | Total | % | 100.00 |
| B. | **ULTIMATE ANALYSIS, % (As received)** | | |
| 1. | Carbon | % | 60.12 |
| 2. | Hydrogen | % | 4.38 |
| 3. | Nitrogen | % | 1.48 |
| 4. | Oxygen | % | 10.37 |
| 5. | Sulphur | % | 0.53 |
| 6. | Ash | % | 6.62 |
| 7. | Moisture | % | 16.5 |
| 8. | Carbonates | % | - |
| 9. | Phosphorous | % | - |
| 10. | Others | % | - |
| | Total | % | 100.00 |
| C. | **Ash f usion temperature** | deg C | |
| 1. | Initial deformation, IT | deg C | 1230 |
| 2. | Spherical, ST | deg C | 1270 |
| 3. | Hemispherical, HT | deg C | 1320 |
| 4. | Fluid, FT | deg C | - |
| D. | **Ash Analysis, %** | | |
| 1. | Sio2 | % | 36.00 |
| 2. | Al 2 O3 | % | 13.90 |
| 3. | Fe2O3 | % | 14.80 |
| 4. | CaO | % | 12.70 |
| 5. | Na2O | % | 0.70 |
| 6. | K2O | % | 1.70 |
| 7. | TiO2 | % | 0.80 |

| Sr. No. | Particulars | Units | Parameters |
|---|---|---|---|
| 8. | SO3 | % | 10.60 |
| 9. | P2O5 | % | 0.20 |
| 10. | MgO | % | 8.60 |
| 11. | Others | % | - |
| 12. | Total | % | 100.00 |

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

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

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

### 1.9.3 Specification of LDO

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

### 1.9.4 Specification of HFO

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

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

**1.9.5 Fuel Linkage**

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

The coal requirement has been worked as under:-

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

| | |
|---|---|
| Per day | 20928 tonnes. |
| Annual | 6.5 MTPA for 85% PLF |

**1.9.6 Fuel Transportation**

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

**1.10 Source Of Water**

**1.10.1 Source**

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

**1.10.2 Chemical analysis of Sea Water:**

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

**1.10.3 Requirement**

The requirement of water for the plant will be for meeting the requirement of make up for the re-circulating cooling water system, dust suppression system in coal handling plants, ash disposal system and the RO/ D.M. water plant which will be supplying the power cycle make up requirements, etc. In addition the water requirements will be for drinking and service purposes. Water requirement is estimated as approx. 15523 $m^3$/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 IN FORMATION 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 desried grade level of +10.00 meter above MSL |
| 1.5.3 | Nature of soil | : | Clayey soil |
| 1.5.4 | Distance from the nearest town / city / major human settlements | : | Chennai -35 km |
| 1.5.5 | Population to be displaced | : | Nil |
| 1.5.6 | Distance from water source | : | Approx. 5 km (from Cooling Water Forebay of NCTPS Stage II) |
| 1.5.7 | Area of forest land, if involved | : | Nil |
| 1.5.8 | Distance of forest from the site | : | N.A |
| 1.6 | Is this an extension? If so indicate capacity of existing plant | : | No |
| 1.7 | What is the ultimate capacity envisaged | : | 2x660 MW |
| **2.0** | **GENERAL ENVIRONMENTAL INFORMATION** | | |
| 2.1 | Area of the land proposed to be acquired | : | Refer Plot Plan Land already acquired |
| | i. Area required for plant | : | 500 Acres |
| | ii. Ash disposal | : | 100 % dry fly ash disposal and |

| | | | |
|---|---|---|---|
| | | | 100% wet bottom ash disposal is envisaged to existing ash pond. |
| | iii. Plant facilities | : | The area is adequate for locating all the required systems for 2x660 MW. |
| 2.2 | Area proposed to be built-up or developed | : | Power station will be built-up in the proposed site as indicated in the plot plan. |
| 2.3 | Specify site characteristics River basin/ estuarine / coastal / others | : | Site is close to Buckingham Canal |
| 2.4 | Is the site situated in the forest area? Give following details | : | No |
| 2.4.1 | Area | : | N.A |
| 2.4.2 | Type of forests | : | N.A |
| 2.5 | Is site situated near to the forests? Give the distance from the site. | : | N.A. |
| 2.6 | Give a description of the flora within 25 km of your plant site under the following heads | : | |
| | a. Crops | : | Refer details in the specification elsewhere. |
| | 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 |

# SECTION: I

# SUB SECTION: C

# TECHNICAL SPECIFICATIONS

# SECTION: C 1

# SPECIFIC TECHNICAL REQUIREMENT

## 1. FUNCTION

The purpose of the system is to provide air-conditioning system for different areas of 2 x 660 MW, Ennore STPP under the scope of BHEL.

## 2. SYSTEM DESCRIPTION

### 2.1 MAIN POWER HOUSE BUILDING- UNIT 1 & 2 (AC PLANT-1)

a) A Central Chilled water type air conditioning plant shall be provided to cater to the air conditioning requirements of the following areas.

- Central Control Room.
- EER Room
- Computer Room
- UPS Room
- SWAS Room (Dry panel)
- Shift in-charge room
- Office area, conference room etc.
- Any other area

b) The air conditioning plant shall comprise of 2 x 100% Screw Chilling machines. The condenser cooling water shall be circulated through these units by means of 2 x 100% horizontal split casing centrifugal pump sets and 2 x 100% FRP cooling towers. The chilled water produced by the chilling units shall be circulated to the air handling units by means horizontal centrifugal pump sets. These AHU shall be located in AHU rooms located adjacent to air-conditioned areas in Power House Building (AHU room shall contain multiple AHUs with 100% standby capacity. The conditioned air from AHUs shall be distributed to the air-conditioned areas by galvanised sheet steel ducting and extruded Aluminium grilles / diffusers with volume control dampers and supporting frames. The return air shall be led back to the AHU Room in ducts for air conditioned areas at 17.0M level in control tower. For balance areas, i.e air conditioned areas at 8.5M level in control tower for unit-1 & 2, the return air shall be collected above the false ceiling and led back to the AHU rooms which acts as mixing plenum for return and fresh air.

c) FCU shall be provided for SWAS room for Unit-1 & Unit-2 & AC Plant control Room.

d) Controls for the AC plant shall be PLC based.

### 2.2 ESP CONTROL ROOM FOR UNIT-1 (AC PLANT-2)

The air conditioning plant shall comprise of (2 x 100%) water Cooled direct expansion AC plant to air-condition areas in ESP Control Room. The conditioned air from water Cooled direct expansion type AC plant is distributed to the air-conditioned areas by galvanized sheet steel ducting and extruded Aluminum grilles / diffusers. The return air is collected above the false ceiling and led back to the AHU room which acts as mixing plenum for return and fresh air.

.

**2.3 ESP CONTROL ROOM FOR UNIT-2I (AC PLANT-3)**

Same as AC Plant-2.

**2.4 SERVICE BUILDING (AC PLANT-4)**

Multiple Water cooled type Package AC shall be provided for each floor of service building. The conditioned air from these P.U shall be distributed to the air-conditioned areas by galvanized sheet steel ducting and extruded Aluminum grilles / diffusers. The return air shall be collected above the false ceiling and led back to the P.U room which acts as mixing plenum for return and fresh air

**2.5 ADMINISTRATION BUILDING (AC PLANT-5)**

Same as AC Plant-4

**2.6 SPLIT TYPE AIR CONDITIONERS**

Split type air conditioners (air cooled) shall be provided to cater to the air conditioning requirements of Compressor house control room areas having workstation for auxiliary plant. For areas requiring multiple working split ACs, One (1) No. standby (of same capacity) shall be provided. (Only those aux. control rooms which are under scope of BHEL). Local isolator / MCB shall be provided with split units.

Local Distribution Boards containing Switch / MCB shall be provided for Split Air Conditioners, and FCUs. Each split unit shall also be provided with suitable rating stabiliser.

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

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

**3. DESIGN CRITERIA**

**3.1 SYSTEM DESIGN CRITERIA**

For design parameters refer to clause 19.3 of section C-2A, customer specifications.

**4. SYSTEM CAPACITY AND CONFIGURATION:**

**A) FOR AC PLANT 1:**

2 x 300 TR Actual capacity water cooled screw chillers (1 working + 1 standby) shall be provided.

**B) FOR AC PLANT 2:**

2 x 30 TR Actual capacity water cooled screw type condensing units (1 working + 1 standby) shall be provided.

**C) FOR AC PLANT 3:**

Same as AC plant 2.

**D) FOR AC PLANT 4 AND 5:**

Multiple water cooled type Package AC shall be provided for each floor of service building.

**5. LAYOUT CONSIDERATIONS:**

**A) AC PLANT-1**

i. The central chilled water plant, condenser water & chilled water pumps for AC plant shall be housed in AC Plant Room at 0.0 M level between E - G Bay Power House Building.

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

1. AHU Room at 8.5 M level of Power House Building in C-D Bay for AC areas at 8.5 m level.
2. AHU Room at 24.0 M level of Power House Building in B-C Bay col 13-16 for AC areas at 17 m level.

iii. The Cooling Towers, Make-up water Storage Tank, Expansion Tank, shall be located at 33.0 M level in B-C Bay.

iv. 3 T electric hoist with monorail for AC plant shall be provided for the AC Plant room only for maintenance purpose by BHEL.

V. One no. of 2 T capacity chain pulley block shall be provided for each AHU room by BHEL. Bidder to develop the layout for provision of erecting of chain pulley block.

**B) AC PLANT-2**

i. Water Cooled direct expansion type AC units shall be housed in AC plant Room at 4.0 M level of ESP Building of Unit-1.

ii. AHUs shall be place inside AHU room at 4.0 M of ESP control room.

iii. The Cooling Towers, Make-up water Storage Tank, Expansion Tank, shall be located at 8.9 M level in B-C Bay

iv. One no. of 2 T capacity chain pulley block shall be provided for AHU room by BHEL. Bidder to develop the layout for provision of erecting of chain pulley block.

**C) AC PLANT-3**

Same as AC plant -2

**D) AC PLANT-4**

i. Multiple Water Cooled Package type AC shall be housed in PAC Room at each floor in service building.

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

**E) AC PLANT-5**

Same as AC plant -2

Note: The locations given above for different plants are tentative and may change during detail engineering.

## 6. SPECIAL CONSIDERATION

a) Water flow rate for chilled water pump selection : 0.7 cmh/TR

b) Water flow rate for condenser water pump selection : 1.0 cmh/TR

c) Condenser water pumps, chilled water pumps shall have further 10% margin on their flow capacities.

d) The IKW/TR of screw chillers shall not be more than 0.7 at 100%

All equipment shall be of high quality and high efficiency meeting the stipulated power consumption as defined elsewhere in the specifications.

e) Other technical details shall be as per relevant clauses of section C-2A, customer specifications.

## 7. EQUIPMENT DESCRIPTION

### 7.1 WATER COOLED SCREW CHILLER/CONDENSING UNIT

a) Refer to clause no. 19.6, 19.8.1 and other relevant clauses of section C-2A, customer specifications.

b) Accessories (valves, pressure gauges, water flow switches, controls and instruments etc. shall be provided with each screw chiller as per customer approved PID.

### 7.2 CONDENSER & CHILLED WATER PUMPS

a) Refer to clause no. 19.8.4 and other relevant clauses of section C-2A, customer specifications.

b) Accessories (valves, pressure gauges, water flow switches, controls and instruments etc. shall be provided with pump as per customer approved PID

### 7.3 AIR HANDLING UNIT

a) Refer to clause no. 19.8.2 and other relevant clauses of section C-2A, customer specifications.

b) Efficiencies of filter shall be as per clause no 19.8.5 of section C-2A, customer specification.

c) Motors shall be installed inside the AHU.

d) Accessories (valves, pressure gauges, water flow switches, controls and instruments etc. shall be provided with pump as per customer approved PID

e) Drain piping from the AHUs up to nearest drain point.

f) Serrated rubber pads for vibration isolation

g) Accessories (valves, pressure gauges, water flow switches, controls and instruments etc. shall be provided with AHUs as per customer approved PID

### 7.4 COOLING TOWER

a) Refer to clause no. 19.8.6 and other relevant clauses of section C-2A, customer specifications.

b) Accessories (valves, pressure gauges, water flow switches, controls and instruments etc. shall be provided with CT as per customer approved PID.

c) The Cooling tower shall be selected for

Design wet bulb: $28^0$ C.

Cold water temp: $32^0$ C.
Hot water temp: $36^0$ C

### 7.5 AIR DISTRIBUTION SYSTEM

a) Refer to clause no. 19.8.7 and other relevant clauses of section C-2A, customer specifications.

b) For galvanising class refer to clause no. 19.3.23 of section C-2A, customer specification.

c) For fire damper refer to clause 19.8.7, 19.8.11 and other relevant clauses of section C-2A, customer specifications.

d) Motorized fire damper shall be installed at supply and return air duct at suitable locations where duct pass through wall & floors for ease of isolation, maintenance and as well as for emergency operation. Fire damper in the supply and return air duct shall close on receiving fire signal from fire protection system and shall also be possible manually from remote control panel. Necessary arrangement shall be incorporated in the duct for providing duct mounted multi- sensor detectors in the return air duct for all air conditioned areas. Also respective Air Handling Units, Air washers/UAFs shall trip on receiving fire signal from fire protection system.

### 7.6 INSULATION WORK

a) Refer to clause 19.3.25, and other relevant clauses of section C-2A, customer specifications

### 7.7 PIPING & VALVES

a) Refer to clause 19.8.8 & 19.8.9 and other relevant clauses of section C-2A, customer specifications

### 7.8 STRIP HEATING & HUMIDIFICATION PACKAGE

a) One common set of electrical strip heaters package of suitable capacity complete with contactor, airstat, humidistat (room or mounted on strip heater control box), safety thermostat, heater box with insulation etc. for winter heating and monsoon reheat, mounted inside the AC plenum/duct for each AHU Room. Refer to relevant clauses of section C-2A, customer specification.

b) One No. Pan humidification system comprising heater, humidistat, water tank, low level switch over flow, draining, make up connection, float valves etc. for each AHU Room. Other points shall be as per clause no. 19.8.11, and other relevant clauses of section C-2A, customer specifications.

### 7.9 NON CHEMICAL TYPE SCALE PREVENTER

a) Refer to clause 19.8.6, and other relevant clauses of section C-2A, customer specifications.

### 7.10 AIR CURTAIN

a) Industrial Grade and fully automatically controlled (with On/Off control with door switch, Heat On/Off control with room thermostat and Fan speed control with two phase thermostat), Air Curtains with minimum velocity in accordance to ISO 27327-1 shall be provided.

b) Self-supporting casing construction along with filter at inlet supply of air shall be provided.

c) Air curtain with Low noise shall be provided.

### 7.11 ELECTRICAL ITEMS

a) Refer to relevant clauses of section C-2A, customer specifications and section C-3, electrical portion of specifications.

b) All the instruments /equipment's/electrical items shall be provided & designed with maximum star rating as available in line with energy conservation policies notified by BEE, GOI at the time of supply.

### 7.12 PAINTING

a) Refer to relevant clauses of section C-2C, painting specifications.

b) Final coat of paint on all the equipment's / item covered under the package shall be done at the time of handing over of package.

**7.13** All the instruments /equipment's/electrical items shall be provided & designed with maximum star rating as available in line with energy conservation policies notified by BEE, GOI at the time of supply

### 7.14 FOR OTHER ITEMS REFER TO TO RELEVANT CLAUSES OF SECTION C-2A, CUSTOMER SPECIFICATIONS

## 8. CONTROL PHILOSOPHY

a) A common PLC based control system shall be provided for control of various equipment of AC plant and Air washers & UAF of ventilation plant. The system shall comply with clause no. 19.8.17 and other relevant clauses of section C-2A, customer specification.

b) The operation of the AC plant shall be done by microprocessor-based panel mounted on the chiller package. Further, overall control of both AC & ventilation system shall be done from common PLC based control panel located in the AC PLANT-1 Room. Control panel shall also be provided with solid –state annunciation, start-stop push buttons, indication lamps & interlocks. The AC Plant compressor can be started only when its associated condenser fan, chilled water pumps are in operation.

c) Chiller Package shall be provided with skid mounted microprocessor based control panel.

d) Stop / trip Annunciation for all the equipment (Fan, Pumps, Chillers and safety interlocks) shall be provided in local control panel.

e) All fire dampers shall be closed on getting signal from the respective fire panels. Necessary cabling required for the purpose shall be covered under bidder's scope. Further the respective AHU motor / PU motor shall stop on closure of fire damper.

### 8.1 SAFETY CONTROLS

All necessary measuring – control instruments & control system shall be provided. With following compressor & evaporator interlock in the control panel of the Chiller Package.

a) High discharge pressure cut-out (HP)

b) Low suction pressure cut out (LP)

c) Oil pressure cut-out (OP)

d) Chilled water flow switch

e) Anti-freeze thermostat (AFT)

f) Airstat / safety thermostat with heaters of the AHU's

### 8.2 OPERATING CONTROL

All operating control as necessary shall be provided. However following minimum control shall be provided. Central chilled water system shall have the following controls:

a) Automatic capacity control system.

b) Automatic unloaded starting device

c) Operating Thermostat

d) Unloading solenoid valves (if applicable)

e) 3 way flow control valve at the AHU's

f) Operation / Sequence Interlock of the Air conditioning system shall be as under:

g) Condenser fan is started.

h) The Air Handling Unit is started.

i) Chiller Pump is started

j) Chilling unit is started

### 8.3 INTERFACE WITH DCS

Following hardwired signals shall be provided in the DCS for monitoring purpose

a) Temperature & Humidity.

b) AC Plant On / Off Status.

c) Pump Run / Trip.

d) AHU Run / Trip.

e) General AC Plant Warning.

f) The operation of the air conditioners shall be done from local start–stop push button. Peripherals serial link shall be provided for the transfer of important signals to DCS in the central control room.

Notes: 1. Parallel redundant UPS system with battery & ACDB shall also be included for power supply

2. 8 Nos. temperature elements/sensors in each units control room shall be provided for monitoring the room temperature.

3. Temp. & humidity monitoring system shall be provided in each control room. Control room areas provided with split AC shall not have humidity monitoring.

## 9. SPECIFIC REQUIREMENT

Efficiency of centrifugal fan and pump shall not be less than 70%.

Electrical feeder suitable for following motor rating shall be provided for following equipment. Vendor to ensure that motor rating is not more than the rating mentioned below.

| Sr. no. | Items | Motor rating (Kw) |
|---|---|---|
| 1. | Screw Chiller | 250 |
| 2. | Chilled Water Pump | 37 |
| 3. | Condenser Water Pump | 45 |
| 4. | AHU for Power House at 24.0Mtr. | 45 |
| 5. | AHU for Power House at 8.5Mtr. | 7.5 |
| 6. | Cooling Tower | 15 |
| 7. | Fresh Air Fan | 0.75 |
| 8. | Water Cooled PAC 15TR | 15 |
| 9. | Water Cooled PAC 10TR | 10 |

## 10. GENERAL

1) Basis of design all calculations including heat load calculations for summer seasons, equipment selection criterion, layout drawings/ schemes/G.A. dwg and documents like data sheet/ technical particulars etc are subject to Customer approval during detail engineering stage.

2) Vendor to furnish characteristic curves for all major equipment offered indicating duty point during detailed engineering.

3) All drawings and documents shall be computer based.

4) All commissioning spares & consumables for trouble free operation shall be provided Vendor to include level gauge & level switch for each tank for alarm & trip of the pumps. Also include one no. Pressure switch for each pump

5) Quality Requirements in the Technical Specification are indicating minimum requirements for inspection and testing. Vendor shall note that quality plan is subject to Customer & BHEL-approval during detail engineering stage. Standard QP format is enclosed in the technical specification.

6) Indicative list of makes is enclosed as per Annexure-I however these equipment's / items shall be subject to Customer & BHEL approval during detail engineering Stage.

7) Inserts or any support arrangement for fixing ducting, fans, piping etc. shall not be provided by BHEL. Necessary supports may be taken from nearest structure / walls / roofs / floors etc. by Vendor.

8) Fixing frame works for diffusers and grilles in the scope of Vendor

9) Anchor fastener shall be used by vendor for fixing duct pipes etc. wherever applicable.

10) Necessary supports and structures / frames etc. as required for supporting the duct / piping / equipment's etc. as lump-sum basis is in the scope of Vendor and no unit rates shall be applicable for these items.

11) Drain piping within room up to the drain point to be provided by the Vendor.

12) Vendor to furnish schedule of power and control cables. Vendor to furnish cable termination details interconnection drawings etc. during detail engineering stage.

13) The tools and machine required for erection of equipment shall be arranged by Vendor.

14) Tools & tackles as required for regular maintenance shall be supplied by Vendor.

15) Instruments required for performance testing of various equipment / system of the package shall be arranged by Vendor at site.

16) Instrument for testing shall be calibrated by Air-conditioning plant supplier before taking up testing.

17) Temperature gauges shall be provided with thermo wells and fixing arrangement.

18) Pressure gauges shall have provision for air venting. Three way valves shall be used which shall have air venting provision.

19) Matching sockets / stubs (weld type) for flow switches and other instruments shall be supplied.

20) Bidders shall guarantee to maintain specified inside design conditions during summer, monsoon and winter and also even if the internal equipment load varies from 100% to 25%.

21) Besides the system performance as above, bidder shall guarantee major technical parameters of various equipments as per design basis / details furnished.

22) The guarantee tests shall cover but not limited to the following rated parameters for smooth operation of ventilation system.

- Design dry bulb temperature and relative humidity of conditioned air, Auxiliary power consumption, Vibration and noise level etc.

- Performance test of the Ventilation system shall be carried out at site after proper installation. The site test shall include performance testing of equipment for 72 continuous hours in summer or monsoon and 24 continuous hours in winter. Bidder, as may be required to carry out site tests shall arrange all instruments, tools etc.

- All calibrated instruments to be used for the tests at manufacturer's works/site shall be arranged by the bidder. Any Electrical/C&I items and accessories like junction box, glands etc. shall be included by vendor in his scope. Only those items shall be provide free of cost which are categorically listed in the Electrical scope sheet of technical specification.

23) For motorized fire damper / 3 Way valve actuators / motorised valves, power supply shall be derived by vendor from respective control panels. BHEL shall not provide any feeder for them. Suitable transformer shall be provided by bidder (if required) to derive the power input. Further distribution through junction box / distribution board shall be in vendor scope and shall have provision for isolation of individual fire damper/ valves.

24) Tender drawings enclosed form the part of specification and the bidder shall check the space requirements for installing the equipment as per the specification and layout requirements given in the specifications.

25) Bidder should suitably group the signals coming from various instruments etc. & the same shall terminate in local JB, from Local JB common cable to PLC / panel / MCC shall be selected. Any Electrical / C&I items and accessories like junction box, glands etc. shall be included by vendor in his scope. Only those items shall be provided free of cost which are categorically listed in the Electrical scope sheet of technical specification.

26) In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, the more stringent requirement as per the interpretation of the owner shall apply.

27) Bidder to note that BHEL reserve the right for drg/doc submission through web based Document Management System. Bidder would be provided access to the DMS for drg/doc approval and adequate training for the same. Bidder to ensure proper net connectivity at their end.

28) Quality requirements in the Technical specification are minimum requirements for inspection and testing. Vendor to note that quality plans are subject to Customer approval during detail engineering stage. Standard QP format is enclosed in the technical specification.

29) The drawings/ documents submitted by vendor shall be complete in all respects with revised drawing submitted incorporating all comments. Any incomplete drawing submitted shall be treated as non- submission with delays attributable to vendor's account. For any clarification/discussion required to complete the drawings, the bidder shall himself depute his personal to BHEL / Customer's place any number of time as per the requirement for across the table discussions/ finalizations/ submissions of drawings.

30) Sealing of duct opening, grouting of foundation / foundation bolts etc. including special type of grouting like GPX2 etc. are in the scope of Air-conditioning system vendor.

31) Flat, platform type RCC / PCC foundation shall be provided for installing Chiller/ PUMP, AHU and FAN etc. Vendor shall fix the equipment using anchor fasteners to secure the equipment obtain parameters related to vibration and noise.

32) Bidder to note that the P&ID shows only the bare minimum requirement of valves and instruments. Any instrumentation & valves as required for the completion of the system in line with technical specification shall be provided by bidder during detailed engineering without any commercial implication.

33) RCC foundation of cooling tower shall be provided by BHEL. However, steel beam / joist etc as required shall be supplied by air-conditioning plant supplier.

34) Air-conditioning plant supplier to furnish drawings/ documents as per the dwg. / documents distribution as per project requirement.

35) Each motor terminal box shall be provided with cable gland and lugs for the size and type of power and control cable of respective motor.

36) All electrical equipment shall be suitable for the power supply fault levels and other climatic conditions indicated in project information / synopsis / specifications enclosed.

37) The bidder's proposal shall be for equipment in accordance with the tech. Specification.

38) The bidder shall furnish complete tech. Particulars in data sheet and schedules as specified elsewhere in the specification.

39) Necessary duct mounted Booster fan (if required) to maintain the static pressure for Precision AC shall be provided without any implication.

## 11. EXCLUSIONS

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

a) Construction of AC plant room, air handling unit room, foundations for AC equipment's.

b) False ceiling, drop ceiling.

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

d) Provision of drain traps / points,

e) For Electrical scope, refer Electrical scope matrix sheet.

## 12. CODES AND STANDARDS

Design, manufacture, inspection and testing of the equipment covered by the specification shall unless otherwise specified conform to the latest edition of the standards and codes including all addenda mentioned below:

| | |
|---|---|
| IS-659 | : Safety code for air-conditioning |
| IS-660 | : Safety code for mechanical refrigeration |
| ASHRAE-23 | : Standard method of testing and rating [67 Standards] air conditioner. |
| ARI-450-6 | : Standards for water cooled refrigerant Condenser. |
| ASME Sec. VII | : Unfired pressure vessels |
| IS-4503 | : Shell and tube type heat exchanger. |
| ASHRAE 22-72 | : Method of testing for rating water cooled refrigerant condenser. |
| ASHRAE-15-2007 | : Safe Standard for Refrigeration System |
| ASHRAE-30-1995 | : Method of testing liquid chilling packages |
| ANSI-8-31.5 | : Refrigeration piping. |
| ANSI-8-9.1 | : Safety code for mechanical refrigeration. |
| AR1-410 | : Standard for air cooling and air heating coils. |
| AR1-210 | : Standard for unitary air conditioning equipment. |
| IS-3588 | : Specification for electrical axial flow fans. |
| AMCA-210 | : Methods of performance test for fans. |
| BS-2831 | : Methods of test for air filters used in AC and general ventilation. |
| IS-4671 | : Expanded polystyrene for thermal insulation purpose. |
| IS-702 | : Industrial bitumen |
| IS-1239 | : Heavy class Pipes for sizes up to 150 mm dia. |
| IS-8188 | : For Water conditioning |
| IS-325 | : 3 phase induction motors |
| IS-4029 | : Guide line for testing 3 phase induction motor |
| IS-210 | : Specification grey iron casting |
| IS-2062 | : Structural steel |
| AMCA – Bulletin | : Standard code of testing centrifugal and axial No. 210 flow fans |
| IS-2825 | : Code of practice for welding mild steel |
| IS-2676 | : Dimensions for wrought aluminium and aluminium alloy sheets and strips. |
| ASHRAE Code | : For various filter |
| ASHRAE-62-2004 | : Ventilation rates |
| IS-655 | : Specification for metal air ducts |

Pump design and testing should correspond to the procedure mentioned in IS-1520.

# SECTION: I

# SUB-SECTION: C 2

# CUSTOMER SPECIFICATIONS

# SECTION: I

# SUB-SECTION: C 2A

# CUSTOMER SPECIFICATIONS
# TECHNICAL REQUIREMENT

CHAPTER 19

## 19.0 AIR CONDITIONING AND VENTILATION SYSTEM

### 19.1 General

The air conditioning and ventilation system shall be provided so as to achieve inside design conditions for proper performance of equipment and personnel.

The extent of supply under this contract includes all items required to complete the intent of the contract not withstanding the fact that such items may have been omitted from the specification or drawings.

The air conditioning and ventilation system shall also meet the requirements specified elsewhere in the specification.

### 19.2 Codes and Standards

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

### 19.3 Design Criteria for Air conditioning system

19.3.1 Dry bulb temperature $47^{o}$ C.

For other details of ambient conditions, refer published documents for meteorological data for Plant site.

19.3.2 Inside design conditions to be maintained in all air-conditioned areas.

Dry bulb temperature : $22 \pm 1.0^{o}$C

Relative humidity : $50 \pm 5$%

19.3.3 A minimum design margin of 10 % shall be considered while sizing AC Plant and related equipment like chillers, chilled water pumps and AHUs for each area. Solar load, all internal loads due to equipment, lighting, fresh air, occupants etc shall be considered while calculating the heat load.

19.3.4 Margins for calculating heat load:

i. 12.5%, 10% & 10% margins on sensible heat, latent heat & overall heat respectively is to be considered while calculating heat load.

ii. For winter load calculations, 50% of the equipment load as available in the room is to be considered.

19.3.5 All windows in the air conditioned area shall be provided with light coloured venetian blinds.

19.3.6 Fresh air quantity of 1.5 air change/hour or $35 m^3$/hr per person or suitable to maintain over pressure of 2 MMWC whichever is higher shall be considered.

19.3.7 False-ceiling shall be provided in all air conditioning areas.

19.3.8 For chemical lab, the airconditioning system shall be designed for 100% outdoor air (the room air is exhausted and not recirculated through the A/C unit). 2 x 100 % Split units are acceptable for chemical lab.

19.3.9 To reduce the air-conditioning load the exposed roof slabs (Including beams and column etc.) of air-conditioning areas , air handling units room and Packaged Air conditioners (PAC) rooms shall be insulated with 50 mm thickness fibre glass insulation of density 48 kg/$m^3$ finished with 26 swg aluminum cladding.

19.3.10 AHU room's walls ,Packaged Air Conditioners room's walls and first 6 meters of supply air duct from AHU/PAC air outlet shall be acoustically insulated with 25 mm thick fiberglass crown 150 of density 48 kg/$m^3$ and shall be covered with 26G aluminum perforated sheet. Perforation area shall be 30% of free area.

19.3.11 Lighting load of 2 Watts per $Ft^2$ or actual which ever is higher shall be considered for heat load calculations.

19.3.12 The occupancy for general/ office area shall be minimum one person per 3 Sq.M and for conference room the same shall be one per 1.5 Sq.M. In the control rooms, control equipment rooms etc, the occupancy may be one person per 20 Sq.M (Minimum).

19.3.13 The Air-conditioning spaces shall be maintained at positive pressure of 2 mmwc to avoid any infiltration of dust.

19.3.14 Plant for all air-conditioned areas shall operate continuous (24 hours a day, 7 days a week except during loss of normal power failure).

19.3.15 Motor operated valves shall be provided as per system requirement for chilling machines, pumps, cooling towers in order to facilitate remote operation of entire air-conditioning plant and to select standby unit.

19.3.16 Noise Criteria – Design noise level shall be of NC 35-45 within Control room, Control equipment room, Instruments and Electronic room and offices.

19.3.17 Design Criteria for Air Inlet Louver – Face velocity of the louver shall be 2.5 m/s (max.).

19.3.18 Design Criteria for Volume Control Damper – Velocity across the Damper shall not exceed 10 m/s.

19.3.19 Duct Design Criteria – Velocity shall be 7.5 m/s.(max.) for main duct, 6.0 M/s. (max.) for branch duct and 2.0 m/s. for the diffusers/grills.

19.3.20 Coil face area of Air handling Units shall be designed considering a face velocity of not more than 2.5 M/ Sec.

19.3.21 Water piping shall be sized for a maximum velocity of 2.5m/sec. However gravity flow/pump suction line shall be sized for a maximum water velocity of 1.5 m/sec.

19.3.22 Refrigerant suction, discharge/hot gas lines & liquid lines shall be sized such that the total pressure drop is equivalent to not more than 1.1 deg C in saturation temperature of refrigerants. However, refrigerant velocity shall not be greater than 0.5 m/sec in liquid line.

19.3.23 All Carbon steel sheets under air conditioning system shall be hot dip galvanized or spray galvanized unless otherwise specified and minimum zinc deposition shall

conform to Class 275 of IS: 277.The air distribution system shall be sized to have a constant frictional drop.

19.3.24 For calculating friction loss in piping system: WILLIAM & HAZEN formula shall be used with C value as 100.

19.3.25 Thermal Insulation Design Criteria –

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

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

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

19.3.28 Redundancy of Equipments

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

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

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

19.4 **Design Criteria for Ventilation system:**

19.4.1 The capacity of Air washers, Supply air fans, exhaust air fans/ roof extractors, ducting system shall be designed as per the Design criteria & Equipment specification elaborated below. Sizing calculations for all the equipments shall be submitted for approval of Owner. However the minimum quantity of the air washer units of Ventilation System for each unit shall not be less than 4 numbers (two numbers on A row and two on B row). A minimum 10% margin shall be considered while sizing the equipment/plant capacity.

19.4.2 The number of air changes per hour in evaporative/mechanically ventilated areas shall be as follows:

| S No. | Area | Air Changes |
|---|---|---|
| i. | For all evaporative type ventilation system | 8 |
| ii. | General areas | 15 |
| iii. | Various pump houses | 20 |
| iv. | Switch gear / MCC rooms. | 25 |
| v. | Battery rooms & other areas where gaseous fumes are generated | 30 |
| vi. | Chlorination plant building | 30 |
| vii. | D G set room | 45 |

19.4.3 However in areas producing lot of heat, the temperature limitation should be the criteria, which is as follows:

- Inside dry bulb temperature shall be minimum 5 deg.C below the design ambient dry Bulb temperature during summer for evaporative cooled areas.

- Inside dry bulb Temperature shall be maximum 3 deg.C above the design ambient dry Bulb temperature during summer for mechanically ventilated areas.

- The criterion which gives higher number of air changes/higher quantity of air in either of the conditions as mentioned above shall be the basis for selecting the required air flow for that area.

- Inside dry bulb temperature for battery room shall be maintained at 25$^{o}$C. The air flow rate for battery room shall be sized considering minimum 30 air changes per hour or hydrogen concentration of 2% or less of the room volume whichever gives higher air flow shall be considered.

19.4.4 All ventilation system shall operate on 100% fresh air.

19.4.5 All mechanically ventilated areas like MCC/Switchgear rooms shall be positively ventilated by means of supply air fans, generally in combination with exhaust fan/ roof extractors. Wherever exhaust fan/ roof extractors are not provided, the pressurised condition shall be maintained with gravity operated backdraft dampers. However, as exception, hazardous areas and fumes/odour generating areas such as toilets shall be negatively ventilated by means of exhaust air fans/ roof exhausters and inlet louvers.

19.4.6 Supply air fan catering for electrical switchgear/MCC rooms, Elevator machine rooms etc. shall be provided with pre filters and fine filters. Efficiency of Pre filter shall not be less than 90% down to 10 microns while for fine filter 99.5% down to 5 microns.

19.4.7 All the equipments of Ventilation system shall be designed for continuous duty for continuous operation of 24 hours a day.

19.4.8 The supply air ducts of evaporative/ UAF type ventilation system shall be provided with automatic (motor operated) fire dampers of fire rating 2 hours at the entry to each of the enclosed area like switchgear rooms, cable galleries etc. The operation of these automatic dampers shall be interlocked with the fire alarm system and the operation of these dampers shall also be possible from the control panel remote manually.

19.4.9 For maintenance of Air washer unit material handling equipment as per size & type defined in Chapter 17, Vol III of specification shall be provided in the Air Washer rooms of Evaporative Ventilation System.

19.4.10 Circulating water capacity for Air washer units shall be minimum 1 $M^3$/hr per 1000 $M^3$/hr of air flow while for Unitary Filtration Unit, it shall be minimum 0.6 $M^3$/hr per 1000 $M^3$ /hr of air flow.

19.4.11 Water piping shall be sized for a maximum velocity of 2.5 m/sec. However gravity flow/pump suction line shall be sized for a maximum water velocity of 1.5 m/sec.

19.4.12 The air distribution system shall be sized to have a constant frictional drop along its length.

19.4.13 The air washer unit and unitary air filtration unit shall be designed for a maximum face velocity of 2.0 m/sec.

19.4.14 The air washer unit shall be designed for at least 90% saturation efficiency while UAF for 60% saturation efficiency.

19.4.15 For pumps, fans and blowers, continuous motor rating (at $50^0$ C ambient) shall be at fifteen percent (15%) above the demand of the equipment at duty point or ten percent (10%) above maximum load demand of the equipment whichever is higher.

19.4.16 For Belt drives, the belts shall be sized for 150% of the rated power and there shall be minimum of two belts per drive.

19.4.17 All Carbon steel sheets under evaporative ventilation system shall be hot dip galvanized or spray galvanized unless otherwise specified and minimum zinc deposition shall conform to Class 275 of IS: 277.

19.4.18 For calculating friction loss in piping system, WILLIAM & HAZEN formula shall be used with C - value as 100.

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

19.4.20 Design Criteria for Back Draft Damper – Velocity across damper shall not exceed 6 m/s.

19.4.21 Duct Design Criteria – Velocity shall be 12 m/s.(max.) for main duct, 9.0 M/s. (max.) for branch duct and 3.75 m/s. for the grills.

19.4.22 REDUNDANCY OF EQUIPMENTS

- Pumps for each Air Washer Unit shall be 2 x 100% Capacity or 3 x50%. For UAF it shall be 1 x 100%.
- Fans for each air washer unit shall be 3x 33% capacity while for unitary air filteration unit shall be 1x100% capacity.
- Supply air fans/Exhaust air fans/roof exhausters shall be in multiplicity.

19.5 **Systems to be Furnished**

19.5.1 **Air Conditioning System**

a) A centralized water cooled chilled water system with screw chilling units shall be provided for the following areas:

Main control room areas comprising unit control room, electronic cubicle room, shift in-charge, engineers room, maintenance engineers room, printer room, UPS room, relay room, SWAS (Dry) panel room, conference room, office rooms, record room, analyzer room and static excitation room in TG building.

b) A separate water cooled direct expansion type air conditioning plant of 2x100% capacity shall be provided for ESP/VFD control room.

c) Water Cooled Precision Type Packaged air conditioners shall be provided for the following areas:

i) Switchyard control room

d) Water Cooled Package Type AC units shall be provided for the following areas

- Each floor of Administration building covering all areas
- Each floor of Service Building

e) Air Cooled Non Ductable Split/Window AC units shall be provided for the following areas

- Office and meeting room areas of workshop building
- Weigh bridge Control Room
- Elechtrochlorination plant control Room
- ETP Control Room
- CW Control room
- Fire Station building control room
- H2 Generation Control Room
- Technical library
- Space/ Room for storing C & I items in warehouse.
- Operator cabin of TG Hall EOT Crane
- Ash handling control rooms
- DM plant control room including labs & offices
- CHP Control Room
- ECHS Control Room in NCPTS Stage II
- Sea Water Intake Pumphouse Control Room at NCTPS
- Clarified Water Pumphouse Control Room
- Filtered Water Pumphouse Control room
- GIS Control Room
- Chemical laboratory
- RO Stage I Control room in including labs & offices
- RO Stage II Control Room
- C&I laboratory, training hall, MRT laboratory
- Fuel oil Control Room
- Any other Control Room

19.5.2 **Ventilation System**

**a) TG Building**

Evaporative type ventilation system shall be provided for TG building as specified below. Air washer units of double bank spray system shall be distributed along A-row and B-row of the building. Filtered and Cooled air from each air washer unit shall be distributed to various areas through supply air ducting and grills. The TG building shall be provided with adequate number of roof extractors.

**b) ESP Control Room (Non air conditioned areas)**

Unitary Air filtration units of single bank spray system using water repellant type nylon filters shall be provided for ESP building. Unitary air filtration units shall be located at roof top of ESP building.

**c) Ambient air ventilation system for the other areas**

i) Turbine hall- Roof exhausters
ii) CW pumphouse
iii) Filtered Sea Water Pumpshouse in NCTPS Stage II
iv) Filtered Water Pumphouse
v) Fire Water Pumphouse
vi) Ash Water Pumphouse
vii) Ash Recovery Pumphouse
viii) Ash Slurry pumphouse
ix) Workshop Building
x) Air compressor room
xi) Air Compressor Room in NCTPS Stage II
xii) AC plant rooms
xiii) DG set rooms
xiv) RO Plant I
xv) RO Plant Stage II
xvi) Sea Water Intake Pumphouse in NCTPS Stage II
xvii) RO Stage I Permeate Pumphouse in NCTPS Srage II
xviii) UF Permeate Pumphouse in NCTPS Stage II
xix) Chemical House in NCTPS Stage II
xx) DM Plant
xxi) CPU
xxii) Stores
xxiii) Gate Houses
xxiv) Switchyard control building (Non a/c areas)
xxv) Battery and battery charger rooms
xxvi) All MCC rooms & cable vaults
xxvii) Compressor/vacuum pumphouse (AHP)
xxviii) Coal handling switchyard gear room
xxix) Transfer tower/tunnel for CHP.
xxx) Elevator machine rooms
xxxi) All other areas not airconditioned.
xxxii) Workshop
xxxiii) Toilets
xxxiv) Stores
xxxv) H2 Generation Building

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

19.6 **System description Air Conditioning System**

19.6.1 **Centralized Water Cooled Chilled Water System**

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

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

(b) The screw chillers shall operate to meet the overall building cooling load requirements through out the day. The chillers shall operate by a combination of chiller optimization and sequencing. The airconditioning controls shall be designed as to interface with the safety controls of each of the air conditioning equipment along with automatic operation. Selector switches and push buttons shall be provided for manual operation of all air conditioning equipment.

(c) Chilled water flow of 10 cum/hr shall be supplied to Sample Cooler in the Analyzer room from the main airconditioning chilled water system.

(d) The air handling units shall be draw through type and casing shall be of double skin construction. Fans shall be double inlet double width (DIDW) centrifugal type. Fans shall have forward or backward curved blades. The cooling coil face air velocity shall not exceed 2.5 m/sec.

(e) Strip heaters of suitable capacity with controls shall be provided in the supply air duct plenum.

(f) Humidification package with all necessary controls.

(g) Air distribution system including ducting, grilles, diffusers fresh air unit, fire dampers, volume control dampers, thermal and acoustic insulation for ducts and accessories.

(h) Monorail and hoist for handling the A/C units, pumps, etc.

(i) Required Pre filters, Fine filters and Absolute (Hepa) filters along with differential pressure gauge shall be provided for sensitive areas of main control room i.e unit control room, electronic cubicle room, printer room, UPS room, relay room, SWAS (Dry ) panel room, & conference room. Other areas shall be provided with pre filters & fine filters. .

(j) The chilling plant and pumps shall be located in a separate room and the A/C plant room layout shall be made such that adequate space is provided for maintenance of chilling units, pumps etc.

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

19.6.2 **Water Cooled Direct Expansion System (DX System)**

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

i. The water cooled condensing unit along with Air handling units, condenser cooling water pumps and cooling towers shall be provided. The number of Air handling units, condenser cooling water pumps, cooling towers shall be equal to the number of condensing units. In addition, one common standby condensing unit and the associated equipment shall be provided. The air conditioning system shall also include associated air distribution system, condenser water piping, valves and fittings, insulation, strip heaters, humidifier, Differential pressure for filters and all other accessories and

controls. A central control panel within air conditioning plant room is to be provided. Local control panel for individual AHU rooms and other areas to be provided. Make up water for the condenser cooling water system to be provided at the air conditioning cooling towers as per required pressure and flow. Fresh air system shall be provided in all the AHU rooms.

ii. The air handling units shall be draw through type and casing shall be of double skin construction. Fans shall be double inlet double width (DIDW) centrifugal type. Fans shall have forward or backward curved blades. The cooling coil face air velocity shall not exceed 2.5 m/sec.

iii. Strip heaters of suitable capacity with controls shall be provided in the supply air duct plenum.

iv. Humidification package with all necessary controls.

v. Air distribution system including ducting, grillers, diffusers fresh air unit, fire dampers, volume control dampers, thermal and acoustic insulation for ducts and accessories.

vi. Monorail and hoist for handling the A/C units, pumps, etc.

vii. Required Pre filters, Fine filters and Absolute (Hepa) filters along with differential pressure gauge.

viii. The condensing plant and pumps shall be located in a separate room and the A/C plant room layout shall be made such that adequate space is provided for maintenance of condensing units, pumps etc.

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

19.7 **System description Ventilation System**

19.7.1 **Evaporative Cooling System for Turbine Building**

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

a) Total internal heat load within the turbine building, inclusive of electricity bay and maintenance bay and considering the heat dissipated by various electrical switchgear, motors, equipment hot surface, steam piping as well as the dissipated heat, solar transmission through the building walls and glass, and any other sources of heat.

b) Summer ambient conditions as furnished to be considered.

c) Efficiency of air washer shall be 90% with two banks opposed type spray system

ii. The number of roof extractors in the turbine building to be sized so as to exhaust about 70% of the total air supplied in order to reduce ingress of dust-laden air into the building.

iii. Air washer shall be double bank spray type mainly consists of an airtight chamber or casing containing air distribution louvers, spray nozzles, a tank for collecting spray water, eliminators with flooding nozzles, pre and fine filters and a pump with piping valves, strainers and specialities for re-circulating water. One (1) level switch in the air washer tank shall be provided to give an alarm in the air washer plant room.

iv. The supplied air will be exhausted through roof exhausters to maintain an overpressure of 1-2mm of water column to reduce dust ingress.

19.7.2 **Unitary Air filtration Unit for ESP Control Building**

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

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

19.7.3 **Ambient Ventilation System for other areas**

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

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

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

19.7.4 **Specific Requirements**

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

iv. In chlorination room, ducted exhausts shall be provided and exhaust air grilles will be located near the floor level. The fan, motors ducting and grilles shall be given acid and fume resistant paint.

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

vi. For elevator machine room, filtered air shall be supplied by supply air fan. Exhaust shall be through gravity dampers.

vii. Evaporative cooling ventilation fans shall be interlocked with fire protection system, to get the same tripped in the event of fire.

viii. Online non- chemical type scale preventer shall be used to avoid formation of scale in the Airwasher nozzles/ water circuit.

19.8 **Equipment Description**

19.8.1 **Chilling Unit/Condensing Unit**

| | | |
|---|---|---|
| Type | | Water cooled type. |
| Vibration isolators | : | Steel spring/ Neoprene rubber cushy foot/ neoprene serrated rubber pad type with isolation efficiency not less than 85%. |
| Compressor Type | : | a) For the Chilling units of T G building control room areas, the compressor shall be Hermetically sealed Screw type operating on R134a/R407C refrigerant complete with accessories and automatic control facilities<br><br>b) For condensing units of ESP/VFD control rooms shall be Hermetically sealed screw type operating on R134a/R407C refrigerant complete with accessories and automatic control facilities |
| Type of drive | : | Motor driven, through direct |
| Accessories | : | High / Low pressure cutouts, Oil pressure switches, relief valves, Pressure gauges at each stage, lube oil/Control oil pressure gauges, Suction and discharge stop valves, Muffler, Crank Case heaters, Oil filters, Magnetic oil Separators, Temperature indicators for Lube oil/ Heaters, Oil level indicators, Safety thermostat for crank case heater, Vibration Isolators etc. |
| **Condenser** | | |
| Type | : | Water cooled, shell and tube type. |
| Fluid | | |
| | : | Shell side – Refrigerant |
| | : | Tube side - Water |
| Capacity | : | To match with respective compressor and to provide atleast 2 deg.C sub-cooling. To store full charge of refrigerant. |
| Design fouling Factor | : | Not less than 0.0002 ( in MKS units) |
| Shell material | : | Mild steel (IS:2062) |
| Tube material | : | Replaceable seamless copper (ASME B-111) |
| Fin material | | Copper |
| Accessories | : | Purge and drain connections, relief valves, liquid line shut-off valves, refrigerant filling charging, flow switches, Isolating valves, Pressure & temperature indicators at inlet and outlet etc. |
| Refrigerant | : | For chilling Unit- R 134a<br>For Condensing Unit - R-22 |
| Steel structure | : | The complete condensing/ chilling unit shall be mounted on steel structure and shall be provided with necessary vibration isolators |
| **Chiller** | | |
| Type | : | DX type and Shell and tube type |
| Superheating of | : | At least 2 deg.C |
| Design Fouling Factor | : | Minimum 0.0001 (MKS units) |
| Fluid | : | Shell side - Water |
| | | Tube side - Refrigerant |
| Capacity | : | To match with respective plant capacity. |

| | | |
|---|---|---|
| Shell material | : | Mild steel (IS : 2062) |
| Tube material | | Replaceable seamless finned copper |
| Fin material | : | Aluminium |
| Accessories | : | Purge and drain connections, Isolating valves, flow switches, Pressure & temperature indicators at inlet and outlet, Anti-freeze thermostats, thermostatic expansion valve or float assembly as applicable, pilot solenoid valve, Relief valves, Operating thermostats for capacity control, supporting frame etc. |
| Steel Structure | : | The complete condensing/ chilling unit shall be mounted on steel structure and shall be provided with necessary vibration isolators. |

19.8.2 **Air Handling Unit (AHU)**

a) Each AHU shall consist of Casing, Fan impeller section, Cooling coil section, damper section, Steel frame with vibration isolators (minimum efficiency of 85%) for the complete AHU, Isolation dampers at the Suction and discharge of each AHU, Pre-filter at the suction and Fine filters (micro-vee type) in the discharge of each individual AHU/common plenum, Absolute (HEPA type) filters in individual discharge of all AHU's/common plenum of Control room, control equipment room, computer, programmer rooms etc and Heater section in the common discharge of AHUs.

b) The casing of AHUs shall be of double skin construction. Double skin sandwich panels (inside and outside) shall be fabricated using minimum 22 swg (0.8 mm) galvanized steel, with 25mm thick polyurethane (PUF) insulation of minimum 40Kg./ Cum density in between. 16 gauge galvanized steel hat-channel shall be used as reinforcing to give structural strength.

c) Face and bypass dampers (motor operated for DX type plant) of opposed blade type shall be provided. Dampers shall be made of 16 gauge G.S sheet metal (class 275 of IS: 277). The area of the bypass section shall be minimum 30% of the coil face area. Damper operating linkage and the operating motor shall be located outside the casing. Each AHU shall be provided with motorized volume control damper at air discharge.

d) Cooling coil shall be of seamless copper tubes with Aluminium fins and shall be provided with suitable drains and vents connections.

e) All filter plenum shall be provided with a walking platform inside the plenum chamber for filter cleaning purpose. Inspection door shall be provided at the plenum chamber and a removable type ladder shall be attached to plenum.

f) Air handling units/centrifugal fans shall be provided with Variable frequency drive (VFD) and velocity sensor/static pressure sensor in supply air path to adjust air flow automatically. The minimum efficiency of VFD at full load shall not be less than 96%.

g) Centrifugal Fan

| | | | |
|---|---|---|---|
| a) | Fan impeller | : | Forward/ backward curved blade & centrifugal type. |
| b) | Impeller material | : | Mild steel spray galvanised with minimum zinc deposition conforming to Class 275 of IS:277. |

| | | | |
|---|---|---|---|
| c) | Fan bearings | : | Self aligning type, permanently lubricated, heavy duty with a design life of 10,000 operating hours. |
| d) | Critical speed | : | First critical speed of rotating assembly shall be at least 25% above the operating speed. |
| e) | Drive | : | Motor driven. With removable belt guard. |
| f) | Static pressure (minimum) | : | 120 mm wc |

19.8.3 **Precision Type Packaged Air Conditioners**

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

i. Compressor shall be hermetically sealed Scroll type with drive motor. It shall be suitable for R22/R407c refrigerant. The compressor shall be mounted on springs at the lower most section of packaged unit such that the same is easily accessible for servicing.

ii. The condenser shall be water cooled shell and tube type having replaceable seamless copper tubes with integral fins and removable head. The condenser shall be provided with fusible relief plug and all other accessories as required.

iii. The air handling fan shall be centrifugal type with forward curved blades and complete with belt drive and electric motor. Each PAC shall be provided with motorized volume control damper at air discharge.

iv. Cooling coils shall be of direct expansion type and made of heavy gauge copper with hydraulically bonded aluminium fins. Rows shall be staggered in the direction of air flow.

v. Filters shall be non-rusting corrugated metallic wire mesh cleanable type and of adequate area so that the air velocity across the filters shall not exceed 2.5 m/sec. Filter shall be in-built with unit heaving efficiency 95% down to 5 microns.

vi. Refrigerant piping shall be heavy gauge copper or IS:1239 heavy class seamless MS pipe complete with thermostatic expansion valve, liquid line shut-off valve, high and low pressure gauges.

**vii. Cabinet Construction:**

The frame & panel shall be constructed of Cold rolled cold annealed sheet steel duly powder coated and shall be assembled with pop rivets. The side panels of unit shall be double skinned for increase life span and reduction of noise & vibration. Front panel shall be removable hinge for easy service.

**viii. De-Humidification**

Specific de-humidification cycle (Split Liquid / Split Suction) shall operate by reducing the operating surface temperature in a section of one of the Refrigeration coil by means of a solenoid valve in the Liquid line / Suction line. Full air flow of the unit will be maintained at all times to ensure consistent air distribution to the conditioned space.

ix. All necessary operating and safety controls shall be provided including the following:

**Controls:**

The controls shall be of microprocessor based programmable PID (Proportional, integral and derivative control logic) controller. The controller shall have a LCD display screen, which shall be visible from the front of the unit without removing any covers/external panels. This LCD display screen should show the following information / data:

a) Modes of operation (cooling, heating, humidification, de-humidification).

b) Simultaneous displays of set temperature and actual temperature and set Relative Humidity and actual Relative Humidity.

c) Date, time and unit identification display.

d) System component Auto / Manual status display on the controller screen.

e) Backup battery charge status display on the controller screen.

f) Visual system alarm indication (along with mutable audio alarm as well).

g) Alarm display menu (incorporating various system alarms like temperature high / low, humidity high / low, Compressor HP/LP, Wet floor and loss of air flow conditions).

h) 24 Hours temperature and relative humidity graph display menu.

i) Programmable services interval indication display / alarm.

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

Safety Protections:

The unit shall also incorporate the following protections:

a) High pressure trip- Manual reset for each compressor
b) Low pressure trip- Manual reset for each compressor.
c) Single phasing preventers.
d) Reverse phasing
e) Phase imbalancing
f) Phase failure

g) Overload tripping (MPCB) of all components

Safety Interlocks:

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

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

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

19.8.4 **Centrifugal Pumps**

| | | | |
|---|---|---|---|
| a) | Type | : | Horizontal Centrifugal, Axially split type casing pump |
| b) | Impeller | : | Closed type |
| c) | **Material of Construction** | : | |
| | i) Casing | : | 2% Ni Cast Iron : IS:210 Gr. FG-260 |
| | ii) Impeller | : | Bronze IS:318 Gr-2 |
| | iii) Wearing rings | : | Bronze |
| | iv) Shaft | : | SS 410 |
| | v) Shaft sleeve | : | SS 316 |
| | vi) Lantern ring | : | Brass / Bronze |
| | vii) Packing | : | As per manufacturer's standard. |
| | viii) Base Plate | : | Carbon steel as per IS:2062 |
| | ix) Speed | : | Maximum 1500 rpm |

19.8.5 **Air Filters**

a) Pre Filter

| | | | | |
|---|---|---|---|---|
| 1) | **Filter medium :** | | | |
| | i) | Fibrous material (extruded polyethylene) or felt filter fabric; Dry type with element of 5 ply construction for Fabric type. | | |
| | ii) | V-fold galvanized wire mesh inter spaced with a flat layer of galvanized wire mesh for Metallic type pre-filters. | | |
| 2) | **Frame** | | | |
| | | GI sheet (minimum 18 gauge thick) or Aluminium alloy of (minimum 16 gauge) supported by galvanised steel wire mesh of 10 mm Square with handles. | | |
| 3) | **Other requirements :** | | | |
| | a) | Suitable aluminium spacers be provided for uniform air flow; | | |
| | b) | Casing shall be provided with neoprene sponge rubber sealing. | | |
| | c) | Capable of being cleaned by water flushing. | | |
| | d) | Density of filter medium shall increase in the direction of air flow in case of metallic filter. | | |
| 4) | **Efficiency :** | | | |
| | | Average arrestance of 65 - 80 % when tested in accordance with BS:6540/ASHRAE – 52 - 76. | | |
| 5) | Minimum thickness | : | 50 mm for Fabric type. | |
| 6) | Face Velocity | : | Not more than 2.5 m/sec. | |

| | | | |
|---|---|---|---|
| 7) | Pressure drop | : | Initial pressure drop - Not to exceed 5.0 mm WC at rated flow. Final pressure drop - Upto 7.5 mm WC. |
| 8) | Location | | |
| | a) Fabric type | : | 1) At the suction of each AHUs (AC system) |
| | | : | 2) At the suction of each Fresh air fan (AC) |
| | | : | 3) At suction of each PAC unit |

b) Fine Filters (Microvee type)

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

c) Absolute Filter / Hepa Filter

| | | | |
|---|---|---|---|
| 1) | Media | : | 100% sub-microscopic glass fibres. |
| 2) | Frame | : | Aluminium alloy of (minimum 16 gauge conforming to IS: 737) with handles. |
| 3) | Other requirements | : | A neoprene sponge rubber sealing shall be provided on either face of the filter frame. |
| 4) | Efficiency | : | 99.97 % down to 0.3 micron when tested in accordance with BS: 3928 (Sodium flame test)/FED–209B. |
| 5) | Minimum thickness | : | 300 mm |
| 6) | Face Velocity | : | Not more than 1.2 m/sec. |
| 7) | Pressure drop | : | Initial pressure drop - Not to exceed 20 mm WC at rated flow; Final pressure drop - Up to 60 mm WC. |
| 8) | Location | : | At the discharge of each individual AHU feeding to computer rooms, programmer rooms, control room and control equipment room in central control building. |

19.8.6 Cooling Towers

| | | |
|---|---|---|
| Type | | Induced draft, cross or counter flow. |
| Capacity | | 110% of rated capacity of each cooling water |

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

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

**Non- Chemical Type Scale Preventor**

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

19.8.7 **Air Distribution System**

I) Galvanized sheet steel fabricated rectangular ducting shall be provided for the low pressure air distribution system. The thickness of sheets type of bracings and other fabrication details shall be as specified below: -

| | Larger dimensions of Duct | Thickness of GS sheet (mm) | Type of Transverse Joint Connection | Bracing |
|---|---|---|---|---|
| a. | Upto 600 | 0.63 (24 g) | S-drive, 25 mm pocket or bar slips on 2.5 m centers | 25 x 25 x3 angles 1.2 m from joint |
| b. | 601 thru 750 | 0.63 (24 g) | S-drive, 25 mm pocket or 25 mm bar slips on 2.5 m centers | 25 x 25 x 3 angles braced at 1.2 m from joints. |
| c. | 751 thru 1000 | 0.80 (22 g) | S-drive, 25 mm pocket or 25 mm bar slips on 2.5 m centers | 25 x 25 x3 angles braced at 1.2 m from joints. |
| d. | 1001 thru 1500 | 0.80 (22 g) | 40 x 40 angle connections or 40 mm pocket or 40 mm bar slips with 35 x 3 bar reinforcing on 2.5 m centers | 40 x 40 x 4 angle braced at 1.2 m from joints. |
| e. | 1501 thru 2250 | 1.00 (20 g) | 40 x 40 angle connections or 40 mm pocket or 40 mm bar slips with 35 x 3 bar reinforcing on 2.5 m centers. | 40 x 40x 4 angle braced at 600 mm from joints. |
| f. | 2251 and larger | 1.25 (18 g) | 50 x 50 angle connections or 40 mm pocket or 40 mm bar slips 1 m centers with 35 x 3 bar reinforcing | 50 x 50 x 5 angle braced at 600 mm from joints. |

II) The longitudinal seams and transverse joints shall be flat and smooth inside the duct. All rectangular ducts shall be flat on face and pittsburgh on corner of duct. Duct pieces shall be joined together by 'S' and drive slip joints or by angle iron flanges. The size of connecting flanges shall be same as that of the bracing angle. The interconnecting flanges shall be connected with 10 mm galvanised bolts and nuts at about 125 mm centres. All flanges shall be connected to the ducts by rivets at about 125 mm centres. The ducts shall be tapped 6 mm across the flanges. All flanged joints shall have 6 mm thick felt packing stuck to the flanges with shellace varnish or approved equal adhesive. The holes in the felt packing shall be burnt through.

III) Ducts 2250 mm and larger require special field study for supporting. Unless otherwise specified, the ducts with larger side greater than 2250 mm shall be supported by 15mm MS rods and 65x65x5 mm MS angles while those below 2250 mm shall be supported by 10 mm MS rods and 50x50x4 mm MS angles. The MS rods and angles shall be given two coats of redoxide primer paint and final coat of silver colour. The duct support shall be at a distance of not more than 1800 mm. The MS rods shall be hung from the building steel with provision of necessary auxiliary steel members or approved means fixed to the ceiling slab. The auxiliary steel members, hooks, coach screws and all other supporting materials required shall be provided by the bidder. Wherever

in passage, if overhead vertical hanger supports are not possible for the duct length, then channel/beam shall be used, grouted in floor foundation is in the scope of bidders.

IV) Flexible joints shall be provided on the inlet and outlet of each fan and unit to which duct connections are made or where fan sections are isolated from other air handling sections. Connections shall be made from non-combustible heavy glass fabric 1.02 kg/$M^2$ (30 Oz per sq.yd) double coated with Du Pont's Neoprene (polychloroprene) or Hypalon. Fire standards shall comply with UL214 and NFPA Pamphlet 90A paragraph 2.1.2.3 outlining standards for vibration isolation connectors to duct systems. Minimum 25 mm stack shall be allowed in these connections to isolate transmission of vibration from fan or fan section. The fabric shall either be folded in with the metal or attached with metal collar frames at each end to prevent leakage. The width of the joints from metal edge to metal edge shall be not less than 80 mm and not more than 250 mm. The ends of the ducts or duct and fan connection shall be in line. Canvas or fiberglass shall not be accepted for flexible joints.

V) All curves, bends, offsets and other transformations shall be made for an easy and noiseless flow of air. The throat of every branch duct shall be sized to have the same resistance in the main duct to which the branch duct is connected. All elbows shall have the throat radius of at least seventy five (75) percent of the duct width. In case the throat radius is smaller, suitable single thickness vanes of approved details shall be provided.

VI) Wherever duct passes through wall, all the openings between masonary and duct work shall be neatly caulked or sealed to prevent movement of air from one space to the adjoining space. Where duct passes through the floor, at the lowest point in the elbow a drain trap of 100 mm width across the width of the duct and 50 mm deep shall be provided with suitable gauge valve.

VII) An adequately sized access doors lined with substantial felt edgings shall be provided in the duct work where required. The access doors shall be built up construction, structurally strong and each shall have two rust proof window sash locks of approved type. All doors shall be set out so as to flush with any insulation or plaster finish on the duct.

VIII) Splitters and dampers shall be placed at approved locations for proportional volume control of the system. Splitters and dampers shall be made in 18 gauge GSS of quadrant type with suitable locking device, mounted outside of duct in an accessible location. The metal shall be bent over at each side of the splitter to form a reinforced edge. Each splitter shall be securely attached with a locking device to rods which shall be installed through ducts. On one end of these rods, there shall be locking device with a mark to show the final adjusted position of the splitter

IX) All the plenum chambers or connections to fans, dampers etc, shall be constructed in 18 gauge GSS, supported on 40x40x6 mm MS angle frames. All vertical angles shall be rivetted at approximately 125 mm centres to the casing. 'Pecora' or equivalent caulking compound shall be inserted between the base of angle and all masonary construction to which angles are fastened.

X) Wherever pipe hangers or rods pass through the ducts, light and stream lined casement around the same shall be provided to maintain smooth flow of air.

XI) Supply air grilles shall be of mill finished extruded aluminium construction. Grilles shall be provided with volume control dampers of opposed blade type.

Supply air grilles shall be of double deflection type. All the required steel/wooden frame work for fixing grilles shall be furnished by the bidder.

XII) All air terminals shall be of mill finish extruded aluminium profile construction.

XIII) The proposed ducting scheme, duct sizes, location of supply air grilles etc shown on the enclosed drawings is tentative and subject to finalisation during detailed engineering by the contractor. The bidders shall furnish in their proposal quantities of ducting, duct insulation, supply air grilles. However, these quantities may increase or decrease depending upon the final layout.

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

19.8.8 **Pipe work Valves and Specialities**

i. Unless otherwise specified herein the specification. Piping for sizes smaller than 150 mm NB shall be continuous welded Galvanised steel pipes to IS: 1239 heavy class. Piping for sizes 150 mm and larger shall conform to IS:3589 with minimum 6.35 mm thickness.

ii. Fabricated elbows from pipe (5 piece mitre) shall be furnished for pipe fittings of sizes 200 mm & larger. Locally available long radius (R=1.5D) hot bends with thickness same as that of the pipe having butt welding ends as per ASA B-16.9 shall be furnished for pipe fittings of sizes 150 mm up to 65 mm NB. 3000 # ASA standard forged carbon steel pipe fittings to A-105 Gr.II or IS:1875 Class-2 or approved equal with socket welding ends as per ASA-B-16.11 shall be furnished for pipe fittings of sizes 50 mm NB and smaller.

iii. Unless otherwise specified, all flanges shall be ASA # 150 standard (as applicable) forged carbon steel slipon flanges to A-105 Gr.II or approved equal, faced and drilled to ASA-B-16.5. The pipework flanges shall match with the valves and equipment connections. Hexagonal head machined carbon steel bolts to IS:1367 Class 4.6 or approved equal shall be furnished with hot forged carbon steel hexagonal head nuts to IS:1367 class 4.6. The gaskets shall be 3 mm thick wire inserted red rubber full face gaskets, 150 # ASA standard and drilling details to match with the flanges as required.

iv. In general, all the line joints for sizes 65 mm and larger shall be butt welded and the joints at valves shall be flanged unless otherwise specified. For pipe sizes 50 mm and smaller, the line joints shall be in general socket welded and the joints at valves shall be screwed unless otherwise specified. The joints at equipment and instruments shall be as per manufacturer's drawings.

v. All valves for sizes 65 mm and larger shall be 150 # ASA standard, double flanged, cast iron body to IS:210 Gr.260, stainless steel trim, bolted bonnet, bolted gland, rising stem outside scraw and yoke, back seated, ends flanged (PF) faced and drilled to ASA-B-16.5. All valves for sizes 50 mm and smaller shall be 800 class standard forged carbon steel body construction to ASTM A 105 stainless steel trim, union bonnets, rising stem inside screw, renewable seats ends female screwed to IS:554.

The butterfly valves shall be designed as per AWWA C 504 and designed to fit between flanges. The butterfly valves shall be provided with flow control lever, black nitrile rubber integrally moulded seating, disc of aluminium bronze to BS 1400 Gr. AB2/AB1, shafts of stainless steel AISI 410. The butterfly valve shall be rated for 16 bar; body/disc tested at 24 bar and seat at 14 bar.

vi. All the pipe supports, guides, anchors, turn buckles, rods, hangers with secondary structural steel framing shall be furnished and installed by the Seller. The Seller's support shall utilize the Purchaser's steel as far as practicable. Where additional secondary steel is required for the hangers, these shall be furnished. The secondary auxiliary steel required for the hangers and supports shall be welded to the Purchaser's steel structure as directed by the Engineer. Welding shall not be permitted across the bottom flange of main structural members.

vii. The bidder shall ensure that the location of hangers and supports shall not increase the force and moments on equipment beyond the permissible limits. The anchors shall be designed for rigid fastening to the structure directly or through brackets. As far as possible, attachments of supports brackets to brick walls shall be avoided. All concrete inserts shall be galvanised and shall be installed on the concrete structure where required for fastening supporting devices.

viii. Bolted pipe clamps used for rod hangers shall be of minimum 6 mm thick. Hanger rods shall be 10 mm dia. All hanger components shall be given a shop prime coat of red lead paint.

ix. Upon completion of the installation of all pipework as per approved drawings, the pipe lines section shall be subjected to hydrostatic testing at 1.5 times the design pressure. All joints shall be carefully examined for sweating or leakage and repairs conducted as necessary and the hydrostatic test repeated till its satisfactory completion to the Engineer's satisfaction. After completing the hydrostatic test, the pipe lines shall be drained and flushed several times to ensure complete cleanliness inside the pipes.

x. All the drain piping between the drain connection of each equipment upto the Purchaser's common drain point in the equipment room shall be provided by the Contractor. Necessary seal loops as required shall be incorporated in the drain piping.

xi. The bidder shall submit the circulating water piping layout for Evaporative Cooling System. The quantities of piping, valves and instruments as required shall be included in the proposal. Requirement of pipe fittings, flanges, bolts and nuts, gaskets, couplings and associated accessories shall be estimated by the bidder and included in the scope of supply.

19.8.9 **Valves**

i. Valves shall have full size port and Suitable for horizontal and as well as vertical installation.

ii. Valves for regulating duty shall be of Globe type suitable for controlling through out its lift.

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

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

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

vi. All valves with rising stem shall have position indicators.

vii. All valves shall be provided with locking arranement.

viii. All valves for sizes 65 mm and larger shall be 150 # ASA standard, double flanged, cast iron body to IS:210 Gr.260, stainless steel trim, bolted bonnet, bolted gland, rising stem outside scraw and yoke, back seated, ends flanged (PF) faced and drilled to ASA-B-16.5. All valves for sizes 50 mm and smaller shall be 800 class standard forged carbon steel body construction to ASTM A 105 stainless steel trim, union bonnets, rising stem inside screw, renewable seats ends female screwed to IS:554.

ix. The butterfly valves shall be designed as per AWWA C 504 and designed to fit between flanges. The butterfly valves shall be provided with flow control lever, black nitrile rubber integrally moulded seating, disc of aluminium bronze to BS 1400 Gr. AB2/AB1, shafts of stainless steel AISI 410. The butterfly valve shall be rated for 16 bar; body/disc tested at 24 bar and seat at 14 bar.

19.8.9 **Air Washer Unit**

i. Each Air Washer Units (Evaporative System) shall consist of the various Sections such as Air washer chamber / Casing, Tank, Distribution louvers, set of metallic/fabric filters, suction louvers, bird screens, water headers, Spray nozzle, piping, valves, etc, Drift eliminators, Pumps, Fans, Necessary controls & Instrumentation and all other required accessories.

ii. The air washer chamber casing shall be RCC or fabricated from MS sheet as the case may be. The sheet metal air washer chamber casing shall be fabricated from 3.15 mm black M.S. sheet with adequate stiffeners etc. and various sections shall be bolted through gaskets to avoid leakage of water. The inside of casing shall be protected by spray galvanization or by three coats of epoxy painting.

iii. The air washer tank shall be fabricated from MS plate of minimum 6 mm thick and inside and outside surface of the casing and tank shall be spray galvanized. Minimum depth of the tank shall be 600 mm. Tank construction shall be such that the suction screen can be replaced while the unit is operating. Tank shall be provided with overflow, drain with valve, float valve makeup connection with a gate valve backup, quick fill connection with globe valve etc. The overflow pipe shall be connected to drain pipe after isolating valve on drain pipe.

iv. The distribution plate shall be fabricated out of 16G galvanized steel sheet & galvanized steel angle supports with minimum 50% free area.

v. Air washer shall be two-bank construction (one uni-flow and the other cross flow). The water shall be sprayed at filter bank. All header and stand pipes shall be galvanized.

vi. The spray nozzles shall be of brass or bronze with chrome plating and shall be self cleaning type. The nozzle shall be designed to produce fine atomised spray and shall be properly spaced to give a uniform coverage of the air washer section. The pressure drop through the nozzle should be in the range of 1.4 to 2.4 Kg/cm$^2$(g).

vii. The eliminator plates shall be of 24G thick GS sheets class 350 or from 100% virgin PVC of minimum finished thickness of 3 mm. The eliminator section

made of GSS shall have minimum six bends. The PVC eliminators shall be UV stabilised using Titanium di-oxide and shall withstand the weathering test as per IS:4892 for 500 hrs. Type test report of the compound testing carried out in any reputed laboratory shall be submitted for approval. All supports, tie rods and space bar shall be of either galvanized steel or PVC construction and shall be complete with suitable drip tray and drain pipe.

viii. An airtight inspection door of 600mm X 700mm size and a water marine light be provided for each air washer unit.

ix. Suitable number of brass screen shall be provided in the air washer tank to arrest the dirt entering the circulating water pump suction. Suitable GI grid shall be used inside the screen for reinforcement

x. The specification for centrifugal fans shall generally be as indicated below. However, the fan shall be of DIDW type for TG building and SISW / DIDW for and ESP/VFD building.

xi. Both inside and outside of all the sections of the metal chamber unit shall be spray galvanized to prevent corrosion. The nuts and bolts used for joining the section shall be stainless steel. The connection pieces shall have at least two (2) coats of rust inhibiting paint.

19.8.10 **Unitary Air Filtration**

Each unitary air filtration shall be of single bank (cross flow) consist of Casing, Tanks, Fans, Distribution plates, Moisture eliminator and water repellant type nylon filter with frame and support, Header and standpipe with support, Spray and flooding type nozzle. Water shall be sprayed at filter bank .Screen type suction strainer, Pumps, Necessary controls & Instrumentation, and all other required accessories.

All equipments, components used in unitary air filtration system shall be in line with the specification requirements stipulated in air washer units above except the fans may be of SISW type.

19.8.11 **Instruments, Protective Devices and Interlock**

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

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

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

19.8.12 **Centrifugal Fans for Evaporative cooling plants**

i. The casing shall be of welded construction fabricated with heavy gauge galvanised sheet steel or MS sheet with spray galvanisation. In case of spray galvaniation zinc deposition should conform to class 275 of IS:277. The minimum thickness of casing shall be 3 mm. It shall be rigidly reinforced and supported by structural angles. The seams shall be permanently sealed air-tight. Split casings shall be provided on larger sizes of fans. Casing drain with valves shall be provided wherever required. The fan shall be of class I construction and Fan velocity should not exceed 10 m/s.

ii. The impeller shall have die-formed backward-curved blades tie welded to the rim and back plate to have a non overloading characteristics of the fan. Rim shall be spun to have a smooth contour. If required intermediate stiffening rings shall be provided. Shaft sleeves shall be furnished wherever required. The impeller, pulley and shaft sleeves shall be secured to the shaft by key and/or nuts. The impeller along with driven pulley shall be dynamically balanced as per AMCA standard.

iii. The bearing shall be self aligning, heavy duly ball, roller or sleeve bearing. They shall be adequately supported. They shall be easily accessible and lubricated properly from outside.

iv. Inlet guard shall be spun to have a smooth contour. Inlet screen, if provided, shall be of galvanized wire mesh of 25 mm square.

v. Base plate with necessary number of spring type vibration isolators or ribbed neoprene rubber pad or cushy foot mounting shall be provided. The vibration isolators should have a minimum of 70% efficiency.

vi. The first critical speed of the rotating assembly shall be at least 25% above the operating speed.

vii. Centrifugal fans shall be provided with Variable frequency drive (VFD) and velocity sensor/static pressure sensor in supply air path to adjust air flow automatically. The minimum efficiency of VFD at full load shall not be less then 96%.

viii. The static pressure of fan shall not be less then 75 mmwc.

19.8.13 **Power Roof Extractors**

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

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

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

19.8.14 **Axial and Propeller Fans**

These fans shall have single piece cast aluminium impeller with blades of aerofoil design.

The fan casing shall be of heavy gauge sheet steel construction minimum thickness of 3 mm up to a fan diameter of 750 mm, 5 mm for fans with impeller diameter of 750 mm and above and the same shall be spray or hot dip galvanized.

Necessary rain protection cowl, inlet and outlet cones, bird protection screen, adjustable damper, vibration isolators, back draft dampers etc. shall be provided.

The speed of the fan shall not exceed 960 rpm for fan with impeller diameter above 450 mm and 1400 rpm for fan with impeller diameter 450 mm or less. However for fans having static pressure of 30 mm WC or above the speed of the fan shall not exceed 1440 rpm for fan with impeller diameter of above 450 mm and 2800 rpm for fan with impeller diameter of 450 mm or less. The first critical speed of rotating assembly shall be atleast 25% above the operating speed.

The static pressure of supply air fans with pre & fine filters shall not be less then 32 mmwc while for exhaust fans 10 mmwc. However the propeller fans for toilets and pantries shall be 5 mm wc.

All other accessories like supporting structure etc. as required shall be provided.

19.8.15 Gravity Damper

Gravity dampers (self acting dampers) are provided to ensure pressurization of electrical rooms, switch gears rooms, substations etc. Dampers shall be of gravity type designed such as not to allow infiltration of air from outside. The louvers of the dampers shall be freely mounted on Spindles to allow the damper to open freely with the pressure developed in the premises. The damper shall be provided with flange at the inlet, the pressure inside the premises shall be 1-2mm WC.

19.8.16 **Fresh Air Unit for Air Conditioning System**

The fresh air unit shall consist of:

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

19.8.17 **Plant Control for Air conditioning system**

a) **General**

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

b) **Control Scheme of Air Conditioning System**

i. The Air Conditioning System control system shall be PLC based. The PLC configuration and detailed specification of the same shall be as per Control & Instrumentation requirements specified elsewhere in the specification.

ii. Each system shall be provided with required I/O modules and two numbers of Operator Work (OWS) Stations. All the functional requirements specified below and general control logic specifed under this section shall be implemented in the respective PLCs.

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

iv. PLC provided for the Control of AC system shall suitably interface with integral microprocessor based controls of Chiller units.

v. The PLC based control system of Air Conditioning system shall also interface with Wide Area Network of the Station to be supplied by the Bidder.

c) **Water Chilling Plant Control**

i. Microprocessor based controls shall be provided along with facilities to interface with central PLC and to meet the requirement of all system operations and controls.

ii. Water chilling unit control system shall be designed to have a constant chilled water outlet from evaporator at all load condition by means of controlling ON-OFF thermostat (one for each compressor). The closure of liquid line solenoid valve and tripping of compressor at lower water temperature and opening of solenoid valve and starting of compressor at high set point shall be automatic through the thermostat. Between the above set points the compressor capacity shall be controlled automatically.

iii. Water chilling unit shall be equipped with superheat control of water chilling unit through thermostatic expansion valve, which gets its impulse from temperature element connected with suction line after chiller outlet.

iv. High discharge pressure cut-out and oil pressure (OP) differential cut-out shall be of manual reset type and low pressure cut-out shall be automatic reset type. The OP cut-out shall trip the compressor in case of low oil pressure.

v.

vi. On-off toggle switch to close the liquid refrigerant line solenoid valve shall be provided to shut the compressor by the operation of the operation of low pressure cut-out (after the refrigerant has been pumped to the condenser).

vii. Switching of Crank case heaters shall be interlocked with starting and stopping/tripping of compressor motor. Further, the safety thermostat shall switch off the crank-case heater in the event temperature rises above safe limit.

viii. Provision shall also be made for the manual restarting of the compressor.

ix. On-off type anti-freeze thermostats, one for each chiller shall be provided in addition to the controlling on-off thermostat for safety purpose and shall act in the event of failure of on-off thermostat to close the liquid line solenoid valve and also to trip the compressor simultaneously.

x. Compressor starting/running shall be interlocked with the flow switches to be provided at the outlet of each chiller and each condenser and as well as with pressure in the inlet of the condensers. In addition closure or open status of various valves through limit switches shall be used for interlock, alarm and control of Air Conditioning System.

xi. The standby condenser water pumps, standby chilled water pumps, & standby AHU shall be started automatically when the working equipments are stopped/ tripped. Auto/Manual selector Switches and working/ Standby selector switches for the pumps/AHU/fresh air fan shall be provided in the panel.

xii. Closure of fire dampers shall raise an annunciation in the panel.

xiii. There shall be provision in control panel for temperature and flow readings in chilled water inlet and outlet line across AHUs to monitor the air conditioning load of each area.

xiv. Operation of Air conditioning system shall be interlocked with the required minimum pressure and temperature of cooling water at inlet to the condenser through pressure and temperature transmitters. Status indication of Station auxiliary Cooling water pumps & associated cooling towers shall be provided in the control panel of air conditioning plant.

d) **Air Handling Unit chilled water type**

i. Control of the inside room temperature and humidity shall be by controlling the chilled water flow by means of motor operated three way modulating valve and the modulating valve shall get its signal from the temperature sensor.

ii. Humidistat located in the return air duct shall actuate the pan humidifier to obtain the desired degree of humidification.

iii. Separate Humidistat and thermostats shall be provided and interlocked in steps with winter heater / re-heater / strip heaters for monsoon and winter re-heating or heating as the case may be.

iv. Heater banks shall be interlocked with the running of AHU, temperature of return air, humidity of return air and safety thermostat (Geyserstat located in front of the each heater in the supply air duct)

v. AHU shall be started either from its local panel or from the main control panel of AC system by means of Remote/Manual selector switches.

vi. The closure of fire dampers, automatic tripping of AHU fans and fresh air fans shall be interlocked with Bidder's fire Detection System.

vii. Each AHU shall be provided with temperature indictors and flow indicator in the chilled water piping inlet and outlet to monitor the air-conditioning load of each area.

viii. Miscellaneous control requirements

ix. Separate emergency local stop push button shall be provided for each pump, compressor, fans etc. of AC system.

x. Lamps shall be provided for indicating the status of each pump, compressor, fans etc. of AC system in the main and local panel.

xi. All the annunciation related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped / tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, compressor, AHU, PAC etc. in the respective panel.

xii. Fully wired, twenty percent (20%) spare annunciation windows shall be provided in all the panels.

19.8.18 **Plant control for Evaporative cooling and Ventilation system**

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

ii. Air Washer Units (AWU) & Unitary Air Filteration Units (UAF)

iii. Air washer units shall be started/stopped by initiation from the local panel and the starting/stopping of fans and pumps shall be automatic upon such initiation.

iv. The operation of the pumps shall be interlocked with the low level of water in the sump. High level of the sump shall be annunciated. The standby pump shall be started automatically when the working pump is stopped/tripped.

v. Auto/Manual selector Switches and working/Standby selector switches for the pump shall be provided in the panel.

vi. A selection switch enabling the running of AWU fan or pump alone shall be provided.

vii. Miscellaneous control requirements

viii. Separate emergency local stop push button shall be provided for each pump, fans etc. of Ventilation system.

ix. Lamps shall be provided for indicating the status of each pump, fans etc. of Ventilation system in the main and local panel.

x. All the annunciations related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped / tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, AWU etc. in the respective panel.

xi. The fans (both supply and exhaust fans) associated with mechanical ventilation system shall be operated locally.

xii. Fully wired, twenty percent (20%) spare annunciation windows shall be provided in all the panels.

**19.8.19** Bidders shall ensure that the guaranteed control room noise level is maintained and the units are designed for achieving the same. The vibration level of the units shall be within limits and vibration isolation shall be achieved by providing suitable spring type or pad type (or combination) vibration isolators for ventilation system equipment (centrifugal fans) and airconditioning system equipment (A/c units, AHUs, Cooling Towers, Pumps etc.)

# SECTION: I

# SUB-SECTION: C 2B

# CUSTOMER SPECIFICATIONS
# PROJECT SPECIFIC GENERAL REQUIREMENTS

# CHAPTER – 3

## GENERAL TECHNICAL REQUIREMENTS

### 1.00.00 INTRODUCTION

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

### 2.00.00 BRAND NAME

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

### 3.00.00 BASE OFFER & ALTERNATE PROPOSALS

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

### 4.00.00 COMPLETENESS OF FACILITIES

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

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

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

## 5.00.00 CODES & STANDARDS

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

(a.) Bureau of Indian Standards (BIS)

(b.) Indian electricity act

(c.) Indian electricity rules

(d.) Indian Explosives Act

(e.) Indian Factories Act and State Factories Act

(f.) Indian Boiler Regulations (IBR)

(g.) Regulations of the Central Pollution Control Board, India

(h.) Regulations of the Ministry of Environment & Forest (MoEF), Government of India

(i.) Pollution Control Regulations of Department of Environment, Government of India

(j.) State Pollution Control Board.

(k.) Rules for Electrical installation by Tariff Advisory Committee (TAC).

(l.) Any other statutory codes / standards / regulations, as may be applicable.

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

(a.) Japanese Industrial Standards (JIS)

(b.) American National Standards Institute (ANSI)

(c.) American Society of Testing and Materials (ASTM)

(d.) American Society of Mechanical Engineers (ASME)

(e.) American Petroleum Institute (API)

(f.) Standards of the Hydraulic Institute, U.S.A.

(g.) International Organisation for Standardization (ISO)

(h.) Tubular Exchanger Manufacturer's Association (TEMA)

(i.) American Welding Society (AWS)

(j.) National Electrical Manufacturers Association (NEMA)

(k.) National Fire Protection Association (NFPA)

(l.) International Electro-Technical Commission (IEC)

(m.) Expansion Joint Manufacturers Association (EJMA)

(n.) Heat Exchange Institute (HEI)

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

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

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

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

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

**6.00.00 EQUIPMENT FUNCTIONAL GUARANTEE**

6.01.00 The Equipment and Auxiliaries shall be capable of continuous operation in frequency range of 47.5 to 51.5 Hz.

6.02.00 The functional guarantees of the equipment under the scope of the Contract is given elsewhere in the technical specification. These guarantees shall supplement the general functional guarantee provisions covered under General Conditions of Contract.

6.03.00 Liquidated damages for shortfall in meeting functional guarantee(s) during the performance and guarantee tests shall be assessed and recovered from the Bidder as specified elsewhere in this specification.

## 7.00.00 DESIGN OF FACILITIES/ MAINTENANCE & AVAILABILITY CONSIDERATIONS

### 7.01.00 Design of Facilities

All the design procedures, systems and components proposed shall have already been adequately developed and shall have demonstrated good reliability under similar conditions elsewhere.

The Bidder shall be responsible for the selection and design of appropriate equipment to provide the best co-ordinate performance of the entire system. The basic requirements are detailed out in various clauses of the Technical Specifications. The design of various components, assemblies and subassemblies shall be done so that it facilitates easy field assembly and dismantling. All the rotating components shall be so selected that the natural frequency of the complete unit is not critical or close to the operating range of the unit.

### 7.02.00 Maintenance and Availability Considerations

Equipment/facilities offered shall be designed for high availability, low maintenance and ease of maintenance. The Bidder shall specifically state the design features incorporated to achieve high degree of reliability/ availability and ease of maintenance. The Bidder shall also furnish details of availability records in the reference plants stated in his experience list.

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

Lifting devices i.e. hoists and chain pulley jacks, etc. shall be provided by the Bidder for handling of any equipment or any of its part having weight in excess of 500 Kgs during erection and maintenance activities.

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

## 8.00.00 DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY BIDDER

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

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

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

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

**Basic Engineering Documentation**

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

i. System description of all the mechanical, electrical, control & instrumentation & civil systems.

ii. Technology scan for each system / sub-system & equipment.

iii. Selection of appropriate technology / schemes for various systems/ subsystems including techno-economic studies between various options.

iv. Optimization studies including thermal cycle optimization.

v. Sizing criteria of all the systems, sub-systems including various piping systems/ equipment/ structures/ equipment foundations along with all calculations justifying and identifying the sizing and the design margins.

vi. Schemes and Process & Instrumentation diagrams for the various systems/ sub-system with functional write-ups.

vii. Operation Philosophy and the control philosophy of the Main Plant and other plants.

viii. General Layout plan of the power station incorporating all facilities in Bidder's as well as those in the Owner's scope. This drawing shall also be furnished in the form of floppy discs to the Owner for engineering of areas not included in Bidder's scope.

ix. Basic layouts and cross sections of the main plant building (various floor elevations), boiler, fuel oil area and other areas included in the scope of the Bidder.

x. Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.

xi. The successful bidder shall furnish within three (3) weeks from the date of Notification of Award, a list of contents of the Plant Definition Manual (PDMs) including techno-economic studies, which shall then be mutually discussed & finalised with the Owner.

xii. After approval of Plant Definition Manual / Design Basis Report, Bidder shall furnish detailed technical specification of all system / packages of the Plant.

i. Layouts, general arrangements, elevations and cross-sections drawings for all the equipment and facilities of the plant.

ii. Flow diagrams, Process & Instrumentation Diagrams alongwith write-up and system description.

iii. Start-up curves for turbine, boiler and both turbine and boiler combined together as a unit for various start-ups, viz. cold, warm and hot start-up.

iv. Piping isometric, composite layout and fabrication drawings.

v. Piping engineering diagrams, pipe and fittings schedules, valve schedules, hanger and support schedules, insulation schedules.

vi. Technical data sheets for all bought out and manufactured items. Bidder shall use the specifications as a base for placement of orders on their sub-vendors.

vii. Detailed design calculations for components, system/sub-system,, piping etc., wherever applicable including sizing calculations for all auxiliaries as per criteria specified elsewhere in specification.

viii. Boiler pressure part schedule and sizing calculations. Boiler performance data and boiler design dossier.

ix. Transient, hydraulic and thermal stress analysis of piping and system wherever applicable & input and output data alongwith stress analysis isometrics showing nodes.

x. Thermal cycle information (heat balance diagrams, boiler performance calculations, condenser and heat exchanger thermal calculations etc.).

xi. Characteristic Curves/ Performance Correction Curves. Hydraulic & Mechanical design calculations for condensers & heaters.

xii. Comprehensive list of all terminal points which interface with Owner's facilities giving details of location, terminal pressure, temperature, fluid handled & end connection details, forces, moments etc.

xiii. Power supply single line diagram, block logics, control schematics, electrical schematics, etc.

xiv. Protection system diagrams and relay settings.

xv. Interconnection diagrams.

xvi. Cable routing plan.

xvii. Instrument schedule, measuring point list, I/O list, Interconnection & wiring diagram, functional write-ups, installation drawings for field mounted instruments, logic diagrams, control schematics, wiring and tubing diagrams of panels and enclosures etc. Drawings for open loop and close loop controls (both hardware and software). Motor list and valve schedule including type of actuator etc.

xviii. Alarm and annunciation list and alarms & trip set points.

xix. Sequence and protection interlock schemes.

xx. Type test reports and power system stability study report.

xxi. Control system configuration diagrams and card circuit diagrams and maintenance details.

xxii. Detailed software manuals & source software listing.

xxiii. Detailed flow chart for digital control system.

xxiv. Mimic diagram layout.

xxv. Civil Task drawings(for the Engineering by Owner),Design and Drawings for the Civil & Structural works in the scope of the Bidder.

xxvi. Model study reports wherever applicable.

xxvii. Functional & guarantee test procedures and test reports.

xxviii. Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.

xxix. Documentation in respect of commissioning as listed out elsewhere in this specification.

xxx. The Bidder while submitting the above documents / drawings for approval / reference as the case may be, shall mark on each copy of submission the reference letter alongwith the date vide which the submissions are made.

8.03.01 **Instruction Manuals**

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

**Erection Manuals**

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

a) Erection strategy.

b) Sequence of erection.

c) Erection instructions.

d) Critical checks and permissible deviation/tolerances.

e) List of tool, tackles, heavy equipment like cranes, dozers, etc.

f) Bill of Materials

g) Procedure for erection.

h) General safety procedures to followed during erection/installation.

i) Procedure for initial checking after erection.

j) Procedure for testing and acceptance norms.

k) Procedure / Check list for pre-commissioning activities.

l) Procedure / Check list for commissioning of the system.

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

**Operation & Maintenance Manuals**

i. The operating and maintenance instructions together with drawings (other than shop drawings) of the equipment, as completed, shall be in sufficient detail to enable the Owner to operate, maintain, dismantle, reassemble and adjust all parts of the equipment. They shall give a step by step procedure for all operations likely to be carried out during the life of the plant / equipment including, operation, maintenance, dismantling and repair including periodical activities such as chemical cleaning of the generator. Each manual shall also include a complete set of drawings together with performance/rating curves of the equipment and test certificates wherever applicable. The contract shall not be considered to be completed for purposes for taking over until these manuals have been supplied to the Owner.

ii. If after the commissioning and initial operation of the plant, the manuals require any modification / additions / changes, the same shall be incorporated and the updated final instruction manuals shall be submitted to the Owner for records.

iii. A separate section of the manual shall be for each size/ type of equipment and shall contain a detailed description of construction and operation, together with all relevant pamphlets and drawings.

iv. The manuals shall include the following :

a) List of spare parts along with their drawing and catalogues and procedure for ordering spares.

b) Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation.

c) Where applicable, fault location charts shall be included to facilitate finding the cause of maloperation or break down.

v. Detailed specifications for all the consumables including lubricant oils, greases, chemicals etc. system/equipment/assembly/sub-assembly - wise required for the complete plant.

vi. On completion of erection, a complete list of bearings / equipment giving their location, and identification marks etc. shall also be furnished to the Owner indicating lubrication method for each type/category of bearing.

8.03.02 **Plant Handbook**

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

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

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

8.03.03 **Project Completion Report**

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

8.03.04 **Drawings**

(a.) All documents submitted by the Bidder for Owner's review shall be in electronic form (soft copies) along with the desired number of hard copies as per Annexure-I. The soft copies to be supplied shall be either in CDs, or through direct transfer via E-mail, etc. depending upon the nature/volume/size of the document. The drawings submitted for approval could be in the Image form.

(b.) Final copies of the approved drawings shall be submitted on CD-ROM along with the requisite number of hard copies as per Annexure-I.

(c.) The completed plant documentation with equipment drawings, data sheets, P&ID, BOQ, schematics, logic diagrams, test reports and quality plan, etc. shall be furnished to Owner.

(d.) All documents/text information shall be in latest version of MS Office.

(e.) All drawings submitted by the Bidder including those submitted at the time of bid shall be in sufficient detail indicating the type, size, arrangement, weight of each component for packing and shipment, the external connection, fixing arrangement required, the dimensions required for installation and interconnections with other equipment and materials, clearance and spaces required between various portions of equipment and any other information specifically requested in the drawing schedules.

(f.) Each drawing submitted by the Bidder (including those of sub-vendors) shall bear a title block at the right hand bottom corner with clear mention of the name of the Owner, Consultant, name of the Project, system designation, the specifications title, the specification number, drawing/document number and revisions. If standard catalogue pages are submitted the applicable items shall be indicated therein. All titles, notings, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

(g.) The Bidder shall also furnish a “Master Drawing List” which shall be a comprehensive list of all drawings/ documents/ calculations envisaged to be furnished by him during the detailed engineering to the Owner. Such list should clearly indicate the purpose of submission of these drawings i.e. “FOR APPROVAL” or “FOR INFORMATION ONLY”.

(h.) Similarly, all the drawings/ documents submitted by the Bidder during detailed engineering stage shall be stamped “FOR APPROVAL” or “FOR INFORMATION” prior to submission.

(i.) The furnishing of detailed engineering data and drawings by the Bidder shall be in accordance with the time schedule for the project. The review of these documents/ data/ drawings by the Owner will cover only general conformance of the data/ drawings/ documents to the specifications and contract, interfaces with the equipment provided by others and external connections & dimensions which might affect plant layout. The review by the Owner should not be construed to be a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. The review and/ or approval by the Owner / Project Manager shall not relieve the Bidder of any of his responsibilities and liabilities under this contract.

(j.) After the approval of the drawings, further work by the Bidder shall be in strict accordance with these approved drawings and no deviation shall be permitted without the written approval of the Owner.

(k.) All manufacturing, fabrication and execution of work in connection with the equipment / system, prior to the approval of the drawings, shall be at the Bidder’s risk. The Bidder is expected not to make any changes in the design of the equipment /system, once they are approved by the Owner. However, if some changes are necessitated in the design of the equipment/system at a later date, the Bidder may do so, but such

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

(l.) Drawings shall include all installations and detailed piping layout drawings. Layout drawings for all piping of 65 mm and larger diameter shall be submitted for review/ approval of Owner prior to erection. Small diameter pipes shall however be routed as per site conditions in consultation with site authority/representative of Owner based on requirements of such piping indicated in approved / finalized Flow Scheme / Process & Instrumentation Diagrams and/or the requirements cropping up for draining & venting of larger diameter piping or otherwise after their erection as per actual physical condition for the entire scope of work of this package.

(m.) Assessing & anticipating the requirement and supply of all piping and equipment shall be done by the Bidder well in advance so as not to hinder the progress of piping & equipment erection, subsequent system charging and its effective draining & venting arrangement as per site suitability.

(n.) As Built Drawings

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

(o.) Drawings must be checked by the Bidder in terms of its completeness, data adequacy and relevance with respect to Engineering schedule prior to submission to the Owner. In case drawings are found to be submitted without proper endorsement for checking by the Bidder, the same shall not be reviewed and returned to the Bidder for re-submission. The Bidder shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data/drawings at site which are needed as an input to the engineering. The Bidder shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Owner’s scope and submit all necessary drawings/ documents for the same.

(p.) The Bidder shall submit adequate prints of drawing/data/document for Owner’s review and approval. The Owner shall review the drawings and return one (1) copy to the Bidder authorizing either to proceed with manufacture or fabrication, or marked to show changes desired. When changes are required, drawings shall be re-submitted promptly, with revisions clearly marked, for final review. Any delays arising out of the failure of the Bidder to submit/rectify and resubmit in time shall not be accepted as a reason for delay in the contract schedule.

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

8.04.00 **Engineering Information Submission Schedule**

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

(a.) Information that shall be submitted for the approval of the Owner before proceeding further, and

(b.) Information that would be submitted for Owner's information only.

The Engineering Information Schedule shall be updated monthwise.

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

8.05.00 **Engineering Progress and Exception Report**

8.05.01 Report giving the status of each engineering information including

(a.) A list of drawings/engineering information which remains unapproved for more than four (4) weeks after the date of first submission

(b.) Drawings which were not submitted as per agreed schedule.

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

8.06.00 **Co-Ordination Meetings**

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

fully co-operate with such persons and agencies involved during the discussions.

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

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

8.06.04 Should any drawing remain unapproved for more than six (6) weeks after it's first submission, this shall be brought out in the monthly Engineering Progress and Exception Report with reasons thereof.

8.06.05 Any delays arising out of failure by the Bidder to incorporate Owner's comments and resubmit the same during the TCM shall be considered as a default and in no case shall entitle the Bidder to alter the Contract completion date.

8.07.00 **Design Improvements**

The Owner or the Bidder may propose changes in the specification of the equipment or quality thereof and if the parties agree upon any such changes the specification shall be modified accordingly.

If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any changing the price and/or schedule of completion before the Bidder proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

8.08.00 **Equipment Bases**

A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base, unless otherwise specifically agreed to by the Owner. Each base plate which support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.

8.09.00 **Protective Guards**

Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards shall be designed for easy installation and removal for maintenance purpose.

8.10.00 **Lubricants, Servo Fluids and Chemicals**

8.10.01 The Bidder's scope includes all the first fill and one year's topping, requirements of consumables such as oils, lubricants including grease, servo fluids, gases and essential chemicals etc. Consumption of all these consumables during the initial operation and final filling after the initial operation shall also be included in the scope of the Bidder. Bidder shall also supply a quantity not less than 10% of the full charge of each variety of lubricants, servo fluids, gases, chemicals etc. used which is expected to be utilised during the first year of operation. This additional quantity shall be supplied in separate Containers.

8.10.02 As far as possible lubricants marketed by the Indian Oil Corporation shall be used. The variety of lubricants shall be kept to a minimum possible.

Detailed specifications for the lubricating oil, grease, gases, servo fluids, control fluids, chemicals etc. required for the complete plant covered herein shall be furnished. On completion of erection, a complete list of bearings/ equipment giving their location and identification marks shall be furnished to the Owner along with lubrication requirements.

8.11.00 **Lubrication**

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

8.12.00 **Material of Construction**

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

8.13.00 **Rating Plates, Name Plates & Labels**

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

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

8.13.03 Such nameplates or labels shall be of white non-hygroscopic material with engraved black lettering or alternately, in the case of indoor circuit breakers, starters, etc. of transparent plastic material with suitably coloured lettering

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

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

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

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

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

(a.) Manufacturer's identification.

(b.) Nominal inlet and outlet sizes in mm.

(c.) Set pressure in Kg/cm2 (abs).

(d.) Blowdown and accumulation as percentage of set pressure.

(e.) Certified capacity in Kg of saturated steam per hour or in case of liquid certified capacity in litres of water per minute.

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

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

8.14.00 **Tools and Tackles**

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

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

8.15.00 **Welding**

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

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

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

8.17.00 **Protection and Preservative Shop Coating**

8.17.01 **Protection**

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

8.17.02 **Preservative Shop Coating**

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

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

8.17.03 Shop primer for all steel surfaces which will be exposed to operating temperature below 95 degrees Celsius shall be selected by the Bidder after obtaining specific approval of the Owner regarding the quality of primer proposed to be applied. Special high temperature primer shall be used on surfaces exposed to temperature higher than 95 degrees Celsius and such primer shall also be subject to the approval of the Owner.

8.17.04 All other steel surfaces which are not to be painted shall be coated with suitable rust preventive compound subject to the approval of the Owner.

8.17.05 All piping shall be cleaned after shop assembly by shot blasting or other means approved by the Owner. Lube oil piping or carbon steel shall be pickled.

8.17.06 Painting for Civil structures shall be done as per relevant part of technical specification.

## 9.00.00 QUALITY ASSURANCE PROGRAMME

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

(a.) His organization structure for the management and implementation of the proposed quality assurance programme

(b.) Quality System Manual
(c.) Design Control System

(d.) Documentation and Data Control System

(e.) Qualification data for bidder's key personnel.

(f.) The procedure for purchase of materials, parts, components and selection of sub-Bidder's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.

(g.) System for shop manufacturing and site erection controls including process, fabrication and assembly.

(h.) Control of non-conforming items and system for corrective actions and resolution of deviations.

(i.) Inspection and test procedure both for manufacture and field activities.

(j.) Control of calibration and testing of measuring testing equipment.

(k.) System for Quality Audits.

(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. With in three weeks of the release of the purchase orders /contracts for such bought out items /components, a copy of the same without price details but together with the detailed purchase specifications,

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 performacne of the equipment/ facility.

d) The Bidder shall intimate the Owner about the commencement of initial operation and shall furnish adequate notice to the Owner in this respect.

e) Any loss of generation due to constraints attributable to the Owner shall be construed as Deemed Generation.

f) An Initial Operation report comprising of observations and recordings of various parameters to be measured in respect of the above Initial Operation shall be prepared by the Bidder. This report, besides recording the details of the various observations during initial operation shall also include the dates of start and finish of the Initial Operation and shall be signed by the representatives of both the parties. The report shall have sheets, recording all the details of interruptions occurred, adjustments made and any minor repairs done during the Initial Operation. Based on the observations, necessary modifications/repairs to the plant shall be carried out by the Bidder to the full satisfaction of the Owner to enable the latter to accord permission to carry out the Guarantee tests on the facilities. However, minor defects which do not endanger the safe operation of the equipment, shall not be considered as reasons for with holding the aforesaid permission.

10.03.00 **Guarantee Tests**

a) The final test as to prove the Functional Guarantees shall be conducted at Site by the Bidder in presence of the Owner. The Bidder's Commissioning, Start-up Purchaser shall make the unit ready to conduct such test. Such test will be commenced and completed as per schedule indicated in Vol I GCC

b) These tests shall be binding on both the parties of the Contract to determine compliance of the equipment with the functional guarantee.

c) For performance/ demonstration tests instrumentations, of accuracy class, to the approval of the Owner shall be used. The numbers and location of the instruments shall be as per the specified test codes. In addition the values of parameters shall be logged from the information system provided under Owner's Distributed Digital Control Monitoring and Information system. Test will be conducted at specified load points.

d) Any special equipment, tools and tackles required for the successful completion of the Guarantee Tests shall be provided by the Bidder, free of cost.

e) The Guarantee tests and specific tests to be conducted on equipment have been brought out in detail elsewhere in the specification.

**11.00.00 TAKING OVER**

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

**12.00.00 TRAINING OF OWNER'S PERSONNEL**

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

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

(a.) Training for Steam Generator Equipment

(b.) Training for TG and related equipment.

(c.) DDCMIS

(d.) Training for Electric Power Supply systems

(e.) Training for HT motor

(f.) Training for power cycle piping/critical piping.

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

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

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

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

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

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

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

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

## 13.00.00 SAFETY ASPECTS DURING CONSTRUCTION AND ERECTION

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

(a.) Working platforms should be fenced and shall have means of access.

(b.) Ladders in accordance with Owner’s safety rules for construction and erection shall be used. Rungs shall not be welded on columns. All the stairs shall be provided with handrails immediately after its erection.

## 14.00.00 NOISE LEVEL

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

(a.) Safety valves and associated vent pipes for which it shall not exceed 105 dBA.

(b.) Regulating drain valves in which case it shall be limited to 90 dBA.

(c.) TG unit in which case it shall not exceed 90 dBA.

(d.) For HP-LP bypass valves and other intermittantly operating control valves, the noise level shall be within the limit of 85 dBA.

## 15.00.00 PACKAGING AND TRANSPORTATION

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

## 16.00.00 ELECTRICAL ENCLOSURE

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

**17.00.00 INSTRUMENTATION AND CONTROL**

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

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

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

| | | | |
|---|---|---|---|
| a) | 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/$Nm^{3.}$.
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 | 2 | 1 CD ROM |
| | and QP approval status | | |
| 20 | QA Documentation Package for items / equipment manufactured and dispatched to site | 2 | 2 CD ROMS |
| 21 | QA Documentation Package for field activities on equipment/systems at site | 2 | 2 CD ROMS |

## ANNEXURE-II

**(Total within 52 man months)**

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

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| PRODUCT | AREAS OF TRAINING REQUIREMENT | | | |
|---|---|---|---|---|
| | **Product Design**<br><br>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<br>Flow scheme develop- ment of air & flue gas, fuel oil, auxiliary steam, main and reheat steam feed water. | **Plant Visit** | **Visit To Manufacturer's Work** | **Operation & Maintenance Of Plant** |
| | Layout of over all plant, steam generator area, pressure part arrangements, platforms, equipment, piping and duct, coal pipe, flue gas ducts, bunker arrangement, valves and damper, ESP area, cable & piping tressels etc. | | | |
| | Erection stretegies, erection procedures | | | |
| | Performance and demonstration tests. | | | |
| **MANDAYS** | **120** | **20** | **20** | **20** |
| CFD model development and validation for Steam Generator | Familarisation of fundamentals and basis for the development of the CFD models. | | | |
| | Solving of set of simple problems by Em- ployer's engineers with the help of trainer. | | | |

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| 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. | Familiarization of power plants of various makes of turbines for super critical units | Manufacturing processes of turbine | |
| | Rotor design and strength calculation | Collection of data for analysis of availability of turbines | Assembly of turbine | |
| | Rotor dynamic behavior studies wrt natural frequency, critical speed, vibration etc. | Comparative studies for integral systems of turbine | Testing of turbines | |
| | Blade profile/root design and blade strength design, blade vibration analysis | O&M history/problems related to turbine | Product development in process | |
| | Casing & diaphragm design | Failure analysis | Future plan for technology induction | |
| | Labyrinth seal selection & design for different turbine configurations | | R&D work in progress | |
| | Selection of turbine type (i.e. Tandem vs cross compounding, separate HP/IP vs combined HP/IP, material of construction etc.) | | | |

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| 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<br>Selection, design and control principle for Turbine governing system<br>Performance calculation<br>Steam path audit<br>Layout principle of various equipment's of TG and its integral system<br>Latest technological advancements | | | |
| **MANDAYS** | **45** | **10** | **10** | |
| **Boiler Feed Pumps** | Techno-economic syudies for Selection of BFP Configuration and its drive<br>Criteria for selection of boiler | Familiarization of power plants of various makes of feed pumps<br>Data collection of BFP | Manufacturing process of various components of BFP<br>Assembly of BFP | |

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

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

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

Anshul S A Khan Praveen Kishore

| 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 | |

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| 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<br>Basis of selection of H/W memory sizing<br>Operating system features, interface with other system, openness & inter- operability<br>Upgradability<br>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 |

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| 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<br><br>System capabilities & system design techniques<br><br>Communication with MMI & other system | Operation feedback | Manufacturing processes special attention to handling of the modules<br><br>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. | | | |

Anshul S A Khan Praveen Kishore

| 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<br>Flame scanner location | Operational feedback | Manufacturing procedure& precautions for handling the system<br>System testing facilities | |
| **MANDAYS** | **16** | **6** | **6** | **12** |
| DDCMIS - EHTC, Turbine stress control system, Turbine protection system& ATRS | Basic design concept& features<br>Logics of turbine stress control system<br>Implementation of failsafe philosophy in turbine protection system | Operational feedback | Manufacturing procedure & precautions for handling for handling the system<br>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 | | | | |

Anshul S A Khan Praveen Kishore

| 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<br>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 &** | | | |

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| 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 & | | | |

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| 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** | | |

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| 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<br>- Familarisation 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 | - Manufacturing process& testing facilities for various equipment of excitation system | |
| | Excitor | - Familiarisation with various equipment functioning at reference plants | | |
| | PMG | | | |
| | Transformer | | | |
| | Controllers & different limiters etc. | | | |
| | PSS & associated system studies | | | |
| **MANDAYS** | **30** | **15** | **15** | |

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| PRODUCT | AREAS OF TRAINING REQUIREMENT | | | |
|---|---|---|---|---|
| | **Product Design** | **Plant Visit** | **Visit To Manufacturer's Work** | **Operation & Maintenance Of Plant** |
| Boiler Feed pump H.T. Motor | Design Criteria for the<br><br>Stator core & wdg<br><br>Rotor core & wdg<br><br>Insulation system<br><br>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 |

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

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| PRODUCT | AREAS OF TRAINING REQUIREMENT | | | |
|---|---|---|---|---|
| | **Product Design** | **Plant Visit** | **Visit To Manufacturer's Work** | **Operation & Maintenance Of Plant** |
| | Static and dynamic analysis of critical piping including siesmic and other occassional load analysis (safety valve blowing condition). A joint activity together with Owner's engineers.<br><br>Study and collection of data pertaining to special welding requirements (pre and post weld heat treat ment and electrode selection criteria etc.) of materials used in high temp piping system.<br><br>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 :**<br>**Stage :**<br>**Package :**<br>**Supplier :**<br>**Bidder No. :** | **LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL**<br><br>**SUB-SYSTEM:** | **DOC. NO.:**<br>**REV. NO.:**<br>**DATE :**<br>**PAGE : OF** |

| S. N. | Item | QP/ Insp. Cat. | QP No. | QP Sub. Schedule | QP approval schedule | Proposed sub-supplier | Place | Sub-suppliers approval status/ category | Sub-supplier Details submission schedule | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| | | | | | | | | | | |
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**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.

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# ANNEXURE-IV

| | | | |
|---|---|---|---|
| | Project : S<br>Package :<br>Bidder :<br>Bidder No. : | STATUS OF ITEM REQUIRING QP& SUB-SUPPLIER APPROVAL | DOC. NO.:<br>REV. NO.:<br>DATE :<br>PAGE : OF |

| S. N. | Item/ Service | QP/ Insp. Cat. | QP Sub. Schedule Approval schedule | Date of sub-mission | Date of commt Appl. | Status Code C/II/I | Proposed Sub-suppliers | Place of manufacturing works | Approval Status | Sub-supplier detail submission schedule | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
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# ANNEXURE-V

| | | | |
|---|---|---|---|
| | Project : Stage :<br>Bidder :<br>Bidder No. :<br>System : | FIELD WELDING SCHEDULE<br>(To be raised by the Bidder)<br>Welding Code: …… | DOC. NO.:<br>REV. NO.:<br>DATE :<br>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**

| | | |
|---|---|---|
| | | |

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# ANNEXURE-VI

| MFGR.'s LOGO | MANUFACTURER'S NAME AND ADDRESS | MANUFACTURING QUALITY PLAN | | PROJECT :<br>PACKAGE :<br>CONTRACT NO. :<br>MAIN-SUPPLIER: |
|---|---|---|---|---|
| | | ITEM :<br>SUB-SYSTEM: | QP NO.:<br>REV.NO.:<br>DATE:<br>PAGE: …. OF…. | |

| SL. NO | COMPONENT & OPERATIONS | CHARACTERISTICS | CLASS | TYPE OF CHECK | QUANTUM OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORMS | FORMAT OF RECORD | | AGENCY | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | M | C | N | |
| 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | D * | ** 10. | | | 11. |
| | | | | | | | | | | | | | |

| | | | | |
|---|---|---|---|---|
| MANUFACTURER/ SUB-SUPPLIER | MAIN-SUPPLIER | **LEGEND:** * RECORDS, INDENTIFIED WITH "TICK" ( √ ) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.<br>** **M:** MANUFACTURER/SUB-SUPPLIER<br>**C:** SUPPLIER/NOMINATED INSPECTION AGENCY,<br>**N**: THE OWNER | FOR THE | DOC. NO.:<br>REV…… CAT….. |

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

# ANNEXURE-VII

| MFGR.'s LOGO | SUPPLIER'S NAME AND ADDRESS | FIELD QUALITY PLAN | | PROJECT :<br>PACKAGE :<br>CONTRACT NO. :<br>MAIN-SUPPLIER: |
|---|---|---|---|---|
| | | ITEM :<br>SUB-SYSTEM : | QP NO.:<br>REV.NO.:<br>DATE:<br>PAGE: …. OF…. | |

| SL. NO | ACTIVITY AND OPERATION | CHARACTERISTICS / INSTRUMENTS | CLASS# OF CHECK | TYPE OF CHECK | QUANTUM OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORMS | FORMAT OF RECORD | D* | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | | 10. |
| | | | | | | | | | | |

| | | | | |
|---|---|---|---|---|
| MANUFACTURER/ SUB-SUPPLIER | MAIN-SUPPLIER | **LEGEND: * RECORDS**, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.<br>**LEGEND TO BE USED: CLASS #: A = CRITICAL, B=MAJOR, C=MINOR;** | FOR THE | DOC. NO.:<br>REV…… |

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| | | | | | |
|---|---|---|---|---|---|
| **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) | **OWNER USE** | **REVIEWED BY** | **APPROVED BY** | **APPROVAL SEAL** |

## 13.0 QUALITY PLAN FOR MANUFACTURE OF EQUIPMENT:

13.1 The Quality plan for manufacture is a document, which presents in a tabular form. The Quality Control checks to be exercised by the Contractor during the various stages of manufacture and despatch in order to meet the requirements of this Contract. This plan shall detail the components manufactured, characteristics being controlled and acceptance norms for this characteristic and the agency responsible for performance and witnessing the checks.

13.2 After issuance of Letter of Intent (LOI), the contractor shall submit to the Owner, the detailed quality plans to be followed during manufacture of all major equipments. These quality plans shall be discussed mutually and updated by the Contractor taking into consideration the requirement of the Owner. The quality plan when approved shall form a part of the contract. This document shall be followed for inspection of the concerned equipment.

13.3 The details of the quality assurance / quality checks envisaged by the Contractor during manufacturing of the equipment supplied by him or procured through his sub-vendors / sub-contractors shall be detailed out in the quality plans to be submitted by the Contractor. The contractor may also furnish any additional information regarding quality assurance / quality checks in the additional sheets, if required. Quality plans for major equipments manufactured by the Contractor or procured through his sub-vendors / sub-contractors shall be submitted during engineering. After approval of the Owner is accorded various quality plans shall be bound as a booklet and shall be submitted to the Owner as soon as possible. The contractor shall ensure that the approved quality plans are followed scrupulously by him and by his sub-vendors / sub-contractors and manufacturing of the items covered under the quality plans shall be taken up only after Owner has approved the quality plan.

## 14.0 OWNER'S REPRESENTATIVE AT SITE:

14.1 SE/ Projects, "2 x 660 MW Ennore SEZ Supercritical Thermal Power Project at Ash Dyke of NCTPS" shall be the Owner's representative at site and shall act as an In-charge for all the site works. The contractor's Resident Engineer shall report to him for all the day to day works.

## 15.0 CONSIGNEE:

All materials shall be consigned to:
SE/ Projects
Tamil Nadu Generation and Distribution Corporation
Ennore SEZ Supercritical TPP

## 16.0 PAINTS, CONSUMABLES:

16.1 Pursuant to the Clause No. 25.0 of Section 3, Volume I, it shall be the responsibility of the contractor to supply all the paints as required.

16.2 It shall be the responsibility of The Contractor to supply all consumables like, grease, lubricating oils, all chemicals, ink & graphs for recorders etc., up to satisfactory completion of trial operation and three months thereafter. The Contractor shall also arrange any additional quantities required specifically for the Performance Guarantee Test. Contractor shall furnish specifications of all such consumables to enable the Owner to purchase his future requirements well in advance.

## 17.0 THIRD PARTY INSPECTION:

a) Indigenous supplies: - The equipment to be supplied under this Contract shall be inspected during manufacturing as per the quality plan to be finalized. Material verification and stage inspection at all important stages as well as final testing and inspection fall within this scope. The inspection shall be carried out by a third party inspection agency to be appointed by the Owner for

indigenous supplies. The cost towards this inspection shall be borne by the Contractor.

b) In the case of imported supplies: - For imported materials or non- indigenous supplies, the inspection shall be carried out by a foreign agency of repute to be appointed by the contractor as approved by the Owner. The cost of such inspection shall be borne by the Contractor.

## 18.0 OPERATION AND MAINTENANCE MANUALS:

18.1 For all the equipments supplied by the Contractor, he shall submit to the Owner ten sets of the O&M manuals. The manual shall contain the operational features of the equipment, DOs & DON'Ts, trouble shooting, maintenance schedules for preventive maintenance, detail dimensional drawings, cross sectional drawings, method of assembly etc. to make the Owner's staff acquainted with the equipment as well as to enable them to operate and maintain the same in prescribed manner. Manuals shall contain all information for ordering of the spares, like part name, part no., Drawing/ material Specifications, address of the supplier with phone no. & fax no. etc. Contractor shall ensure that these O&M manuals are made available to the Owner well before starting of initial trials of equipment.

## 18.2 ERECTION MANUALS:

18.2.1 In order to enable the engineers of the Owner to supervise the works properly, Contractor shall furnish five copies of erection manuals depicting therein the erection procedure, special precautions to be taken, various clearance to be maintained, erection checks and tests to be carried out before the equipment is put to initial trials.

## 19.0 SUBMISSION AND APPROVAL OF DRAWINGS:

19.1 The contractor shall submit the drawings in sequential order to match with completion of milestone activity. The contractor shall submit all the G.A. drawings, mechanical, electrical and

civil drawings, data sheets etc. for approval of the Owner along with the design calculations and general write up wherever involved. The drawings for all the systems shall be properly coordinated. While scrutinizing the drawings, the Owner shall indicate the corrections to be made in these drawings and documents, which the contractor shall incorporate or justify its correctness. The Contractor then shall submit the revised drawings for approval of the Owner. On approval of the same, Contractor shall furnish six copies and soft copy on CD of these approved drawings to the Owner as per the distribution to be intimated. Any delay in approval of drawings by Owner, due to submission of incorrect data, non-submission of data, non-updating the drawings in line with the corrections indicated shall be to the Contractor's account. During the currency of the contract, if any approved drawings are required to be modified, such details of the modifications required to be carried out shall be separately maintained. On completion of all the works, the Contractor shall incorporate all the changes necessitated in the drawings and submit 6(six) sets of all the "As built" drawing for the records of the Owner. As the drawings shall be approved based on the basic information furnished by the Contractor, approval by the Owner shall not absolve the Contractor of his responsibilities towards correctness of design & performance of the equipment.

## 20.0 TEST REPORTS:

20.1 On completion of tests of equipment at manufacturer's works, the Contractor shall furnish 4 copies of test certificates to the Owner for approval and subsequent despatch clearance. The test report shall invariably indicate identification data, including model no., sl. no. etc. of the equipment, method of application and duration of test along with test results. Only on approval of these test results by the Owner or Owner's representative, dispatch clearance will be issued for dispatch of material to site.

## 21.0 FIELD QUALITY PLAN:

21.1 Erection shall be carried out as per ECC, manufacturer's manual, approved quality plan & best practices of the industry. After completing erection of individual equipment, the equipment shall be tested for starting up. The list of all the inspections, tests to be carried out before starting up of the equipment shall be mutually decided. Subsequent to these tests, the equipment shall be tried as a sub system and further as a system as a whole. All the inspections and tests to be carried during these stages shall be mutually decided and as per the best practices. This schedule of inspections and the tests shall be called as field quality plan and Contractor shall follow the same during various stages of erection, testing and operations.

## 22.0 COMMISSIONING AND HANDING OVER:

## 22.1 INITIAL TRIAL:

On completion of erection of equipment, each item of the equipment shall be thoroughly cleaned and inspected jointly by the Owner / Consultant and Contractor for correctness and completeness of installation and acceptability for initial trials of the equipment by the Contractor & Owner. During the above joint walk down, the list of equipment deficiency & defects shall be prepared and for such a punch list, action shall be initiated by the Contractor in agreed time frame. The list of tests to be performed prior to initial trials shall be mutually agreed and included in the Field Quality Plan by Contractor. The purpose of these trials is to ensure integrity of each individual equipment for its operation in the system for initial operation.

## 22.2 INITIAL OPERATION:

After successful initial trials of all the individual equipment, all equipments shall be operated together as a system. The purpose of this initial operation is to ensure integrity of all the

sub-systems which compose the total system. Based on the observations made during initial operation, necessary corrections shall be effected in the equipment / systems to ensure proper integrated operation of the system. After satisfactory completion of initial operation for each equipment & sub-system, the complete equipment shall be considered ready for trial operation. During initial operation, any adjustments/calibrations to the instruments fitted in the new system shall be done in the presence of testing staff of Owner so as to enable them to familiarize themselves with its adjustments and maintenance. The Contractor has also to ensure that he trains Owner's Engineers at site dealing with this system in proper way.

## 22.3 TRIAL OPERATION:

22.3.1 After satisfactory initial operation, the plant shall be put on trial operation. The period of trial operation shall be Thirty (30) days of which minimum continuous seventy two (72) hours shall be at full load. During the period of trial operation, all the necessary adjustments in the plant / equipments shall be made by the Contractor to establish that the complete system as a whole with all sub-systems and with all standby equipment is ready for continuous operation. During these trials, all the standby equipments also shall be run alternatively and continuously for 14 days to prove their performance. During this period, the Contractor shall demonstrate capabilities of his supplied equipment as indicated in the specification or in subsequent discussions. Duration of Breakdown due to grid disturbances will not be reckoned as interruption.

22.3.2 A trial operation report comprising of dates and duration of trial, observations and recordings of various parameters to be measured shall be prepared by the Contractor and signed jointly by the Owner and the Contractor. The report shall have sheets, recording all the details of interruptions occurred, adjustments made and any minor repairs done during the trial operation. If the trial operation is established

to be satisfactory, except for some minor adjustments, if any, the plant shall be taken over by the Owner for day to day operation and maintenance from the date of conclusion of trial operation. If the trial operation is not satisfactory, then based on the observations during trial operation, necessary modification / repairs to the plant / equipment shall be carried out by the Contractor and on completion of such works, the trial operation shall be repeated again on a date and for a period for 28 days as per clause no. 22.3.1 mentioned above.

22.4 After the trial operation is carried out successfully, to declare it as such, a joint protocol should be signed between TANGEDCO and the Contractor.

22.5 The goods supplied under the contract shall be fully insured up to 3 months from the date of taking over of the plant. However in case the trial operation is extended due to reasons attributable to the Owner, then the insurance policy shall be extended by the Contractor till successful completion of trial operation / taking over of the plant and the actual premium charges towards this extension of insurance policy shall be reimbursed by the Owner to the Contractor without any handling charges.

## 23.0 PERFORMANCE GUARANTEE TEST:

23.1 After satisfactory completion of the trial operation, the performance test shall be conducted at site by the Contractor. Any preparations required for this test shall be carried out by the Contractor for which Owner will provide required shutdown. The duration of the Performance Guarantee Test of the Plant at the rated capacity shall be mutually agreed. However, a stability period of 2 hours before commencement of test and 2 hours test period followed by another 2 hours stable period shall be maintained. The PG test procedure should be submitted to the owner well in advance and got approved before the commencement of PG test. Performance Guarantee Test shall be conducted within 30 days of intimation from the

Contractor about his readiness for conducting Performance Guarantee Test. These tests shall be binding on both the Owner and the Contractor to determine performance of the equipment/system with the performance guarantee data.

23.3 The tests shall be conducted at the specified load conditions or as near the specified conditions as practicable. The Owner/Contractor will apply agreed factors to compensate for deviation from the designed parameters. The suitable correction curves mutually agreed by the Owner and the Contractor shall be used.

23.4 All test instrumentation as required for the Performance Guarantee Test shall be arranged by the Contractor free of cost. Precision instruments required for Performance Guarantee Test shall, however, be arranged by the contractor. Calibration before and after test and installation of the test instrumentation for the test shall be the Contractor's responsibility. All test instrumentation shall be in accordance with the applicable code. All test instruments and calibration procedures shall be duly approved by the Owner. Batch calibration shall not be accepted. The test shall be commenced only after clearance of owner on the above vital issues.

23.5 Any special equipment, tools and tackles required for the successful completion of the performance tests shall be provided by the Contractor free of cost.

23.6 The performance guarantee figures of the equipment shall be proved by the Contractor during the Performance Guarantee Test.

23.7 Should the results of these tests show any decrease from guaranteed values, the Contractor shall modify the equipment within 90 days from the date of intimation by the owner as required to bring it to meet the guarantees. In such cases, the performance tests shall be repeated within one month from the date on which the equipment is made ready again for tests subject to grid requirements at that time. All

costs of modifications including labour, material and the cost of additional testing to prove that equipment meets the guarantee shall be borne by the Contractor.

23.8 The provisions outlined in the ASME performance test code or other International and Indian approved equivalents shall generally be used as a guide for all the above test procedures unless specified otherwise in the specification. The details of all measuring/recording meters, test instrumentation such as class of accuracy, make etc. shall be covered in the trial operation/ performance test reports. All the list of equipments, accuracy class and test certificates to be submitted and got approved by the owner before the commencement of trail operation.

PG test to be witnessed by the consultant and the owner.

23.9 The above shall be read in conjunction with Volume – I, Section 1, General Technical Specification on Performance Guarantee Test.

## 24.0 PERFORMANCE GUARANTEES, PENALTIES & CAPABILITY TESTS:

24.1 The Contractor shall meet the Performance Guarantees as have been indicated in the Specifications and Schedule thereof.

24.2 The penalty for not meeting the performance guarantees during the Performance Guarantee Test shall be assessed and recovered from the Contractor. Such penalty shall be levied without limitations, in accordance with stipulations made in Technical Specification and shall be without prejudice to all the other conditions of the contract.

24.3 If the guarantees specified are not achieved by the Contractor within 90 days of notification by the Owner, he may at his discretion reject the equipment or accept it after levying and recovering suitable penalties.

24.4 In case there is shortfall in capability of equipment while demonstrating capability tests, the Contractor shall forth-with rectify his equipment within 90 days and re-perform the capability tests to Owner's satisfaction.

24.4.1 Any recoveries by the Owner from the Contractor due to shortfall in guaranteed performance shall be independent of provisions of clause no. 6.0 "Liquidated damages of Special Conditions of the Contract. "

## 25.0 PENALTY FOR POOR PERFORMANCE:

25.1 The contractor shall furnish performance guarantee as have been specified in Guarantee Schedule under Technical Specification Vol-II. This guarantee shall be met by the Contractor.

25.2 The penalty for not meeting the performance guarantees during the Performance Guarantee Tests shall be assessed and recovered from the Contractor as under.

**EVALUATION / LOADING CRITERIA & PENALTY TOWARDS SHORTFALL IN PERFORMANCE PARAMETERS:**

| S. No. | Variation Factor | Loading for evaluation of shortfall in performance | Penalty for shortfall in performance |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| 1 | HEAT RATE:- Increase in Station heat rate in kCal / kWh under rated steam conditions at 100% TMCR | Rs.428.41 lakhs per kCal / kWh increase in heat rate over lowest quoted Heat Rate as base. | Rs. 428.41 lakhs per kCal / kWh or part thereof increase in heat rate from guaranteed value |

| S. No. | Variation Factor | Loading for evaluation of shortfall in performance | Penalty for shortfall in performance |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| | after subtracting excitation power with following conditions:<br><br>1.Cycle make-up : 0% makeup<br>2.Cooling water inlet temperature of 33 deg.C<br>3.TDBFP's in operation<br>4. Generator power factor of 0.85<br><br>(Gross Turbine cycle heat rate at 100% TMCR condition is guaranteed after accounting for pressure drop in main steam piping, Reheater system and all extraction steam piping from steam turbine to feed water heaters & deaerator) | | |

| S. No. | Variation Factor | Loading for evaluation of shortfall in performance | Penalty for shortfall in performance |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| 2 | Total auxiliary power consumption of all auxiliaries (*) at 660 MW at after subtracting excitation power with following conditions:<br><br>1. Cycle make-up : 0% makeup<br>2. Cooling water inlet temperature of 33 deg.C<br>3. TDBFP's in operation<br>4. Generator power factor of 0.85 | Rs.4,70,72,094 for every 0.01 % increase (considering 5.5 % lowest quoted Auxiliary Power Consumption as base) | Rs.4,70,72,094 for every 0.01 % increase or part thereof from guaranteed value |
| 3 | Capitalization of losses of Transformers<br>Iron losses<br>Copper losses<br>Cooler pump/fan losses<br>(applicable for each transformer separately | Rs.3,49,880 /kW<br>Rs.2,89,701 /kW<br>Rs.2,79,904 / kW<br>(considering lowest quoted values as base) | Rs.3,49,880 /kW<br>Rs.2,89,701 /kW<br>Rs.2,79,904 / kW<br>Increase per kW or part thereof from guaranteed value |

| S. No. | Variation Factor | Loading for evaluation of shortfall in performance | Penalty for shortfall in performance |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| | | | |
| 4 | Deficiency in capacity of TG from 660 MW at Generator terminals with following conditions:<br><br>1. Cycle make-up : 0% makeup<br>2. Cooling water inlet temperature of 33 deg.C<br>3. TDBFP's in operation<br>4. Generator power factor of 0.85 | -- | Rs 10,55,668 for every kW or part thereof by which output determined by the tests fall short of guaranteed figure of 660 MW |
| 5 | Steam Generator Efficiency with following conditions:<br>i) 100% TMCR<br>ii) Firing design coal<br>iii) On Gross Calorific value | -- | Rs 9,33,52,000/- for every 0.1% (zero point one percent) shortfall in efficiency |

| S. No. | Variation Factor | Loading for evaluation of shortfall in performance | Penalty for shortfall in performance |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| | (GCV) basis<br>iv) Rated excess air<br>v) At 32 deg C DBT and 65% RH ambient air conditions. | | |

Note: All above loadings & penalties as mentioned in Col. 3 & 4 shall be calculated on pro-rata basis.
The penalty indicated above is in addition to the liquidated damages as stipulated in clause no.6.0 of this Section.

* The guaranteed auxiliary power consumption shall be furnished as per list enclosed in Schedule 15 A. Bidder shall list out any additional continuous working equipment in addition to the item listed , which are required for the plant to operate at 100% TMCR load.

## 26.0 FINAL ACCEPTANCE:

26.1 In case Performance Guarantee Test cannot be carried out at specified time due to reasons attributable to Owner, the Plant shall be taken over 180 days after the intimation from the Contractor provided the Owner is satisfied about his readiness for conducting the Performance Guarantee Test. In such case, the Owner shall give an adhoc final acceptance certificate for the purpose of triggering the Guarantee/Defect Liability period which will be subject to revision based on actual PG test results. In such an eventuality, the Owner shall give a notice to the Contractor of

his readiness to give necessary inputs to enable the Contractor to do the Performance Guarantee Test, in which case the Contractor shall arrange the Performance Guarantee Test within 30 days on receipt of such notice without any additional financial implication to the Owner.

26.2 On conducting the Performance Guarantee Test, if it is established to the satisfaction of the Owner that the equipment is performing as specified in the Technical Specifications, the Owner shall issue to the Contractor a final acceptance certificate indicating the date from which the equipment has been taken over.

26.3 Such a certificate shall be given within 30 days after satisfactory completion of the performance guarantee test and PG test results are furnished by the Contractor to prove the achievement of the assured PG values. Owner shall not delay the issuance thereof on account of minor omissions or defects which do not affect the safe and reliable operation and/or cause any risk to the equipment. Such certificate shall, however, not relieve the Contractor of any of his obligations which otherwise survive by the terms and conditions of the contract.

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# SECTION: I

# SUB-SECTION: C 2C

## CUSTOMER SPECIFICATIONS

## PAINTING SPECIFICATIONS

# CHAPTER - 6

## PAINTING

### 1.0 SCOPE

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

The following surface and material shall require painting:

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

The following surfaces and materials shall not require painting :

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

### 2.0 CODES AND STANDARDS

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

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

| | | |
|---|---|---|
| IS:5 | : | 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<br>(a) Undercoating<br>(b) finishing |
| IS:4682 | : | Code of practice for lining of vessels & equipment |
| SIS 559000 | : | Swedish standard for blasting |
| ISO 8504-2 | : | Preparation of steel substrates before application of paints and related products. Surface preparation methods Part 2 Abrasive blast cleaning |
| ISO 8501-1 | : | Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness. Part 1 : Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings. |
| SIS 05 5800 | : | Surface preparation by acid pickling |
| SSPC SP08 | : | Surface preparation by acid pickling |
| IS 2629 | : | Recommended practice for hot dip galvanizing of iron and steel |
| ASTM A780 | : | Standard practice for repair of damaged galvanized coatings |
| SSPC | : | Steel structures painting council |
| NACE | : | National association of Corrosion Engineers |
| DIN | : | Deutsehes Institute for Normung |
| BS | : | British Standard |
| ASTM | : | American Society for Testing material |
| AWWA | : | American Water works association |

## 3.0 SURFACE PREPARATION

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

## 3.1 BLASTING

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

Abrasive used for blast cleaning carbon steel and alloy steel shall be as per ISO 8504-2 and SSPC painting manual. Suggested abrasives are chilled iron grit, shot steel, malleable iron grit and shots of non metallic abrasive (aluminum oxide, copper slag, garnet etc.).
The grade of blasting shall be performed in line with the approved painting scheme.
The nature, quality and grain size of abrasives and the parameter of their use are to be chosen to obtain the required surface profile depth and cleanliness.
Surfaces prepared for coating shall be coated the same day and before any visible rusting occurs (the time elapsed between blast cleaning and commencement pf painting shall under no circumstances exceed 4 hours, but in any case must commence before signs of degradation occur).

The grades of surface finish

| | ISO 8501-1 | SIS 055900 | SSPC | NACE |
|---|---|---|---|---|
| White metal | Sa3 | Sa3 | SP5 | 1 |
| Near White 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 eg Trichloro trifluoro ethane and solvents containing acetone (renew solvent and rag frequently) |

### 3.4 Acid Pickling

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

## 4.0 PROCESSING

### 4.1 General
**Application Conditions**

The primer shall be applied to properly prepared surfaces only. The specifications of the coating material manufacturers shall be observed. The minimum temperature shall be + $5^0$C and the relative humidity shall not exceed 80%. The temperature of the work piece shall be at least $3^0$C above dew point.

### 4.2 Application Procedure

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

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

### 4.3 Touching Up

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

### 4.4 Uncoated Surfaces

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

### 4.5 Bond Strength

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

## 5.0 SURFACE CONDITIONS OF COATING SURFACES

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

## 6.0 COATING SYSTEMS

### 6.1 General Requirements for Coating Systems

Coating materials according to SSPC, BS 5493 or DIN 55 928 shall be used. Intermediate coats are to be pigmented with micaceous iron oxide. The materials shall be matched with each other so that they are compatible. Coatings deviating this

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 fim thickness 75µm.

**At Site**

Thorough cleaning to remove oil, grease, dirt and any other contaminants. Derusting of all mechanical damages according to SIS 055900 Grade ST3. Touch up with dry film thickness 50 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 $120^0$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 fim thickness 75µm.

**Intermediate Coat**

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

**Finish Coat**

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

## 6.5 Special Coating

### (a) Parts exposed to temperatures above $120^0$C, upto $200^0$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 fim thickness 75µm.

(ii) At Site

**Pretreatment**

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

**Intermediate Coat**

I pack silicon acrylic dry film thickness 35 µm.

**Final Coat**

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

(b) **Parts exposed to temperatures above 200$^0$C, upto 400$^0$C, not insulated**

(i) At Works

**Surface Preparation**

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

**Prime Coat**

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

(ii) At Site

**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 < 400$^0$C

**Surface Preparation**

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

Parts exposed to temperature above $400^0$C at works (Steam pipes, pressure tubes and parts for the HRSG, such as heating surfaces, heaters and superheaters, reheaters etc)

**Temporary Primer**

Varnish

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

(i) At Works

**Surface Preparation**

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

**Prime Coat**

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

(ii) At Site

**Pretreatment**

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

**Intermediate Coat**

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

**Finish Coat**

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

Total system dry film thickness 205µm.

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

(e) **Water Exposure**

(i) At Site/ Works

**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 $60^0$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 fim thickness >75µm.

**Pretreatment**

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

**Intermediate Coat**

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

**Finish Coat**

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

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

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

**6.6.2 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 phosphate/ oven dried and then painted with two coats of zinc rich primer paint. After application of the primer, two coats of finishing epoxy paint shall be applied. The colour of the finishing coats inside shall be glossy white and exterior of the treated sheet steel shall be shade 631 of IS-5/ RAL 7032 for all switchboard/ MCC/ Distribution boards, control panels etc.

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

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

**6.8 SUGGESTED COLOUR CODES FOR PAINTING**

| SL. NO. | ITEM/SERVICE | COLOUR | IS-5 | COLOUR (BAND) | IS-5 |
|---|---|---|---|---|---|
| 1. | Structures, platforms, galleries, ladders and handrails | Dark Admirality 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) | 631/70 78 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 | Condenstae | Sea Green | 217 | Light Brown | 410 |
| c | DM Water | Sea Green | 217 | Light Orange | 557 |
| d | Soft Water | Sea Green | 217 | French Blue | 166 |
| e | Bearing Cooling Water | Sea Green | 217 | French Blue | 166 |
| f | Potable & filtered Water | Sea Green | 217 | French Blue | 166 |
| g | Service and clarified water | Sea Green | 217 | French Blue | 166 |
| h | Cooling water | Sea Green | 217 | French Blue | 166 |
| I | Sea Water | Sea Green | 217 | White | - |
| 14. | Ash Transmitting Vessels and pipe lines | Aluminium | - | - | |
| 15. | **Air System** | | | | |
| 15.1 | Station air | Sky blue | 101 | - | - |
| 15.2 | Control air | Sky blue | 101 | White | - |
| 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.

**SECTION: I**

**SUB-SECTION: C-3**

**TECHNICAL SPECIFICATION (ELECTRICAL PORTION)**

# ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGES : AIR CONDITIONING
SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT
PROJECT: 2X660 MW ENNORE TPP

| 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<br>a) both end equipment in BHEL's scope<br>b) both end equipment in vendor's scope<br>c) one end equipment in vendor's scope | <br>BHEL<br>BHEL<br>BHEL | <br>BHEL<br>Vendor<br>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.<br>2. Termination at BHEL equipment terminals by BHEL.<br>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<br><br>100/ 50 mm cable trays/ Conduits/ Galvanised steel cable troughs for local cabling | BHEL<br><br>Vendor | BHEL<br><br>Vendor | Local cabling from nearby main route cable tray (BHEL scope) to equipment terminal (vendor's scope) shall be through 100/ 50 mm. cable trays/ conduits/ Galvanised steel cable troughs, as per approved layout drawing during contract stage. |
| 7 | Cable glands ,lugs and bimetallic strip for equipment supplied by Vendor | Vendor | Vendor | 1. Double compression Ni-Cr plated brass cable glands<br>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) & | BHEL | BHEL | Refer note no. 4 for electronic earthing |



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ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGES : AIR CONDITIONING

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

PROJECT: 2X660 MW ENNORE TPP

| S.NO | DETAILS | SCOPE SUPPLY | SCOPE E&C | REMARKS |
|---|---|---|---|---|
| | lightning protection | | | |
| 11 | Below grade grounding | BHEL | BHEL | |
| 12 | LT Motors with base plate and foundation hardware | Vendor | Vendor | Makes shall be subject to customer/ BHEL approval at contract stage. |
| 13 | Mandatory spares | Vendor | - | Vendor to quote as per specification. |
| 14 | Recommended O & M spares | Vendor | - | As specified elsewhere in specification |
| 15 | Any other equipment/ material/ service required for completeness of system based on system offered by the vendor (to ensure trouble free and efficient operation of the system). | Vendor | Vendor | |
| 16 | a) Input cable schedules (Control & Screened Control Cables)<br>b) Cable interconnection details for above<br>c) Cable block diagram | Vendor<br>Vendor<br>Vendor | -<br>-<br>- | 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.



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ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGES : AIR CONDITIONING

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

PROJECT: 2X660 MW ENNORE TPP

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.



Anshul S A Khan Praveen Kishore

## SPECIFIC TECHNICAL REQUIREMENTS: ELECTRICAL

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER/ PURCHASER

1.1 Scope for supply, and erection & commissioning of various equipment forming part of electrical system for this package shall be as per Annexure–I to Section – C [Scope of Work (Electrical)].

1.2 Make of various equipment/ items in the scope of bidder shall be to approval of owner during detailed engineering stage without any commercial implications.

1.3 Bidder shall furnish all AC as well as DC loads required for the system at different voltage levels (eg. 415V AC, 240 V AC, 220 V DC etc.) of all types, such as motor feeders, supply feeders in PEM format along with the offer.

1.4 All electrical equipment shall be suitable for the power supplies, fault levels and climatic conditions indicated in project information enclosed with the specification.

1.5 All drawings, data sheets, Quality Plan, calculations, test reports, test certificates, etc. shall be submitted during detailed engineering stage as per formats enclosed. The same shall be subject to approval without any commercial implications.

1.6 Technical requirements shall be as per specifications listed in Clause 4.1, 4.2, 4.3, 4.4 & 4.5. In case of any discrepancy between Customer specification and BHEL standard specification, Customer specification shall prevail.

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

3.1 Bidder shall confirm total compliance to the electrical specification without any deviation from the technical/ quality assurance requirements stipulated. In line with this, the bidder as technical offer shall furnish two signed and stamped copies of the following:

a) A copy of this sheet “Electrical Equipment Specification for AC System’ and sheet “Electrical Scope between BHEL and Vendor” with bidder’s signature and company stamp.
b) List of Erection and Commissioning spares.
c) List of Erection & Maintenance tools & tackles.
d) Electrical load requirement in the load data format.

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

4.0 LIST OF ENCLOSURES

4.1 Electrical scope between BHEL & vendor (Annexure-I).
4.2 Technical specification – Customer specification - Motors
4.3 BHEL standard specification for LT motors : PE-SS-999-506-E101
4.4 Datasheets – A and C
4.5 Quality Plan for motors.
4.6 Load data format (Annexure-II).

# GENERAL TECHNICAL REQUIREMENTS

# FOR

# LV MOTORS

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

## 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.

The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.

3.3.3 The following frequency of starts shall apply

i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature.

ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour)

iii) Motors for coal conveyor and coal crusher application shall be suitable for three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be suitable for mimimum 20,000 starts during the life time of the motor

3.4 **Running Requirements**

3.4.1 Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.

3.4.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage upto 70% of the rated voltage for duration of 2 secs.

3.5 **Stress During bus Transfer**

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

3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.

3.6 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.

3.7 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.

4.0 **CONSTRUCTIONAL FEATURES**

4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy

4.2 Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362.

Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled

4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.

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

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

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**

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.

# BASIC TECHNICAL FEATURES

# FOR HT/LT MOTORS

# (FOR BHEL-PEM SCOPE PACKAGES)

| REV | DATE | ALTD | CHD | APPD |
|---|---|---|---|---|
| 02 | 13.05.15 | RKG/ AB | SL | RG |

REVISED AS PER TANGEDCO COMMENTS DATED 10.04.2015

| REV | DATE | ALTD | CHD | APPD |
|---|---|---|---|---|
| 01 | 13.03.15 | BKR -SD- | SL -SD- | RG -SD- |

REVISED AS PER TANGEDCO COMMENTS DATED 13.02.2015

| | |
|---|---|
| PROJECT | 2X660MW ENNORE SEZ SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS,CHENNAI |
| OWNER | TAMIL NADU GENERATION & DISTRIBUTION CORPOARATION LIMITED |
| OWNER'S CONSULTANT | DESEIN PRIVATE LIMITED, DESEIN HOUSE,NEW DELHI |
| EPC CONTRACTOR | BHARAT HEAVY ELECTRICALS LIMITED POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA(U.P) INDIA |

BHARAT HEAVY ELECTRICALS LTD.
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

| DEPT CODE | | NAME | SIGN | DATE |
|---|---|---|---|---|
| E | DRN | BKR | | |
| | DSGN | BKR | -SD- | 13.01.15 |
| | CHD | SL | -SD- | 13.01.15 |
| | APPD | RG | -SD- | 13.01.15 |

TITLE: BASIC TECHNICAL FEATURES FOR HT/LT MOTORS

DRAWING NO. PE-DC-412-565-E003

SHEET 1 OF 7 REV 02

Anshul S A Khan Praveen Kishore

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 IE3 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.

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:

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.

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.

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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.

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.

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.

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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT<br>TITLE | | | SPECIFICATION :<br>NUMBER : | | | |
| | | | BIDDER/ VENDOR : | | | QUALITY PLAN<br>NUMBER PED-506-00-Q-006, REV-01 | | | SPECIFICATION<br>TITLE | | | |
| | SHEET 1 OF 2 | | SYSTEM | | | ITEM AC ELECT. MOTORS BELOW 55KW (LV) | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTICS CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY P | AGENCY W | AGENCY 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** | | | | | | | | | |

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| | **QUALITY PLAN** | CUSTOMER : | | PROJECT<br>TITLE | | | SPECIFICATION :<br>NUMBER : | | | |
| | | BIDDER/ :<br>VENDOR | | QUALITY PLAN<br>NUMBER PED-506-00-Q-006, REV-01 | | | SPECIFICATION :<br>TITLE : | | | |
| | SHEET 2 OF 2 | SYSTEM | | ITEM AC ELECT. MOTORS BELOW 55KW (LV) | | | SECTION VOLUME III | | | |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTICS CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY P | AGENCY W | AGENCY V | REMARKS |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | 11 |
| | | 3.NAMEPLATE DETAILS | MA | VISUAL | 100% | IS-325 & DATA SHEET | IS-325 & DATA SHEET | INSPN. REPORT | 2 | 1 | - | |

NOTES:

1 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON

2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER.

3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW , ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY.

Legends for Inspection agency

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 |

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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT<br>TITLE | | | SPECIFICATION :<br>NUMBER : | | | |
| | | | BIDDER/ :<br>VENDOR | | | QUALITY PLAN<br>NUMBER PED-506-00-Q-007, REV-03 | | | SPECIFICATION :<br>TITLE | | | |
| | SHEET 1 OF 9 | | SYSTEM | | | ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV) | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY P | W | V | REMARKS |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | 11 |
| 1.0 | RAW MATERIAL & BOUGHT OUT CONTROL | | | | | | | | | | | |
| 1.1 | SHEET STEEL, PLATES, SECTION, EYEBOLTS | 1.SURFACE CONDITION | MA | VISUAL | 100% | - | FREE FROM BLINKS, CRACKS, WAVINESS ETC | LOG BOOK | 3 | - | - | |
| | | 2.DIMENSIONS | MA | MEASUREMENT | SAMPLE | MANFR'S DRG./SPEC | MANFR'S DRG./SPEC | -DO- | 3 | - | - | |
| | | 3.PROOF LOAD TEST (EYE BOLT) | MA | MECH. TEST | -DO- | -DO- | -DO- | INSPEC. REPORT | 3 | - | 2 | |
| 1.2 | HARDWARES | 1.SURFACE CONDITION | MA | VISUAL | 100% | | FREE FROM CRACKS, UN-EVENNESS ETC. | -DO- | 3 | - | - | |
| | | 2.PROPERTY CLASS | MA | VISUAL | SAMPLES | MANFR'S DRG./SPEC BOOK | RELEVENT IS/SPEC. | SUPPLIERS TC & LOG | 3 | - | 2 | PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR |
| 1.3 | CASTING | 1.SURFACE CONDITION | MA | VISUAL | 100% | | FREE FROM CRACKS, BLOW HOLES ETC. | LOG BOOK | 3 | - | 2 | |
| | | 2.CHEM. & PHY. PROP. | MA | CHEM & MECH TEST | 1/HEAT NO. | MANFR'S DRG./SPEC | RELEVENT IS/ | SUPPLIER'S TC | 3 | - | 2 | HEAT NO. SHALL BE VERIFIED |
| | | 3.DIMENSIONS | MA | MEASUREMENT | 100% | MANUFR'S DRG. | MANUFR'S DRG. | LOG BOOK | 3 | - | 2 | |
| 1.4 | PAINT & VARNISH | 1.MAKE, SHADE, SHELF LIFE & TYPE | MA | VISUAL | 100% CONTINUOUS | MANFR'S DRG./SPEC | MANFR'S DRG./SPEC | LOG BOOK | 3 | - | 2 | |
| **BHEL** | | | **PARTICULARS** | | **BIDDER/VENDOR** | | | | | | | |
| | | | **NAME** | | | | | | | | | |
| | | | **SIGNATURE** | | | | | | | | | |
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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT<br>TITLE | | | SPECIFICATION :<br>NUMBER : | | | |
| | | | BIDDER/ :<br>VENDOR | | | QUALITY PLAN<br>NUMBER PED-506-00-Q-007, REV-03 | | | SPECIFICATION :<br>TITLE | | | |
| | SHEET 2 OF 9 | | SYSTEM | | | ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV) | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY P | AGENCY W | AGENCY V | REMARKS |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | 11 |
| 1.5 | SHAFT<br>(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.<br>BHEL SPEC. | -DO- | 3 | 2 | 1 | FOR DIA OF 55 MM & ABOVE |
| 1.6 | SPACE HEATERS, CONNEC-TORS, 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** | | |
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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT<br>TITLE | | | SPECIFICATION :<br>NUMBER : | | | |
| | | | BIDDER/ :<br>VENDOR | | | QUALITY PLAN<br>NUMBER PED-506-00-Q-007, REV-03 | | | SPECIFICATION :<br>TITLE | | | |
| | SHEET 3 OF 9 | | SYSTEM | | | ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV) | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY P | W | V | REMARKS |
| 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. | MA | VISUAL | 100% | - | NO VISUAL DEFECTS | INSPT. REPORT | 3 | - | 2 | |
| | | 2. OTHER CHARACTERISTICS | MA | TEST | SAMPLE | MANUF'S SPEC. | MANUF'S SPEC. | LOG BOOK AND OR SUPPLIER'S TC | 3 | - | 2 | |
| 1.8 | SHEET STAMPING (PUNCHED) | 1. SURFACE COND. | MA | VISUAL | 100% | - | NO VISUAL DEFECTS (FREE FROM BURS) | LOG BOOK | 3 | - | - | |
| | | 2.DIMENSIONS INCLUDING BURS HEIGHT | MA | MEASUREMENT | SAMPLE | MANUFR'S DRG. . | MANUFR'S DRG. | -DO- | 3 | - | 2 | FOR MV MOTOR INSULA-TION/VARNISH THICKNESS SHALL BE MORE THAN THE BURS HEIGHT |
| | | 3. ACCEPTANCE TESTS | MA | ELECT. & MECH TESTS | -DO- | MANUF'S SPEC./ RELEVANT IS | RELEVANT IS | SUPPLIER'S TC | 3 | - | 2 | |
| 1.9 | CONDUCTORS | 1. SURFACE FINISH | MA | VISUAL | 100% | - | FREE FROM VISUAL DEFECTS | LOG BOOK | 3* | - | 2* | * MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY BHEL/CUSTOMER. |
| | | 2.ELECT. PROP, & MECH. PROP | MA | ELECT. & MECH.TEST | SAMPLES | RELEVANT IS/ BS OR OTHER STANDARDS | RELEVANT IS/ BS OR OTHER STANDARDS | SUPPLIERS TC & VENDOR'S INSPN. REPORTS | 3 | - | 2 | |

| **BHEL** | **PARTICULARS** | **BIDDER/VENDOR** | |
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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT<br>TITLE | | | SPECIFICATION :<br>NUMBER : | | | |
| | | | BIDDER/ :<br>VENDOR | | | QUALITY PLAN<br>NUMBER PED-506-00-Q-007, REV-03 | | | SPECIFICATION :<br>TITLE | | | |
| | SHEET 4 OF 9 | | SYSTEM | | | ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV) | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY<br>P | <br>W | <br>V | REMARKS |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | 11 |
| | | 3.DIMENSIONS | MA | MEASUREMENT | -DO- | -DO- | -DO- | Log Book | 3 | - | 2 | |
| 1.10 | BEARINGS | 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** | | | | | | | |
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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT<br>TITLE | | | SPECIFICATION :<br>NUMBER : | | | |
| | | | BIDDER/ :<br>VENDOR | | | QUALITY PLAN<br>NUMBER PED-506-00-Q-007, REV-03 | | | SPECIFICATION :<br>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 NORM | FORMAT OF RECORD | AGENCY | | | REMARKS |
| | | | | | | | | | P | W | V | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | 11 |
| 2.0 | IN PROCESS | | | | | | | | | | | |
| 2.1 | STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR ) | 1.WORKMANSHIP & CLEANNESS | 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** | |
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| | **QUALITY PLAN** | CUSTOMER : | PROJECT<br>TITLE | SPECIFICATION :<br>NUMBER : | |
| | | BIDDER/ :<br>VENDOR | QUALITY PLAN<br>NUMBER PED-506-00-Q-007, REV-03 | SPECIFICATION :<br>TITLE | |
| | SHEET 6 OF 9 | SYSTEM | ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV) | SECTION | VOLUME III |

| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY P | AGENCY W | AGENCY V | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | - | - | |
| | | 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 | (FOR MOTORS OF 2MW AND ABOVE)<br>* ON 10% RANDOM SAMPLE |
| 2.5 | WINDING | 1.COMPLETENESS | CR | VISUAL | 100% | MANUFR'S SPEC./BHEL SPEC. | MANUFR'S SPEC./BHEL SPEC. | Log Book | 2 | - | - | |
| | | 2.CLEANLINESS | CR | -DO- | -DO- | -DO- | -DO- | Log Book | 2 | - | - | |
| | | 3.IR-HV-IR | CR | ELECT. TEST | -DO- | -DO- | -DO- | Log Book | 2 | - | 1 | |
| | | 4.RESISTANCE | CR | -DO- | -DO- | -DO- | -DO- | Log Book | 2 | - | 1 | |
| | | 5.INTERTURN INSULATION | CR | -DO- | -DO- | -DO- | -DO- | Log Book | 2 | - | - | |
| | | 6.SURGE WITH STAND AND TAN. DELTA TEST | CR | -DO- | -DO- | -DO- | -DO- | Log Book | 2 | - | 1 | FOR MV MOTOR |
| 2.6 | IMPREGNATION | 1.VISCOSCITY | MA | PHY. TEST | AT STARTING | -DO- | -DO- | Log Book | 2 | - | - | |
| | | 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 | THREE DIPS TO BE GIVEN |

| BHEL | PARTICULARS | BIDDER/VENDOR | |
|---|---|---|---|
| | NAME | | |
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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT<br>TITLE | | | SPECIFICATION :<br>NUMBER : | | | |
| | | | BIDDER/ :<br>VENDOR | | | QUALITY PLAN<br>NUMBER PED-506-00-Q-007, REV-03 | | | SPECIFICATION :<br>TITLE | | | |
| | SHEET 7 OF 9 | | SYSTEM | | | ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV) | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY P | W | V | REMARKS |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | 11 |
| | | 4.DURATION | MA | -DO- | -DO- | -DO- | -DO- | Log Book | 2 | - | 1 | |
| 2.7 | COMPLETE STATOR ASSEMBLY | 1.COMPACTNESS & CLEANLINESS | MA | VISUAL | 100% | -DO- | -DO- | Log Book | 2 | - | - | |
| 2.8 | BRAZING/COMPRESSION JOINT | 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 | |
| 2.9 | COMPLETE ROTOR ASSEMBLY | 1.RESIDUAL UNBALANCE | CR | DYN. BALANCE | -DO- | MFG SPEC./ ISO 1940 | MFG. DWG. | Log Book | 2 | | 1 | VERIFICATION FOR MV MOTOR ONLY |
| | | 2.SOUNDNESS OF DIE CASTING | CR | 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** | |
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| | **NAME** | | |
| | **SIGNATURE** | | |
| | **DATE** | | BIDDER'S/VENDORS COMPANY SEAL |

Anshul S A Khan Praveen Kishore

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

| **BHEL** | **PARTICULARS** | **BIDDER/VENDOR** | |
|---|---|---|---|
| | **NAME** | | |
| | **SIGNATURE** | | |
| | **DATE** | | BIDDER'S/VENDORS COMPANY SEAL |

Anshul S A Khan Praveen Kishore

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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT<br>TITLE | | | SPECIFICATION :<br>NUMBER : | | | |
| | | | BIDDER/ :<br>VENDOR | | | QUALITY PLAN<br>NUMBER PED-506-00-Q-007, REV-03 | | | SPECIFICATION :<br>TITLE | | | |
| | SHEET 9 OF 9 | | SYSTEM | | | ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV) | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY | | | REMARKS |
| | | | | | | | | | **P** | **W** | **V** | |
| **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.

Legends for Inspection agency

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 |

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# 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 | | N.A. |
| 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.<br><br>All motors shall be subjected to routine tests as per IS: 325 / IS: 12615.<br><br>The motors shall generally conform to IS: 325 / IEC-60034. |
| 18 | ENERGY EFFICIENT | | All LV MOTORS ABOVE 10 KW WITH S1 DUTY SHALL BE COMPULSORILY OF ENERGY EFFICIENT LEVEL IE3 AS PER IS 12615:2011 |

| | TITLE | SPECIFICATION NO. |
|---|---|---|
| | MOTOR | VOLUME II B |
| | | SECTION D |
| | DATA SHEET - C | REV NO. 00 DATE 29/08/2005 |
| | | 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 | | | |

| 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**<br>(To be enclosed for motors of rating ≥ 55KW) | |
| | a) Torque speed characteristic | |
| | b) Thermal withstand characteristic | |
| | c) Current vs time | |
| | d) Speed vs time | |

| NAME OF VENDOR | | | | REV. | |
|---|---|---|---|---|---|
| | | | SEAL | | |
| NAME | SIGNATURE | DATE | | | |

| LOAD TITLE | RATING (KW / A) | | UNIT (U)/STN (S) | Nos. | | VOLTAGE CODE* | FEEDER CODE** | EMER. LOAD (Y) | CONT.(C)/ INTT.(I) | STARTING TIME >5 SEC (Y) | LOCATION | BOARD NO. | CABLE | | BLOCK CABLE DRG. No. | CONTROL CODE | REMARKS | LOAD No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NAME PLATE | MAX. CONT. DEMAND (MCR) | | RUNNING | STANDBY | | | | | | | | SIZE CODE | NOs | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| | | | | | | | | | | | | | | | | | | |
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NOTES:
1. COLUMN 1 TO 12 & 18 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY PEM (ELECTRICAL)
2. ABBREVIATIONS : * VOLTAGE CODE (7):- (ac) A=11 KV, B=6.6 KV, C=3.3 KV, D=415 V, E=240 V (1 PH), F=110 V (dc): G=220 V, H=110 V, J=48 V, K=+24V, L=-24 V
: ** FEEDER CODE (8):- U=UNIDIRECTIONAL STARTER, B=BI-DIRECTIONAL STARTER, S=SUPPLY FEEDER, D=SUPPLY FEEDER (CONTACTER CONTROLLED)

| | | | | | | |
|---|---|---|---|---|---|---|
| BHEL | LOAD DATA (ELECTRICAL) | JOB NO. | 412 | ORIGINATING AGENCY | | PEM (ELECTRICAL) |
| | | PROJECT TITLE | 2X660MW ENNORE TPP | NAME | | DATA FILLED UP ON |
| | | SYSTEM / S | AIR CONDITIONING SYSTEM | SIGN. | | DATA ENTERED ON |
| | | DEPTT. / SECTION | SHEET 1 OF 1 | REV. 00 | | DE'S SIGN. & DATE |

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## SECTION: I

## SUB-SECTION: C-4
## TECHNICAL SPECIFICATION (C&I PORTION)

# C&I SPECIFICATION
# FOR
# AIR CONDITIONING SYSTEM
# FOR
# 2X660 MW ENNORE SEZ STPP

| | |
|---|---|
| DESIGN | AC |
| CHECKED | SK/SCS |
| APPROVED | SCS |
| REV- 02 | DATE 09.01.17 |
| JOB NO. | 412 |



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H. Drive control philosophy

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L. Drawings

M. Erection Hardware

N. Vendor List

# A.SPECIFIC

# TECHINICAL

# REQUIREMENT

# FOR

# AC SYSTEM

**Specific Technical Requirements (C&I):**

The control of Air Conditioning System Plant shall be through PLC based control system having hot redundant Central Processing Unit. The control of Ventilation system shall also be through above PLC based system. The operation and control philosophy of Air Conditioning System has been elaborated in separate section in the specification. The PLC shall be common for both units, and shall be located in AC Plant Control Room. One no. OWS with 24" LED monitor with anti-glare coating, one no. Operating cum engineering station with redundant hot standby processor with one no. A4 size B/W Laser jet printer & A3 sized Dot Matrix Printer shall be provided by the bidder for operation & monitoring of the Air Conditioning System and Ventilation system. In addition to OWS operation, Back up control desk with colored Process mimics, Hardwired annunciation system , required Push Button arrangements in Back Panel for complete operation of the systems, ammeters, process parameters indicators, LED based indication lamps etc. shall also be provided. The Complete PLC based control system with OWS, Laptop, Remote I/Os, Printer, UPS (for PLC, OWS, Remote I/Os, Printer etc.), desk along with furniture for Air Conditioning System and Ventilation system shall be in Bidder's scope. PC for OWS shall be of workstation grade. Additional laptop shall be provided with the AC system individually.

1. Bidder to consider I/Os for ventilation system in offered PLC. Same shall be finalized during detail engg.

2. Bidder to keep the provision for accepting fire signals from Fire Alarm & Protection System and the closure of relevant fire dampers in Air Conditioning and Ventilation System.

3. 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.

4. 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.

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 electrical actuators shall be conventional of integral starter type.

7. 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.

8. The solenoid valves shall have limit switches for open/close feedback.

9. 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.

10. All the instruments/drives shall be terminated on JBs/Panels in field. JBs/Panels shall be in Bidder's scope. RTD’s shall be of duplex type. Temperature transmitters are envisaged for RTD for monitoring services/application only.

11. Provision for redundant soft interfacing and Hardwired interfacing shall be included for signal exchange between Air conditioning PLC and chiller's Microprocessor based control panel.

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 (Common) 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. 8 Nos. temperature elements/sensors in AC control room shall be provided for monitoring the room temperature. Temperature & humidity monitoring system shall be in bidder's scope.

18. Bidder to comply with codes and standards as mentioned in the specification.

19. 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.

20. 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.

21. PLC network shall have Intrusion Detection System (IDS) and Intrusion Prevention System (IPS) with following features:

In order to inspect all inbound and outbound network 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.

i. Able to analyze, detect and report on security related events.
ii. Able to inspect traffic and to drop malicious traffic based on the configuration of security policy.
iii. Able to inspect the content of network packets for unique sequences/signatures.
iv. Able to detect and prevent known types of attacks such as worm or Trojan infections and hacks.
v. Able to prevent denial of service (DOS) and Distributed Denial of Service attacks.
vi. Able to prevent abnormal behaviors by monitoring and learning normal network behaviors.
vii. Keeps up-to-date on new threats and vulnerabilities.
viii. Should provide user friendly interface to queries and reports on threats and event data so that security administrators can gain a better understanding of their ability to protect their network.
ix. Should provide detailed activity logs for auditing.
x. Able to detect known threats via deep-packet inspection.
xi. Able to defect unknown threats via anomaly scanning.
xii. Able to detect unknown threats via behavior pattern to protect from zero day.

22. All local gauges , transmitters and switches shall be mounted on suitable enclosures, racks subject to owner's approval. All transmitters shall be HART compatible.

23. Bidder to delegate /depute their persons/experts as per owner/consultants' requirement.

24. Bidder must offer general tools and tackles and special calibration instruments required during start-up, trial run, operation and maintenance of the system.

25. 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.

26. All the instruments /equipments/electrical items shall be provided and designed with maximum star rating as available in line with energy conservation policies notified by BEE ,GOI at the time of supply.

27. Bidder shall provide complete and independent control & instrumentation system with all accessories, auxiliaries and associated equipments for the safe, efficient and reliable operation of auxiliary systems.

28. 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.

29. 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.

30. 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.

31. The customer specification attached as Specific Technical Requirement will supercede the Data sheets, if there is any mismatch.

**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.

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 Specfication 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.

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.

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 ammeters, voltmeters, PB indicating lamp, mimic, electrical scheme, indicators, chartless recorders and HW annunciations 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 importants 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/softwares 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).

## 8.00.00 AIR CONDITIONING SYSTEM & VENTILATION SYSTEM

i) Air conditioning facilities shall be provided for areas of central control room, control equipment room, shift- in-charge room, Engineer's room, UPS room, analyzer room etc. in the main plant building; ESP control room; service building; all control rooms and other rooms in the scope of the bidder requiring provision of air conditioning. The system shall consist of:

a) Central chilled water type air conditioning plant for main plant building and service building (Including Instrumentation Lab, Electrical lab and Computer server room , telephone exchange room, etc., )

b) DX air conditioning plant for ESP control room , AHP , Switchyard Control Building & RO-DM plant ( Including Chemical Lab) FOPH and CWPH

c) Split/ window type for other areas as required.( Zero meter control Room, boiler A Elevation, SWAS and Chemical Express Lab, FWPH, Service Water Pump House , Compressor room , etc.,

The PLC shall be preferably from plant DDCMIS family.

The PLC system shall be provided as detailed in chapter 4 of this specification..

Open and Close limit switch feed backs of valves are to be connected to PLC for remote viewing and for interlocks and protection.

Remote and local indications of various parameters to the process requirement shall be provided. (The same can be decided during detailed engineering)

The OLCS and CLCS philosophy shall be as per the section V of this volume

The One no of Operator work station and one no. of Operation cum Engineering work station with 24 " LED Monitor and printers as defined in the Vol. V, Annexure A shall have to be complied. In addition to OWS operation, Backup control desk with coloured Process Mimics, Hard wired Annunciation system, required Push .Button arrangements in Back Panel for complete operation of the systems, Ammeters, Parameter Indicators, LED Based indication Lamps etc., shall also be provided.

This PLC shall have interface module for redundant and bi-directional OPC connectivity with DDCMIS

ii) Evaporative type ventilation system shall be provided for main plant building with air washer units distributed along 'A' row and 'B' row of the building. Filtered and cooled air from the air washer unit shall be distributed to various areas through diffusers. The main plant building shall be provided with adequate number of roof exhausters. Unitary air filtration system using water repellent type nylon filters shall be provided for ESP control buildings as applicable. Mechanical type ventilation system using supply air fans, exhaust air fans and roof exhausters as applicable shall be provided for other miscellaneous areas such as cable vaults, electrical switch gear rooms, battery rooms, toilets, elevator machine rooms, AC plant room, DG set room etc..

iii) The basic function of the system shall be to closely control and monitor inside temperature and humidity conditions inside the air-conditioned spaces, to provide remote centralized monitoring & control for various mechanical facilities including sequential start/stop of the whole HVAC System, automatically calculate record and cooling load for each hour/ day/season, to generate maintenance data & alarms, to maintain records of plant operation & energy consumption for varying loads, duty cycling to operate all the equipment including standby equipment for equal duration, automatic startup of standby equipment in case of failure of operating unit and displaying fault alarm status of the tripped unit, activating/ deactivating water valves to startup/stop water flow

through chiller/condenser circuit.

**0 WATER CHILLING PLANT CONTROL**

i) Microprocessor based controls shall be provided along with facilities to Interface with central PLC and to meet the requirement of all system operations and controls.

ii) Water chilling unit control system shall be designed to have a constant chilled water outlet from evaporator at all load condition by means of controlling ON-OFF thermostat (one for each compressor) in an automatic manner.

iii) Water chilling unit shall be equipped with superheat control of water chilling unit through thermostatic expansion valve, which gets its impulse from temperature element connected with suction line after chiller outlet.

iv) High discharge pressure cut-out and oil pressure (OP) differential cut-out shall be of manual reset type and low pressure cut-out shall be automatic reset type. The OP cut-out shall trip the compressor in case of low oil pressure.

v) On-off toggle switch to close the liquid refrigerant line solenoid valve shall be provided to shut the compressor by the operation of the operation of low pressure cut-out (after the refrigerant has been pumped to the condenser).

vi) Switching of crank case heaters shall be interlocked with starting and stopping/tripping of compressor motor. Further, the safety thermostat shall switch off the crank-case heater in the event temperature rises above safe limit.

vii) Provision shall also be made for the manual restarting of the compressor.

viii) On-off type anti-freeze thermostats, one for each chiller shall be provided in addition to the controlling on-off thermostat for safety purpose and shall act in the event of failure of on-off thermostat to close the liquid line solenoid valve and also to trip the compressor simultaneously.

ix) Compressor starting/running shall be interlocked with the flow switches to be provided at the outlet of each chiller and each condenser and as well as with pressure in the inlet of the condensers. In addition closure or open status of various valves through limit switches shall be used for interlock, alarm and control of air conditioning system.

x) The standby condenser water pumps (if applicable), standby chilled water pumps, standby fresh air fan & standby AHU shall be started automatically when the working equipments are stopped/tripped. Auto/manual selector switches and working /standby selector switches for the pumps/AHU/fresh air fan shall be provided in the panel.

xi) Closure of fire dampers shall raise an annunciation in the panel.

xii) Condenser water pumps shall be interlocked with the low level switch in each cooling tower sump and operation of cooling tower fans. High level in the cooling tower shall be annunciated in the panel by means of a separate level switch.

**1 AIR HANDLING UNIT**

i) Control of the inside room temperature and humidity shall be by controlling the chilled water flow by means of motor operated three way modulating valve and the modulating valve shall get its signal from the temperature sensor.

ii) Humidistat located in the return air duct shall actuate the pan humidifier to obtain the desired degree of humidification.

iii) Separate Humidistat and thermostats shall be provided and interlocked in steps with winter heater / re-heater / strip heaters for monsoon and winter re-heating or heating as the case may be.

iv) Heater banks shall be interlocked with the running of AHU, temperature of return air, humidity of return air and safety thermostat (Geyserstat located in front of the each heater in the supply air duct)

v) AHU shall be started either from its local panel or from the main control panel of AC system by means of Remote/Manual selector switches.

vi) The closure of fire dampers, automatic tripping of AHU fans and fresh air fans shall be interlocked with Bidder's fire Detection System.

vii) Each AHU shall be provided with temperature indictors and flow indicator in the chilled water piping inlet and outlet to monitor the air-conditioning load of each area.

viii) The motorised air regulators shall be provided for individual rooms for regulating the room temperature. The temperature control of different partions of central control room shall also be possible for maintaining different temperature.

**2 D-X AIR-CONDITIONING SYSTEM**

i) The control and interlocks described above for water chilling plant shall be application for this system also.

ii) Further, the compressor starting/ running shall be interlocked with the flow switches in condenser water circuit and as well as with AHU motors.

iii) The standby condenser water pumps, fresh air fan & standby AHU shall be started automatically when the working equipments are stopped/ tripped. Auto / manual selector switches and working/ standby selector switches for the pumps, fresh air fans and AHU shall be provided in the panel.

**3 GENERAL REQUIREMENTS**

i) Separate emergency local stop push button shall be provided for each pump, compressor, fans etc. of AC system.

ii) Lamps shall be provided for indicating the status of each pump, compressor, fans etc. of AC system in the main and local panel.

iii) All the annunciation related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped/tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, compressor, AHU etc. in the respective panel.

iv) Fully wired, twenty percent (20%) spare annunciation windows shall be provided in all the panels.

v) Air washer units shall be started/stopped by initiation from the local panel and the starting/stopping of fans and pumps shall be automatic upon such initiation.

vi) The operation of the pumps shall be interlocked with the low level of water in the sump. High level of the sump shall be annunciated. The standby pump shall be started automatically when the working pump is tripped.

vii) Auto/manual selector switches and working/standby selector switches for the pump shall be provided in the panel.

iv) A selection switch enabling the running of AWU fan or pump alone shall be provided.
Separate emergency local stop push button shall be provided for each pump, fans etc.

vi) Lamps shall be provided for indicating the status of each pump, fans etc. in the main and local panel.

vii) All the annunciations related to failure of equipments, tripping of equipments, source of failure/ reason due to which the equipment is stopped/ tripped, low and high limits of parameters such as level, temperature, pressure, pressure drop etc. shall be provided for each pump, fan, AWU etc. in the respective panel.

viii) Both supply and exhaust fans shall be operated locally.

ix) Fully wired, twenty percent (20%) spare annunciation windows shall be provided in all the panels.

# B.C&I DELIVERABLES

# FOR

# AC SYSTEM

| LIST OF DELIVERABLES OF PEM - C&I DEPARTMENT FOR AC SYSTEM | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2X660MW ENNORE SEZ TPP | | | | | | | |
| DOCUMENT NUMBER PE-GL-412-145-I100 | | | | | | | |
| Sl.No. | DRAWING NO. | DRAWING/DOCUMENT TITLE | CATEGORY | CUSTOMER | FROM | USER | REMARKS |
| | | | | | | | |
| INSTRUMENTATION | | | | | | | |
| 1 | PE-V9-412-553-I901 | INSTRUMENT DATA SHEETS | A | - | VENDOR | C&I | |
| 2 | PE-V9-412-553-I902 | INSTRUMENT SCHEDULE | I | - | VENDOR | C&I | |
| 3 | PE-V9-412-553-I903 | INSTRUMENT INSTALLATION/ HOOK UP DIAGRAMS | A | - | VENDOR | C&I | |
| 4 | PE-V9-412-553-I904 | FIELD JB TERMINATIONS /GROUPING DOCUMENT | I | - | VENDOR | C&I | |
| 5 | PE-V9-412-553-I905 | QUALITY PLANS (CV,FE, Tx and Analyser) | A | - | VENDOR | C&I | |
| PLC PANEL | | | | | | | |
| 1 | PE-V9-412-553-I906 | PLC CONFIGURATION DRAWING | A | A | VENDOR | C&I | |
| 2 | PE-V9-412-553-I907 | PLC PANEL GA (INTERNAL & EXTERNAL) DRAWING | A | - | VENDOR | C&I | |
| 3 | PE-V9-412-553-I908 | CONTROL SCHEMES (BLOCK LOGIC) | A | - | VENDOR | C&I | |
| 4 | PE-V9-412-553-I909 | PLC INPUT / OUTPUT SIGNAL LIST | I | - | VENDOR | C&I | |
| 5 | PE-V9-412-553-I910 | UPS BATTERY CHARGER/ BATTERY DATASHEET & SLD | I | $$ | VENDOR | C&I | |
| 6 | PE-V9-412-553-I911 | UPS SIZING CALCULATIONS | I | - | VENDOR | C&I | |
| 7 | PE-V9-412-553-I912 | BATTERY SIZING CALCULATIONS | I | - | VENDOR | C&I | |
| 8 | PE-V9-412-553-I913 | CONTROL DESK LAYOUT / GA DRAWING | A | - | VENDOR | C&I | |
| 9 | PE-V9-412-553-I914 | PLC-OWS/PRINTER FURNITURE BOM | A | - | VENDOR | C&I | |
| 10 | PE-V9-412-553-I915 | PLC CONTROL ROOM LAYOUT DRAWING | A | - | VENDOR | C&I | |
| 11 | PE-V9-412-553-I916 | PLC CATALOGUE | I | - | VENDOR | C&I | |
| 12 | PE-V9-412-553-I917 | PLC QUALITY PLAN & FAT PROCEDURE | A | - | VENDOR | C&I | |
| 13 | PE-V9-412-553-I918 | LIST OF SIGNAL EXCHANGE WITH DDCMIS (BOTH HARDWIRED & SERIAL INTERFACE IN BHEL FORMAT) | A | ` | VENDOR | C&I | |
| 14 | PE-V9-412-553-I919 | PROCESS GRAPHIC MANUSCRIPTS PLC | I | - | VENDOR | C&I | |
| 15 | PE-V9-412-553-I920 | PROCESS GRAPHIC MANUSCRIPTS FOR DDCMIS | I | - | VENDOR | C&I | |
| 16 | PE-V9-412-553-I921 | CABLE SCHEDULE (IN BHEL EXCEL FORMAT) & CABLE INTERCONNECTION DETAILS | I | - | VENDOR | C&I | |
| 17 | PE-V9-412-553-I923 | PANEL & ELECTRONIC EARTHING REQUIREMENT | I | - | VENDOR | C&I | |
| 18 | PE-V9-412-553-I924 | PANEL HEAT DISSIPATION DATA | I | - | VENDOR | C&I | |
| 19 | PE-V9-412-553-I925 | MANDATORY SPARES BILL OF MATERIAL | A | A | VENDOR | C&I | |
| 20 | PE-V9-412-553-I926 | PLC O & M MANUAL | I | - | VENDOR | C&I | |
| 21 | PE-V9-412-553-I927 | PLC EARTHING SCHEME | I | - | VENDOR | C&I | |
| | | | | | | | |
| | Notes: | 412 - Project No. | | | | | |
| | | 553 -SI No of MAX Package ( AC SYSTEM) | | | | | |
| | | $$ -Approval by BHEL if Vendor BBU Item Approval by Customer if Customer BBU Item | | | | | |

Documents of C&I System shall be submitted to end user/owner for approval during detail engineering. Changes, if any, shall be accommodated by the bidder without any price/time implication.

# C.SPECIFICATION

# FOR

# MOTORISED

# VALVE ACTUATOR

| | | |
|---|---|---|
| BHEL | **Data Sheet FOR MOTORISED VALVE ACTUATOR** | SPECIFICATION NO.: PE-ID-412-145-I902<br>VOLUME II B<br>SECTION D<br>REV. NO. 01 DATE: 04.07.15<br>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)<br>A: ☐ DRG. NO. 3-V-MISC-24227 R00<br>B: ☐ DRG. NO. 3-V-MISC-24550 R00<br>C: ☐ DRG. NO. 3-V-MISC-24283 R00<br>D: ☐ DRG. NO. 4-V-MISC-90271 R11<br>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 |

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| | | |
|---|---|---|
| BHEL | **SPECIFICATION FOR MOTORISED VALVE ACTUATOR** | SPECIFICATION NO.: PE-ID-412-145-I902<br>VOLUME II B<br>SECTION D<br>REV. NO. 01 DATE: 04.07.15<br>SHEET 2 OF 3 |

## Data Sheet A & B

| | DATA SHEET-A (TO BE FILLED BY PURCHASER) | DATA SHEET-B (TO BE FILLED-UP BY BIDDER) |
|---|---|---|
| | @ ENCLOSURE CLASS OF MOTOR | ☐ IP 67 ☐ FLAME PROOF |
| | @ INSULATION CLASS | CLASS-F TEMP. RISE LIMITED TO CLASS-B |
| | @ WINDING TEMP PROTECTION | ■ THERMOSTAT (3 Nos.,1 IN EACH PHASE)<br>☐ ---------- |
| | SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION | REQUIRED |
| **INTEGRAL STARTER** | INTEGRAL STARTER | ■ REQUIRED ☐ NOT REQUIRED |
| | TYPE OF SWITCHING DEVICE | ■ CONTACTORS ☐ THYRISTORS |
| | TYPE | ■ CONVENTIONAL ☐ SMART (NON-INTRUSIVE) |
| | STEP DOWN CONT. TRANSFORMER | ■ REQUIRED |
| | OPEN / CLOSE PB | ■ REQUIRED ☐ NOT REQUIRED |
| | STOP PB | ■ REQUIRED ☐ NOT REQUIRED |
| | INDICATING LAMPS | ■ REQUIRED ☐ NOT REQUIRED |
| | LOCAL REMOTE S/S | ■REQUIRED ☐ NOT REQUIRED |
| | STATUS CONTACTS FOR MONITORING | ■ REQUIRED ☐ NOT REQUIRED |
| | INTEGRAL STARTER DISTURBED SIGNAL | REQUIRED (MOTOR THERMOSTST TRIP,O/L RELAY OPERATED, CONT./POWER SUPPLY FAILED, PHASE LOSS, S/S IN LOCAL/OFF MODE, STOP PB OPTD, TORQUE OPEN/CLOSE CUTOFF) |
| **INTERPOSING RELAY/OPTO COUPLER** (Applicable for integral Starter) | TYPE OF ISOLATING DEVICE | ☐ INTERPOSING RELAY ☐ OPTO COUPLER ☐ EITHER |
| | QUANTITY | ■ 2 NOs. ☐ 3 NOs. |
| | DRIVING VOLTAGE | ■ 20.5 – 24V DC ☐ _____V DC |
| | DRIVING CURRENT | ■ 125mA MAX ☐ _____mA MAX |
| | LOAD RESISTANCE | ■ > 192 ohms - <25 k ohms<br>☐ > _____ohms - < _____ohms |
| **TORQUE SWITCH** (Not Applicable for Smart Actuator) **($$ Refer Notes)** | MFR & MODEL NO. | BIDDER TO SPECIFY |
| | OPEN / CLOSE | ■1 No. ☐2Nos. / ■1 No. ☐2Nos |
| | CONTACT TYPE | 2 NO + 2 NC |
| | RATING | 5A 240V AC AND 0.5A 220V DC |
| | CALIBRATED KNOBS(OPEN&CLOSE TS) | REQUIRED FOR SETTING DESIRED TORQUE |
| | ACCURACY | +3% OF SET VALUE |
| **LIMIT SWITCH** (Not Applicable for Smart Actuator) **($$ Refer Notes)** | MFR & MODEL NO. | BIDDER TO SPECIFY |
| | OPEN : INT : CLOSE | ☐1 No ■2 Nos. / 2 Nos. (ADJ.) / ☐1 No. ■2Nos. |
| | CONTACT TYPE | 2 NO + 2 NC |
| | RATING (AC / DC) | 5A 240V AC AND 0.5A 220V DC |

| | | |
|---|---|---|
| BHEL | **Data Sheet FOR MOTORISED VALVE ACTUATOR** | SPECIFICATION NO.: PE-ID-412-145-I902<br>VOLUME II B<br>SECTION D<br>REV. NO. 01 DATE: 04.07.15<br>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<br>■ ELECTRONIC (2 WIRE) CONTACTLESS | |
| | SUPPLY | ■ 24V DC ☐ ..... | |
| | OUTPUT | ■ 4-20mA | |
| | ACCURACY | ± 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 COMMD, LS/TS FEED BACK, PoT) | ☐REQUIRED ■ NOT REQUIRED☐<br>☐ 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 INTERNATION 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.
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.
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.

**$$ 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

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# 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 else where 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 & JBs etc used for measurement for HFO, LDO & Turbine Lube Oil system shall be flame proof (IEC-79.1, Part I). All primary Instruments, hardwares & JBs etc used for measurement for Hydrogen shall be intrinsically safe and explosion proof as per NEC article 500, class 1, Division 1 area I.

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, hermitically sealed load cell of precision strain gauge type,100% over load protection of cell and 250% overload protection for the construction; one calibrator attachment with two 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 wide 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 algebric 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:**

## 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<br>SS316 for other services |
| - Diaphragm | : | 316 SS |
| - Measurement element | : | Teflon seal |
| - Valves | : | Carbon steel for non-corrosive Applications<br>SS316 for corrosive applications. |
| Output signal | : | 4 to 20 m Amp. DC (Two wires)<br>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<br>$\pm$ 0.065% or better of Span for BOP packages<br>$\pm$ 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)<br>Quarter (1/4) inch NPT<br>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 | : | ± One (1) percent or better |
| Repeatability | : | ± 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 soldiered 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 | : | ± 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 Pulsation dampener/snubber (S316) | : | Pump and compressor discharge lines |
| - 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/cm2 | : | Rubber blow out disc with open front construction. |
| Ranges above 20 Kg/cm2 | : | 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 of0-10000 mm wc or suitable range having **dial size of 300mm or bigger size** shall be provided.

3.03.04 **TEMERATURE TRANSMITTERS**

| | | |
|---|---|---|
| Type | : | SMART type configurable from control room through HART protocol (HMS System). |
| Display type | : | Indicating type (5 digit LCD Display), |
| Accuracy | : | ±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 | : | ± 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<br>DIN EN 60751:1996, BS EN/IEC60751: 2008 |
| Element | : | Platinum, R0=100 ohm 4-wire<br>Duplex for Process Temp. Measurement<br><br>Platinum, R0=100 ohm 3-wire<br>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.<br>- Inconel for air & flue gas services<br>For furnace zone, impervious ceramic protecting tube of suitable material along |

| | | |
|---|---|---|
| | | with Incoloy supporting tubes and adjustable flanges.<br><br>For Mill classifier outlet long life solid sintered tungsten carbide material or better of high abrasion resistance.<br><br>Bidder shall provide calculation for thermowell as per ASME – PTC-19.3 2010.<br>"All Thermowells in high velocity steam service shall be checked for Strouhal's frequency limit to arrive at a safer size and design of Thermowells". |
| - Process Connection | : | (i) M 33 x 2<br>(ii) SS316 Flanged, for Air & Gas systems, with mating flanges, fasteners, gaskets etc. |
| - Extension | : | Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends |
| Immersion length | : | Within ± 10 mm of center line of pipe and as per ASME – PTC-19.3 - 2010 |
| Extension neck length | : | Minimum 100 mm above insulation of pipe and Minimum 160 mm when there is no insulation on pipe. |
| IBR Certification | : | For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations |
| **Note** | **:** | **Extension /**Compensating/paired cable exposed to atmosphere in the conventional method melts away due to high temperature at the top of mill or due to coal burning. Hence The terminals of temperature sensors shall not be at the top of mills itself. The temperature sensors wires are to be laid up to JB though SS tube of required diameter and the head shall be placed nearer to the JB. |

## 3.03.08 TEMPERATURE SWITCHES (TS)

**Type/Construction**

| | | |
|---|---|---|
| - Switch | : | Industrial type inert gas filled with capillary and separable thermowell and contacts directly connected to Bourdon element/vapor pressure sensing, gas filled bellows type preferred. |
| - Thermowell | : | Bar stock |

**Material**

| | | |
|---|---|---|
| - Bulb | : | 316 SS |
| - Capillary | : | Armored Stainless Steel |
| - Bourdon | : | 316 SS |
| - Bourdon Movement | : | SS 316 |
| - Casing | : | Die-cast aluminum with stoved enamel black finish Epoxy coating shall be provided for corrosive atmosphere. |
| Setting and Differential | : | Adjustable |
| Accuracy | : | ± One (1) percent of setting and differential |
| Repeatability | : | One half(1/2) percent of setting. |

Contacts

| | | |
|---|---|---|
| - 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

| | | |
|---|---|---|
| Pipe | : | M33 x 2 |
| - Extension | : | Threaded union (SS316) 1/2" NPT (F) |

| | | |
|---|---|---|
| | | with two nipples of SS 316 having 1/2"NPT(M) threads at both ends |
| Thermowell | : | To suit Temp. switch with same design criteria as specified for RTDs. |
| Electrical | : | Suitable for Plug in type.<br><br>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 soldiered in connector and to be inserted for easy maintenance. |
| Other Particulars | | |
| - Capillary length | : | As per requirement (min 10 meters) |
| - Immersion Length | : | Within + ten (10) mm of center line of pipe with adjustable nuts. |
| - Extension neck length | : | Minimum 50 mm above insulation of pipe /As per approved hookup drawings. |
| - Packing glands | : | Yes |
| IBR Certification | : | For high pressure service, Steam Temp, Fuel oil temp. measurement as per IBR rules and regulations |
| N.B | : | Switches designed for cross ambient operation shall be used in applications where the ambient temperature will approximate or exceed the switch set point. |

**3.03.09 TEMPERATURE GAUGES (TG)**

| | | |
|---|---|---|
| Applicable standard | : | IS : 3602,BS:5235 ISA:RP:8.1 except as modified in this specification |
| **Type/Construction** | | |
| - Thermometer | : | Industrial type, Gas in Filled type with separable thermowell |
| - Thermowell | : | Bar stock |
| **Material** | | |
| - Bulb | : | 316 SS |
| - Capillary | : | Armoured SS (Applicable for capillary Type) |
| - Casing | : | SS 316/ Die-cast aluminum with stoved enamel black finish. Epoxy coating |

| | | |
|---|---|---|
| | | shall be provided for corrosive atmosphere |
| Dial Size | : | 150mm with shatter proof glass |
| Scale Details | : | 270 degree dial rotation/deflection. Graduations in black lines on white dial provided with glass cover. Smallest scale division shall be one (1) percent of full scale value or smaller .Pointer stop for all gauges |
| Accuracy | : | ± One (1) percent or better |
| Response time | : | Maximum 15 seconds without thermowell and 30 seconds with thermowell |
| Connection | | |
| - Pipe | : | M33 x 2 |
| - Thermowell | : | To suit instrument with same design criteria specified for RTDs. |
| - Process Connection | : | (i) M 33 x 2<br>(ii) SS316 Flanged, for Air & Gas systems, with mating flanges, fasteners, gaskets etc. |
| - Extension | : | Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends |
| Other Particulars | | |
| - Capillary length | : | 5Meters/10 Meters as required |
| - Immersion Length | : | Within + ten (10) mm of center line of pipe with adjustable nuts. |
| - Extension neck length | : | Minimum 50 mm above insulation of pipe /As per approved hookup drawings. |
| - Stop at Maximum value | : | For all gauges of scale |
| - Pointer | : | Externally adjustable |
| | : | In general, Contact type Temp. gauges are not acceptable for interlock & protection.<br><br>Contact type Temp. gauges are acceptable for interlock & protection in case of bearing temp. only. |
| - Over range protection | : | 150 percent (%) of full scale |
| Enclosure Class | : | IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area) |
| IBR Certification | : | For high pressure service, Steam |

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<br>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 – Polyurethene |
| 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.<br>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 / ¾" 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 ºC. |
| Mounting | : | Wall / Surface |
| Supply voltage | : | 240V AC, 50Hz / 24V DC |
| Response time | : | 100 m sec or better |
| Cable connection | : | ¾" 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, |

| | | |
|---|---|---|
| | | Condenser Hotwell, LP heaters, CBD tank level, Stator water expansion level, and other Low pressure, Vacuum vessels. |
| Environment Class | : | Highly abrasive with Gases and Fumes |
| Orientation | : | Vertical |
| Probe Type | : | Flexible Single lead with chuck |
| Probe Material | : | SS 316L |
| Connection Size & Type | : | 2” Flanged ANSI 300 lb SS316L material |
| Connection material | : | SS 316L |
| Accuracy | : | +/- 5 mm |
| Resolution | : | ± 1 mm |
| Type (Transmitter) | : | SMART, 2 Wire |
| Operating Principle | : | Time Domain Reflectrometry |
| Output | : | 4-20 mA, DC with **HART protocol** and 600 Ω output load. |
| Electrical Connection | : | ½” NPT |
| Enclosure Class | : | IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area) |
| Electrical Power | : | 11-42 V DC |
| Housing material | : | Die Cast Aluminum |
| Vent & Drain Plug material | : | SS |
| Side Flange Material | : | SS |
| Local Display | : | Provided (LCD Digital) |
| Units of Measurement | : | Length M |
| Electromagnetic compatibility: | | EN-61326 |

### 3.03.15 3 D TYPE ACOUSTIC WAVE LEVEL TRANSMITTER

| | | |
|---|---|---|
| Type | : | Acoustic Wave Level Transmitter (3 D type) |
| Application | : | Coal and Ash Bunker Level, Volume & Mass. |
| Temperature compensation | : | Required for high temp applications |
| Operating Principle | : | Non - Intrusive acoustic wave transmission & Reflection |
| Frequency Range | : | 3 – 10 KHz |
| Accuracy | : | +/- 0.25 % for even surface & ± 0.5% for uneven surface. |
| Resolution | : | 1 mm |
| Output | : | 4-20mA DC with HART |
| **Display Unit:** | | |
| Type | : | Head mounted LCD Display with Engg. Units |
| Location | : | Suitable location at bunker / Silo operating floor area |
| Protection Class | : | IP 65 or better// flame proof (IEC-79.1, Part I) As applicable). |
| **Material Of construction:** | | |

| | | |
|---|---|---|
| Housing | : | Polypropylene |
| Flange | : | Polypropylene |
| **Sizes:** | | |
| Flange Size | : | 2” ANSI 300 # RF SS |
| Electrical connection size | : | ½” NPT (F) |
| Accessories | : | i. Double compression type Nickel Plated Cable glands |
| | | ii. Suitable Mating Flange, necessary gaskets, |
| | | iii. Local display unit and Suitable mounting brackets, necessary mounting hardware for Local display unit. |
| | | iv. Complete software as required to have 3 D view on monitors. |

### 3.03.17 LEVEL SWITCHES (LS)

| | | |
|---|---|---|
| **Type/Construction** | : | a) External float cage type with magnetic switch actuator for tanks and vessels.<br>b) Electrode/Capacitance (for oil tanks)<br>c) Displacer -Top mounted for all clean water sumps.<br>d) Conductivity type for high Pressure and high temperature enclosed vessel like drain pot, HP heaters etc. |
| **Materials** | | |
| - Body | : | Cast Carbon Steel/Die cast Aluminum suitable for specified pressure and temperature ratings |
| | : | For corrosive liquids suitable anti-corrosive coat/lining shall be provided. |
| - Float/Displacer | : | 316 SS |
| - Wire rope | : | 316 SS |
| Differential | : | $\pm$ 12 mm minimum (Adjustable) |
| Contacts | | |
| - Number | : | DPDT/2 SPDT |
| - Type | : | Snap action micro switch Auto reset with internal Adjustable |
| - Rating | : | 5 Amp 240V AC 0.2 Amp 220V DC |
| Connection - Process | : | One (1) inch SCRD NPT Female Or<br>One (1) inch ANSI Flanged<br>Four(4) inch ANSI Flange for sump services. |
| Electrical | : | Suitable for Plug in type connection |

| | | |
|---|---|---|
| Temperature/pressure rating | : | As per service conditions |
| Accessories | : | Counter flanges, still pipe of requisite length with anticorrosive coating for sump services. |

Nuclear, capacitance, or ultrasonic type level switch for bulk material applications shall be provided.

**3.03.17.01 Conductivity Type Level Switch**

| | | |
|---|---|---|
| Type | : | Conductivity discrimination. |
| Mounting | : | Flanged – on standpipe. |
| Probe MOC | : | Stainless steel with high purity ceramic. |
| Probe rating | : | > Maximum design pressure of vessel. |
| Input | : | Four independent channel with selectable switching threshold for water conductivity. |
| Relay Output | : | Four isolated output relays for Hi, Lo, Hi-Hi, Lo-Lo. |
| Contact type & rating | : | 2SPDT or 1 DPDT @ 5A 30V DC. |
| Faults Detection | : | Power Fail/Electrode Connection<br>Open circuit/short circuit to ground, Ground failure.<br>In built Fail Safe Logic. |
| Indicator | : | One Red LED for steam/ one Green LED for water/ Two no. LED one each for Process & system fault. |
| Power supply | : | Dual 240V AC, 50 Hz, 1Ph. From UPS |
| Enclosure | : | IP–65, corrosion resistant & wall mounting type. |
| Accessories | : | i. PTFE cable from probe to electronics unit. **Electronic unit shall be separate.** Head mounted electronic unit is not preferred.<br>ii. Mounting accessories<br>iii. standpipe<br>iv. Washer & gasket |
| Test pressure | : | Two times rated pressure |

**3.03.17.02 Capacitance Type Level Switch**

| | | |
|---|---|---|
| Type | : | Capacitance type |
| Probe | : | a) Rod or suspended electrode<br>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 / ¾" NPT (M) |
| Material of construction | : | 316 SS |
| Insulation | : | PTFE Part/Full as per service. |

| | | |
|---|---|---|
| Enclosure | : | Powder/Epoxy coated Die cast Aluminium. with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area). |
| Ambient temperature | : | 0-60 ºC. |
| Mounting | : | On Top |
| Supply voltage | : | 240V AC, 50Hz from UPS/ 24V DC |
| Relay output | : | 2SPDT |
| Contact rating | : | 5A min. at 240V AC on resistive load |
| Response time | : | 100 m sec or better |
| Cable connection | : | ¾" ET |
| Accessories | : | Counter flange, Cable gland, prefab cable and stainless steel name plate engraved with alpha-numeric. |

**3.03.17.03 RF TYPE LEVEL SWITCH**

**A. Electronic Controller**

| | | | |
|---|---|---|---|
| 1. | Input Supply | : | 240 V AC from UPS |
| 2. | Construction | : | Cast Aluminum Housing |
| 3. | Relay Output | : | 2 Nos. Relay Changeover Potential Free Contacts( 2SPDT) |
| 4. | Contact Rating: | : | 5A at 240 V AC & 0.25 at 220 V DC |
| 5. | Class of Protection | : | IP-66 |
| 6. | Ambient Temperature | : | 55 Deg. C(Max) |
| 7. | Local Indication | : | Local LED Indications |
| | Green | : | Normal Level |
| | Red | : | Alarm Level |
| | Yellow | : | Probe Healthy |
| 8. | Cable Connection | : | 3/4" ET(2 Nos.) for Supply and Output<br>5/8" ET(1 No.) for Probe Connection |
| 9. | Repeatability | : | 100% |

**B. Sensing Probe**

| | | | |
|---|---|---|---|
| 1. | Type of Probe | : | Rigid |
| 2. | Material | : | Stainless steel SS 316 |
| 3. | Probe Head Housing | : | Cast Aluminum |
| 4. | Insulation (B/W Active & Shield And Shield & Ground) | : | PTFE |
| 5. | Probe Head Protection | : | IP-66 |
| 6. | Mounting | : | Side Mounted |
| 7. | Cable Connection | : | 5/8" ET(1No.) |
| 8. | Process Connection | : | 40 NB BSP THREADED |
| C. | Signal Cable | : | Coaxial cable for Connection Between Sensing probe and electronic Controller(@ 10 Mtrs. Per Level Probe) |

| | | | |
|---|---|---|---|
| D. | Application | : | Ash Silos |

3.03.18 **LEVEL INDICATORS (Gauge Glass) (LI)**

| | | | |
|---|---|---|---|
| **Type/Construction** | | : | **a) Reflex**<br>b) Tubular (For tanks open to atmosphere only) |
| Material: | | | |
| a) | Glass | : | Tempered borosilicate resistant to thermal shock |
| b) | Case | : | Carbon steel |
| c) | Integral cocks and | : | i) Forged carbon steel with drain valves stainless steel internals<br>ii) Rubber lined corrosion resistant 316 stainless steel (for Demineralised and Osmosis water service) |
| d) Fittings | | : | i) Forged carbon steel<br>ii) Rubber lined 316 steel/PVC for corrosive liquids Demineralised and Osmosis water service)<br>iii) 304 Stainless Steel for non-corrosive liquids |
| e) | Packing | : | Teflon |
| Dial size/scale | | : | 150 mm /1.5 Meters maximum length with |
| Scale details | | : | Aluminum/SS316 scale Graduated in mmwc |
| Connection | | : | 25 Nb/40 Nb ANSI Flanged |
| Accessories | | : | a) Integral cocks<br>b) Drain valves<br>c) Bolts, nuts and gaskets<br>d) Illuminating lamps as required<br>e) Periscope as required |
| Tests | | : | Tested at two hundred (200) percent of the maximum process pressure |
| Other details | | : | For larger lengths, additional gauge glasses shall be provided with minimum of 50 mm overlap. |

**3.03.19 FLOAT & BOARD TYPE LEVEL GAUGE**

| | | |
|---|---|---|
| Type of Instrument | : | Mechanical Type (Float Operated) |
| Service/ Application | : | As per service requirement |
| Measuring Range | : | as per requirement |
| Material Specification | | |
| a) Float Material | : | SS316 having 2 nos. Guide wires |
| b) Float Wire Pulley | : | Shall comprise of 2 nos. Cast Aluminum Pulley hosing Assembly with SS 304 pulley and pulley shaft. Steel ball bearings shall be provided in pulley housing for easier float movement. Float wire material shall be |

| | | |
|---|---|---|
| | | SS316L. Between 2 pulleys, 1" NB G.I. short pipe with tentative length as per P&ID |
| c) Guide wire Assembly | : | CS chamber with spring and adjuster having 1" Class 150 ANSI RF MS flange. Guide wire rope shall be SS316L. |
| d) Counter Weight | : | MS counter – weight with Aluminum Pointer and Brass assembly Pull Chain. |
| e) Scale | : | SS 316/Aluminum material in mm with 1 % accuracy. |
| Nozzle Details | : | For float wire pulley assembly, one tapping and for guide wire assembly two tapping at the top of the tank; Size 1" NB (Top Mounting Type) |
| Process Connection | : | Flanged as per ANSI B 16.5 to suit 1" NB nozzle (Nozzle length - 150 mm for float wire, 100 mm for guide wire) |
| Accessories (to be supplied with the instrument) | | |
| a) Counter flange | : | All mating Flanges, Nozzle |
| b) Mounting Accessories | : | All mounting accessories |
| c) Tag Plate | : | To be provided (material SS316) |

**3.03.20 MASS FLOW METER**

**Sensor**

| | | |
|---|---|---|
| Measuring Principle | : | Coriolis Mass flow. |
| Primary Element | : | Flow Tube of 316SS or better |
| Heating Arrangement | : | Integral with Flow meter. |
| Temperature Control For Heating | : | To be provided. |
| Process Connection | : | ANSI RF Flanged and rating as per process requirement. |
| Drain | : | Self-draining facility |
| Accessories | : | Counter flanges, Mounting nuts, bolts, gaskets etc. |

**Transmitter**

| | | |
|---|---|---|
| Measured quantities | : | Mass Flow rate, Total Mass Flow, Density, Temperature as minimum. |
| Input Signal Processing | : | Digital Processing. |
| Display | : | Digital Display (LCD). |
| Output | : | 2 Nos. isolated output of 4-20mA DC selectable from four measured quantities. |
| Load | : | < 750 ohms. |
| Power supply | : | 240V AC, 50 Hz. From UPS |
| Accuracy | : | 0.15% of measured value for Liquid<br>0.5% of measured value for Gas |
| Repeatability | : | 0.05% |
| Housing | : | IP 65 (Explosion proof for NEC Class-1, Division 1 area) |
| Hazardous duty Version | : | FM Standards. |

| | | | |
|---|---|---|---|
| | Nameplate | : | Tag number, service engraved in stainless steel tag plate |
| | Accessories | : | a) As required for field mounting, Handheld configurator & complete Software, External zero adjustment facility<br>b) Mounting U-bolts, nuts, bolts, prefab cable etc. |
| | Application | : | HFO main line, LDO lines, HFO recirculation lines etc. |

**3.03.21 Turbine Flow meter**

**Sensor**

| | | |
|---|---|---|
| Type | : | Turbine (in line full-bore, based on magnetic pick of pulses) |
| Output Signal | : | Pulse |
| Material of Construction | : | a) Body : AISI 316<br>b) Rotor: AISI 431 or 410<br>c) Bearings: Tungsten Carbide / Stellited Sleeve |
| Flow rate range | : | As required. |
| Linearity | : | 0.25% or better. |
| Repeatability | : | 0.02% or better. |
| Ambient temperature | : | 50 deg C |
| Mounting | : | On-Line mounting with ANSI RF flanges of stainless steel. |
| Enclosure | : | IP 65 |

**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 | : | a) clamping strip, bracket, prefab cable etc. and Calibration or configurator kit. |

**3.03.22 VORTEX FLOW METER**

**Sensor**

| | | |
|---|---|---|
| Type | : | Vortex |

| | | |
|---|---|---|
| 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 | : | ± 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<br>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 | : | ± 0.5% or better of reading |
| Repeatability | : | ± 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 ±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<br>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 | : | ± 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 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$^0$ C, RH-95%<br>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 values are laid to the application.

These bulk header are to be provided with **mechanical / electronic based automatic Drains.**

Individual moisture separator for $O_2$ 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 $\pm$ 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 convertors 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 ±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 SS. E/P convertors shall have fail freeze (stay put) feature also. Process connection shall be 1/4" NPT (F) and Electrical connection shall be ½" 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 varister, 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 / Cm2. |
| 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<br>b) Hand wheel.<br>c) Air filter regulator with gauge.<br>d) Volume Booster.<br>e) Limit Switches.<br>f) Positioner with Input, Output and supply pressure gauges.<br>g) Pilot Solenoid Valve (Double Coil type)<br>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. |
| Hysterisis | : | 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)**

Electro magnetic 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 | : | $\leq$ 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 | : | $\geq$ 10.5" colour LCD TFT |
| | Resolution | : | $\geq$ 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 | : | ±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 NO/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 | : | ± 0.2% of span ± 1 count |
| Resolution | : | 0.5% Span |
| Dead band | : | ± 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<br>ii. Channel to Channel online Isolation shall be provided<br>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 | : | $\pm$ 1 percent (class 1) |
| Indication | : | Pointer with scale |
| Magnetic Shield | : | Shielded Case |
| Quantities | : | For all HT Motors & LT motor with rating $\geq$ 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)**

| | | |
|---|---|---|
| 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 | : | 41/2 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 | : | ± 0.25% |

**3.03.52 DC CURRENT TRANSDUCERS**

| | | |
|---|---|---|
| Input | : | 0 - 75 mV |
| Output | : | Dual 4-20 mA with 500 impedance |
| Mounting | : | Back rail |
| Accuracy | : | ± 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 | : | + 0.25% |

**3.03.54 DC VOLT TRANSDUCERS**

| | | |
|---|---|---|
| Input | : | System Voltage |
| Output | : | 4-20 mA with 500 impedance |
| Mounting | : | Back rail |
| Accuracy | : | ± 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 | : | ± 0.25% |

**3.03.56 TRANSDUCERS FOR FREQUENCY**

| | | |
|---|---|---|
| Input | : | 110 V PT Volts |
| Output | : | 4-20 mA with 500 impedance |
| Mounting | : | Back rail |
| Accuracy | : | ± 0.25% |

**3.03.57 TRANSDUCERS FOR POWER FACTOR**

| | | |
|---|---|---|
| Input | : | PT (110V) |
| Output | : | 4-20 mA with 500 impedance |
| Mounting | : | Back rail |
| Accuracy | : | ± 0.25% |

**3.03.58 TRANSDUCERS FOR MVAR**

| | | |
|---|---|---|
| Input | : | CT & PT (110V/1A) |
| Output | : | 4-20 mA with 500 impedance |
| Mounting | : | Back rail |
| Accuracy | : | ± 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 | : | ± 0.25% |

**3.03.60 DIFFERENTIAL VOLT TRANSDUCERS (FOR SYNCHRONIZATION)**

| | | |
|---|---|---|
| Input | : | System voltage |
| Output | : | 4-20 mA with 500 impedance |
| Mounting | : | Back rail |
| Accuracy | : | ± 0.25% |

**3.03.61 PUSH BUTTONS (PB)/ ILPBs FOR ON/OFF, OPEN/CLOSE, START/STOP**

| | | |
|---|---|---|
| Type | : | Momentary/Miniaturised<br>Suitable for mosaic grid 24x48<br>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

# E.SPECIFICATION

# FOR

# PLC

## 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 it's 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 most 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 included 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 in-appropriate 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 function allocated 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, 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.

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 duplex 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 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.

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. Incase 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 thru 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 auto for different loads. If required, the system shall have the feasibility of **auto changing of PID constants (K constants)** 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 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 & CWPH (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/OWS, 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, CWPH, 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, Qunatities 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, Qunatities 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 high way/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 parallely. 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 channel 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 Lube 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 redundant processor from DDCMIS family 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 grouping 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 within1 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/meantime between failures (MTBF) & meantime 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, annunciation 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 MRPII 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 crads 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 key boards 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. QWETRY 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 E.I.A. 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, it's functions shall automatically be transferred to the other printer. Failure of the printer 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<br>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<br>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<br>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<br>ii) Connector Cable<br>iii) Duplex Unit. Automatic<br>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 OS 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)<br>Ultra 320 SCSI adaptors with internal storage capacity 3.6 TB<br>DVD/CDROM – 24X CD – RW/DVD IDE combo<br>USB – 4 ports<br>DAT – 36 / 72 GB |
| Peripherals | : | PS/2 keyboard<br>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<br>Humidity range - 8 to 80% (Non-Condensing)<br>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.<br>Application engineering & HMI software - to suit project Specific requirement |
| Miscellaneous | : | i. 1 Parallel port<br>ii. 1 Serial port<br>iii. 4 – 10/100/1000 MB/1GB network ports<br>iv. Two non-boards and two added<br>v. External SCSI port<br>vi. Dual hot plug power supplies<br>vii. Dual Hot plug fans<br>viii. 2 PCI Express slots (1x4 lane and 1x8 lane)<br>ix. 2 PCI X slots (64bit/100MHz)<br>x. 2 PCI slots (one 32bit/33MHz, 5V & one 64bit/66Mz)<br>xi Redundant Server shall be provided, wherever required.<br>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 Monitors 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. Lap top 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 wth 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:-

a) Configuration or re-configuration of a system.
b) Possibility to introduce or modify parameters.
c) 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. <u>It is preferred to have each PLC system with hardwares from same family of Plant DDCMIS.</u>

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 confirm 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. $\leq$ 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 us 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.

i. 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.

ii. The communication system design shall ensure that any single point failure on the system bus / media shall not disrupt not more than single message and disrupted message shall be automatically retransmitted after the standby communication link takes over control.

iii. Failure of physical removal of any station / modules connected on the system bus shall not lead to any loss of communication.

iv. Diagnostics display both at operating workstation and module front end shall be provided for easy fault detection.

v. Bus change over from active bus to stand by bus, during failure of active bus shall be performed automatically and bumpless. Such event shall be suitably logged or alarmed.

vi. 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.

vii. System should have open bus structure and should allow further extension facility and connection with any third party system.

h. 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 $\leq$ 2 second.

4.05.02.8 The Operator's station shall perform the following minimum requirements.

a. Selection of Auto / Manual, Open / Close operation, sequence auto, start / stop operation etc.
b. 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. Again 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 by pass 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 provide across the coil.

4.05.03.9 **Displays**

4.05.03.9.1 The operator's station 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 | : ±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, Engg 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 µSec between core-core and 20 KA, 8/20 µSec 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 panels/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 & $\geq$ 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 Spcific :**

| | | | |
|---|---|---|---|
| 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)

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Format for vendor to furnish signal
Exchange list between DCS-PLC

| Tag Name | Tag Description | Modbus address | Point type | Range | Alarm Setpoint | Alarm priority | History reqd | Function code | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

| Sl. No. | Component / operation | Characteristics Checked | * Category | Type/Method of Check | Extent of Check | Reference documents | Acceptance Norms | Format of Records | Agency $ | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | P | 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 | 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<br>Physical Damages<br>Dimensions<br>Mounting Accessories | MA | Visual | 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<br>Physical Damages<br>Dimensions<br>Accessories | MA | Visual | 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<br>• Identification Labels<br>• Physical Damages<br>• Quantity<br>• Spare Capacity | MA | Visual | 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

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| Sl. No. | Component / operation | Characteristics Checked | * Category | Type/Method of Check | Extent of Check | Reference documents | Acceptance Norms | Format of Records | Agency $ | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | P | W | V | |
| 1.5 | CPU, Monitor, Keyboard, Mouse, CD Drives, Printers, OS, System Software, Engineering software in the form of Licensed CD. | Physical Inspection<br>Identification Labels, Tech. Specification<br>Physical Damages<br>Accessories<br>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 | |

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics
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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | P | 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% | FAT Procedure | Test certification as per FAT | BHEL Quality Inspection Report. | 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

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| Sl. No. | Component / operation | Characteristics Checked | * Category | Type/Method of Check | Extent of Check | Reference documents | Acceptance Norms | Format of Records | Agency $ | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | P | 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 | |

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

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## 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

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

## 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:

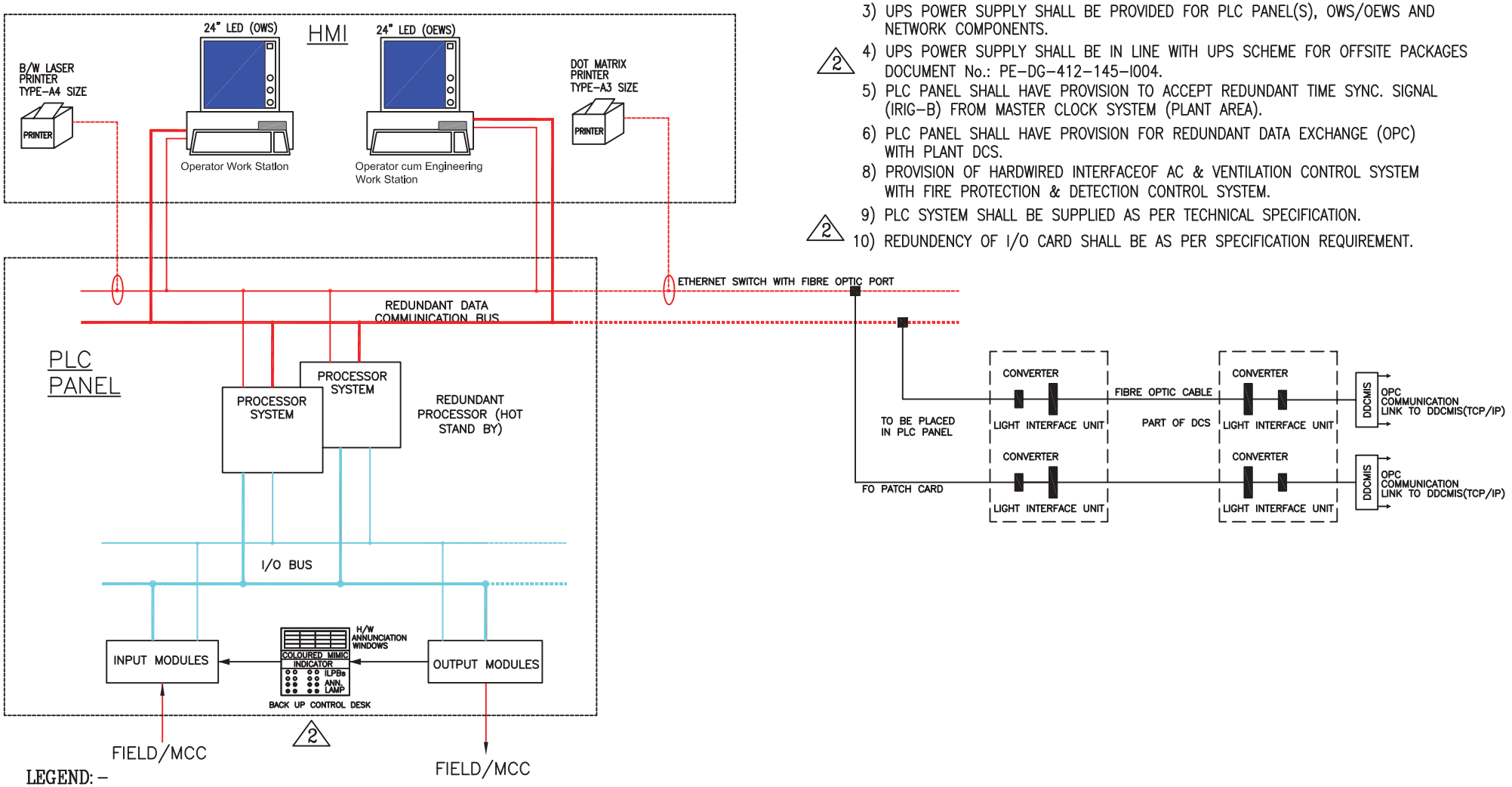
a) (i) PLC modules are kept at 50 Deg c under continuous energized condition for 48 hours.

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.

## 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-I004.
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.
8) PROVISION OF HARDWIRED INTERFACEOF AC & VENTILATION CONTROL SYSTEM WITH FIRE PROTECTION & DETECTION CONTROL SYSTEM.
9) PLC SYSTEM SHALL BE SUPPLIED AS PER TECHNICAL SPECIFICATION.
10) REDUNDENCY OF I/O CARD SHALL BE AS PER SPECIFICATION REQUIREMENT.




**LEGEND:-**

| | | |
|---|---|---|
| PLC | – | PROGRAMMABLE LOGIC CONTROLLER |
| DCS | – | DISTRIBUTED CONTROL SYSTEM |
| UPS | – | UNINTERRUPTED POWER SUPPLY |
| OEWS | – | 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 |

| | | | |
|---|---|---|---|
| BHEL | TITLE:- PLC SYSTEM CONFIGURATION<br>AC & VENTILATION | DRG. NO. | |
| | | REV. No. | DATE |
| | | SHEET | 1 OF 1 |

Anshul S A Khan Praveen Kishore

# F. SPECIFICATION

# FOR

# UN-INTERUPTED

# POWER

# SUPPLY

## 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, TEEE, 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 µs 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 Buss man 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. Min. 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, SWAS, 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 milli seconds. 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 redudnat 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 Hz, 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, KVA & KW 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 12 | 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 Votage 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. Out put 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, PF 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, ACDB & loads. For emergency trip push | 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 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.

1. 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.

2. 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 Hz within $\pm$ 0.1 percent 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 bypass 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 lease 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 excursios, loss, or restoration of DC input voltage and synchrnising voltage. The inverter output voltage shall be 230 V AC , 50 Hz, Single phase.

**7.03.04 OVER LOADS, SHORT CIRCUITS AND LOAD LOSS PROECTION**

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 bidders loads bidder shall detail the nature of non linearity. For loads provided by owner, bidder may assure a non linear wave form with a current crest factor of 3.0 occuring 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 percent 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 $\pm$ 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 inputcurrent 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 in rush 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 (Battery output ) | : | As per system requirement |
| 2. | Nominal voltage output: | | 240V, 50Hz, single phase |
| 3. | Inverter capacity (output KVA) | : | As per clause 7.03.02 |
| 4. | Voltage regulation | : | |
| | a) Steady state (0-100% load at all input voltages & all power factors) | : | $\pm$ 1 % |
| | b) Transient voltage regulation (on application or removal of 100% load) | : | $\pm$ 5% |
| | c) Time to recover from transient to normal voltage with $\pm$ 1% of steady state ( on application or removal of 100% load) | : | <50 milli second |
| 5. | Wave Form | | |
| | a) Nominal Frequency | : | 50 Hz |
| | b) Frequency regulation for all conditions of input supplies, loads and temperature occurring simultaneously or in any combination (automatically controlled) | : | $\pm$ 0.1Hz |

| | | | |
|---|---|---|---|
| c) | Synchronization limits ( for maintenance & synchronism between the inverter and standby AC source). | : | 48 Hz to 52 Hz ( factory test) |
| d) | Field adjustment range for (c ) above | : | 50 $\pm$ 0.5 Hz to 50 $\pm$ 2 Hz |
| e) | Total harmonic content | : | <4% max. |
| f) | Harmonic content max.for any single harmonic | : | <2.5% |

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 :

| ITEM | QUANTITY |
|---|---|
| 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 | |
| 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 contract 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**

**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** **<u>TRANSFER INITIATION</u>**

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 $I^2t$ 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 Hz. 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, PF 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 backup 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 woodfor 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 ± 10% plant auxiliary AC supply to 240V ± 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/offsie 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 any where in UPS & 24 V DC charger circuitry shall be copper wire winded 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 out going 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 D C 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 semi conductor fuse, MCB & LED indication for ON status.

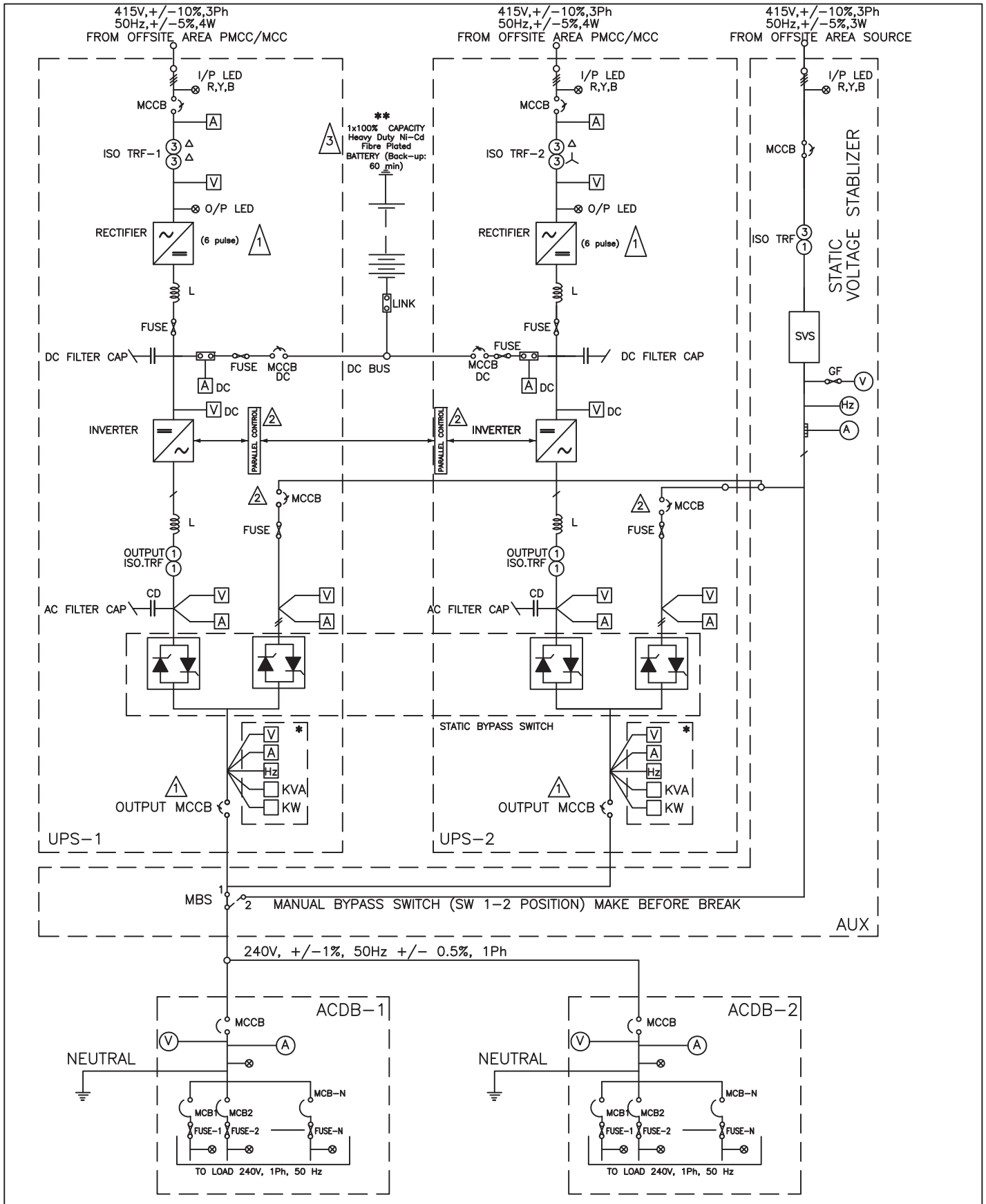
**7.13.00 AC DISTRIBUTION BOARDS PANEL**

**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 A C 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.




* 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. 2

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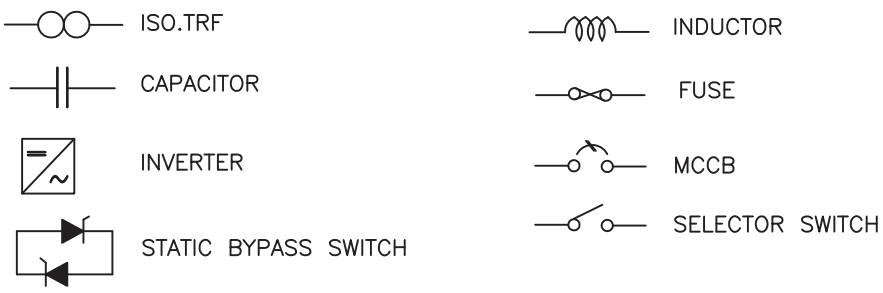
## GENERAL NOTES:

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. △3
4. △2 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 1∅240V MCB OUTGOING FEEDER.
8. RECTIFIER SHALL HAVE FACILITY FOR BOOST CHARGING THE BATTERY.
9. △1 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. △2 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. △2 SURGE PROTECTION DEVICE (SPD) SHALL BE PROVIDED AT INPUT SIDE OF EACH UPS & STATIC VOLTAGE STABILIZER.
14. △2 BATTERY JUNCTION BOXES SHALL BE AS PER CUSTOMER SPECIFICATION REQUIREMENT.
15. △2 THE REQUIREMENT OF INDICATION OF ON, OFF & TRIP SHALL BE AS PER CUSTOMER SPECIFICATION.
16. △3 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:

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## ⚠2 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.

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Anshul S A Khan Praveen Kishore

# 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 else where 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, PC & 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 offie table with lockable drawers shall be provided for Chief Enginner 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 braking 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/polyurethene 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, PC's, various peripherals & similar devices shall be complete with desks and they shall be of industrial grade stands and other mounting accessories and the same shall be completely erected & commissioned by the bidder. Details for other operating and enginering 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/polyurethene 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 confirm 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, Polymetric/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)<br>Low voltage signals<br>(AI/AO & DI signals) | :<br>: | 0.75 sq.mm |
| b. | DO signals, Ammeter/ voltmeter circuit,control switches, indicator,recorder | : | 1.5 sq.mm |
| 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**

**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 AC universal type power sockets with switch for maintenance purposes. These switches shall be with quick make and break mechanism. 100 % spare LED lamps shall be provided with each panel, these are in additional to mandatory spares.

## 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 fuses. For all DC Powered devices, similarly the fuses shall be fast acting compatible to DCDB fuse provisions. All the AC power supplies shall be provided with the protection of Fast acting semi conductor fuses & 2 P thermomegnetic type MCB. Make of Fuses shall be GE or Siemens. For all the DC power supply circuits, electronic type DC MCB shall be used only. Make of DC MCB shall be Siemens, Phoenix contacts, Murr, Weidmuller, or Lutze.
50 % spare fuses shall be provided with each panel, these are in additional to mandatory spares.

## 6.11.00 MOULDED CASE CIRCUIT BREAKERS

Moulded case circuit breakers used in equipment covered under these specifications shall have not less than 5000 amp. Interrupting capacity at 220 Volts DC 10,000 Amp. Symmetrical interrupting capacity at 240 Volts AC. MCCB shall be provided at each main feeder line like ACDB & DCDB main feeders, PLC main feeder, control panels, UPS circuits etc.

## 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 connection of ground leaks (6 mm x 50 mm GI Flats) by suitable bolting. All system cabinets shall be brought to a common system ground by the bidder. Electronic earthing resistance shall be < 0.5 ohms.

Each circuit requiring grounding shall be individually and directly connected to the panel ground bus by ring tongue type compression lugs. For electronic system cabinets the system ground bus shall be insulated from the cabinet enclosure and shall be separately

connected to the system ground. All system cabinets shall be brought to a common system ground by the bidder.

The Bidder shall furnish his recommendations regarding grounding requirements for all equipment/systems and shall specifically indicate the deviations if any from the above requirements as a part of his proposal.

**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 polymide 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 RESISITANCE according to DIN EN 61010-1/VDE 0411-1.

# H.DRIVE

# CONTROL

# PHILOSOPHY

# FOR

# ANALOG
# &

# BINARY

# DRIVES

## 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. (1)

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. (4)

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). (4)
- 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. (3)

g) For Bidirectional drives of >=15 KW, CURRENT TRANSDUCER shall be located in MCC. (4)

*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.

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. 1

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. 1

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). 3
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 $\geq$ 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. 1

g. The Control & Operation from Backup Control Desk/UCP shall be envisaged for critical Drives. 3

h. Start & Stop command shall be latched at MCC end.

*The above signal exchanges are diagrammatically represented in sheet no. 8.*

**3 <u>Solenoid Operated Drives (24V DC/220V DC/240V AC)</u>** 2

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.

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.

e. Following signal exchange shall take place between solenoid operated drive & DDCMIS/DCS/PLC

1

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)

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.

1

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

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. 1

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. 2

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. 3

h. Latching as required shall be done at MCC/SWGR end. 5

*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).

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

3 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.

5 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

3 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

2 (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

3

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

3

**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.

5

**2) Email & Message alert**

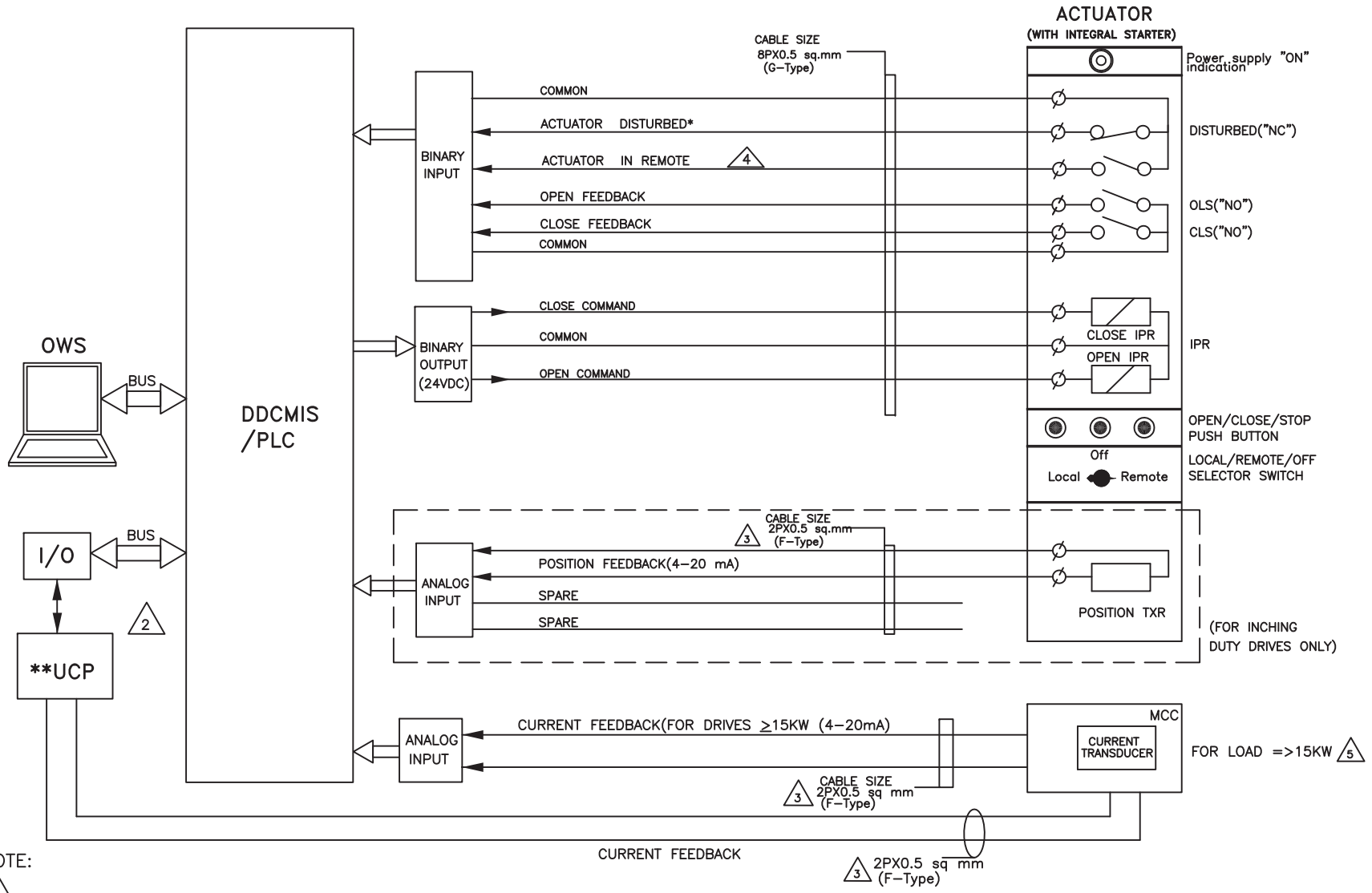
Intimation through message & E-mail shall be provided for tripping of all HT drives & critical LT drives.

**3) Drives with VFD will have the following signal exchange:-**

4

| | |
|---|---|
| a) Speed Input | AI |
| b) Speed Output | AO |
| c) VFD Mode/Bypass Mode selection | DI |
| d) VFD Mode/Bypass Mode command | DO |

# DCS INTERFACE FOR BIDIRECTIONAL DRIVE(WITH INTEGRAL STARTER)




NOTE:

4 REDUNDANCY OF IO SHALL BE AS PER CUSTOMER SPECIFICATION.

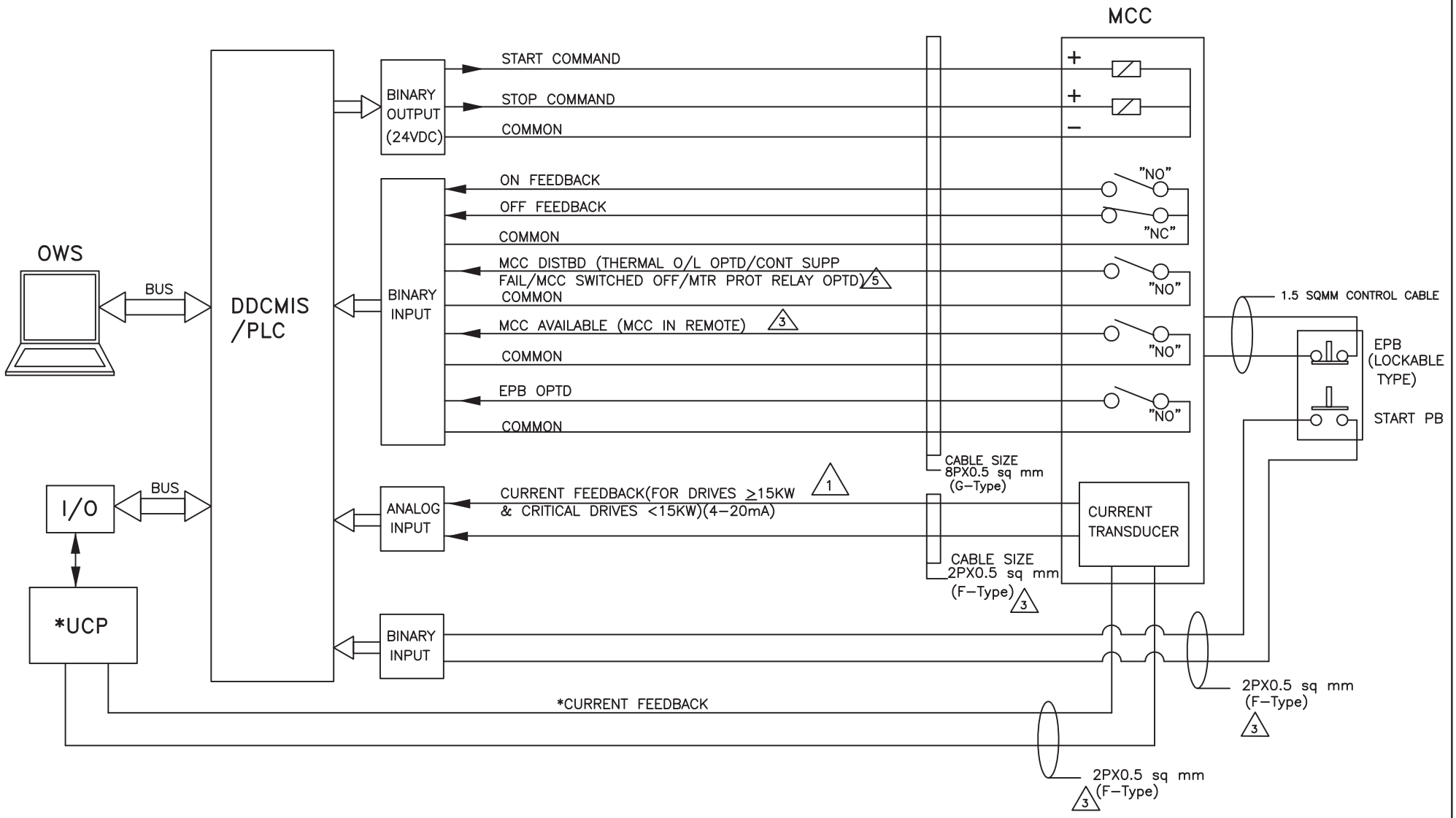
* DISTURBED= Loss of Power supply (1 Phase/3 Phase)/ Loss of control supply/ Motor thermostat trip/Thermal over load/Torque open/close cutoff Local/Off/Remote Sel. switch in local or off mode/Stop PB optd.

2 ** AS APPLICABLE.

| | | | |
|---|---|---|---|
| BHEL | PROJECT: 2X660 MW ENNORE SEZ STPP | DRG.NO. | PE-DM-412-145-I002 |
| | | DATE | 20.10.2016 |
| | TITLE DDCMIS INTERFACE FOR BIDIRECTIONAL DRIVE | REV.NO. | 05 |
| | | SHT | 8 OF 12 |

Anshul S A Khan Praveen Kishore

# DCS INTERFACE FOR UNIDIRECTIONAL LT DRIVE




NOTE:

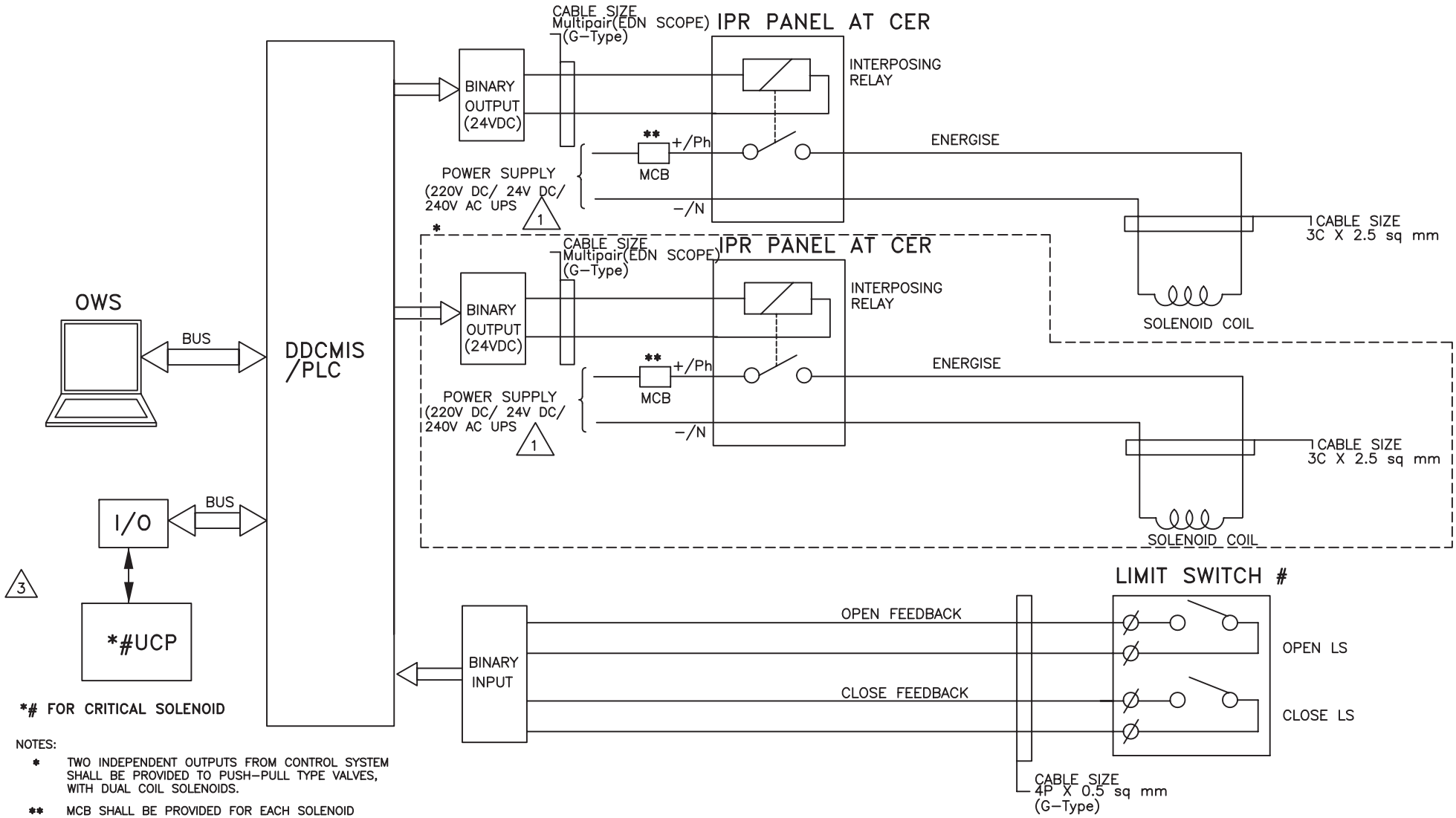
* CURRENT FEEDBACK IN DDCMIS SHALL BE PROVIDED FOR ALL DRIVES > 15 KW AND FOR IMPORTANT DRIVES <15 KW. 4

I/O REDUNDANCY SHALL BE AS PER SPECIFICATION REQUIREMENTS.

| | | |
|---|---|---|
| PROJECT: 2X660 MW ENNORE SEZ STPP | DRG.NO. | PE–DM–412–145–I002 |
| | DATE | 20.10.2016 |
| TITLE: DDCMIS INTERFACE FOR UNIDIRECTIONAL LT DRIVE | REV.NO. | 05 |
| | SHT | 9 OF 12 |

Anshul S A Khan Praveen Kishore

# DCS INTERFACE FOR SOLENOID DRIVE
## △1 (220V DC/ 24V DC / 240V AC UPS)




NOTES:

* TWO INDEPENDENT OUTPUTS FROM CONTROL SYSTEM SHALL BE PROVIDED TO PUSH-PULL TYPE VALVES, WITH DUAL COIL SOLENOIDS.

** MCB SHALL BE PROVIDED FOR EACH SOLENOID

△1 # FOR ON/OFF TYPE, SOLENOID ACTUATED VALVE. RELAY CONTACTS SHALL BE WIRED AS FEEDBACK WHEREVER LIMIT SWITCH FEEDBACKS ARE NOT AVAILABLE. 1 CONTACT FOR SINGLE COIL & 2 CONTACT FOR DUAL COIL (OPEN LIMIT SWITCH & CLOSED LIMIT SWITCH. △2

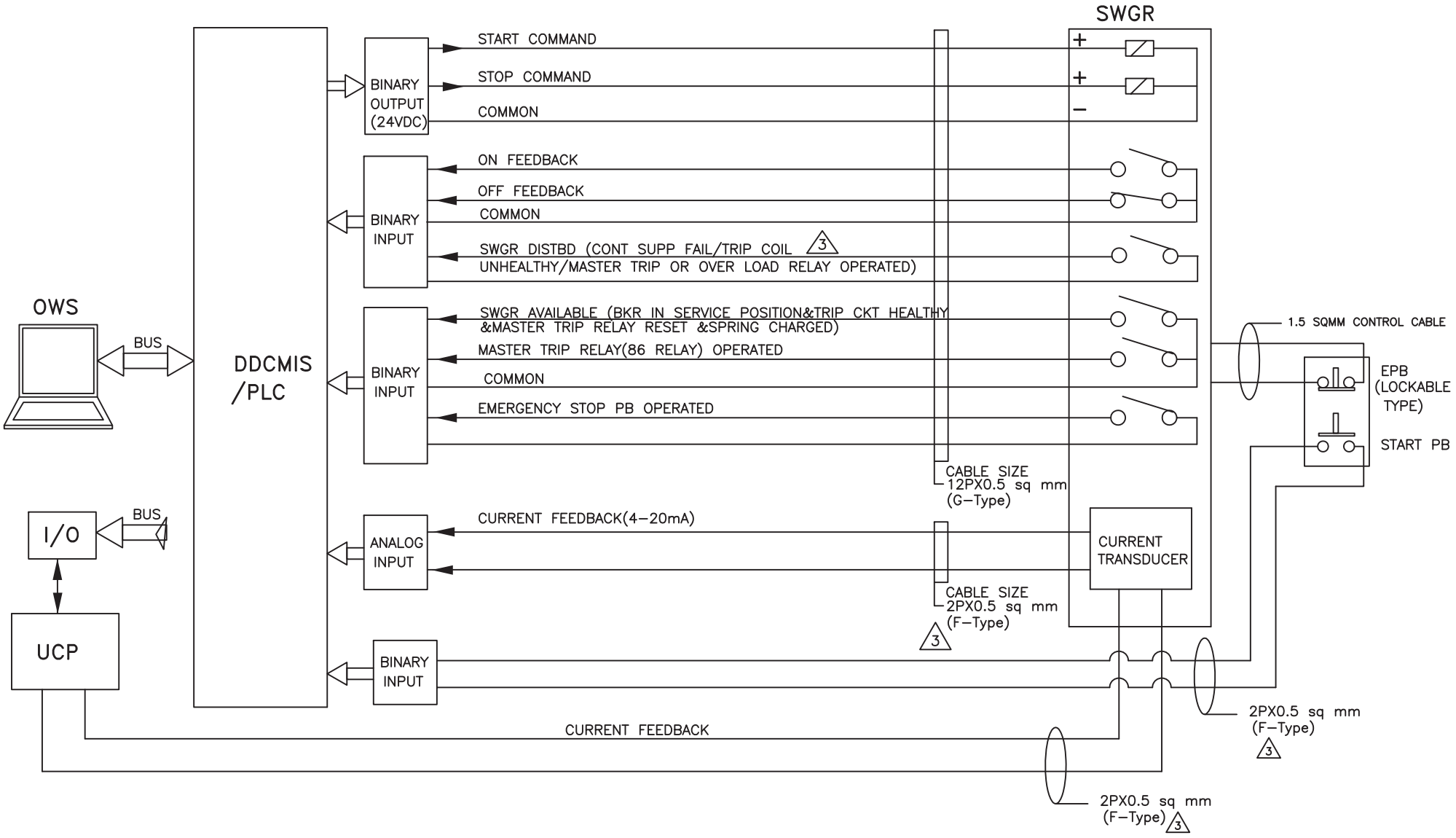
△1 *** BHEL WILL TAKE CARE OF DE-ENERGISE TO TRIP PHILOSOPHY FOR FAIL SAFE CONTROL SYSTEM (WHEREVER REQUIRED)

I/O REDUNDANCY SHALL BE AS PER SPECIFICATION REQUIREMENTS. △3

| | | |
|---|---|---|
| PROJECT: 2X660 MW ENNORE SEZ STPP | DRG.NO. | PE-DM-412-145-I002 |
| | DATE | 20.10.2016 |
| TITLE DDCMIS INTERFACE FOR SOLENOID DRIVE | REV.NO. | 05 |
| | SHT | 10 OF 12 |

Anshul S A Khan Praveen Kishore

# DCS INTERFACE FOR HT/LT UNIDIRECTIONAL DRIVES(BREAKER OPERATED)




NOTE:

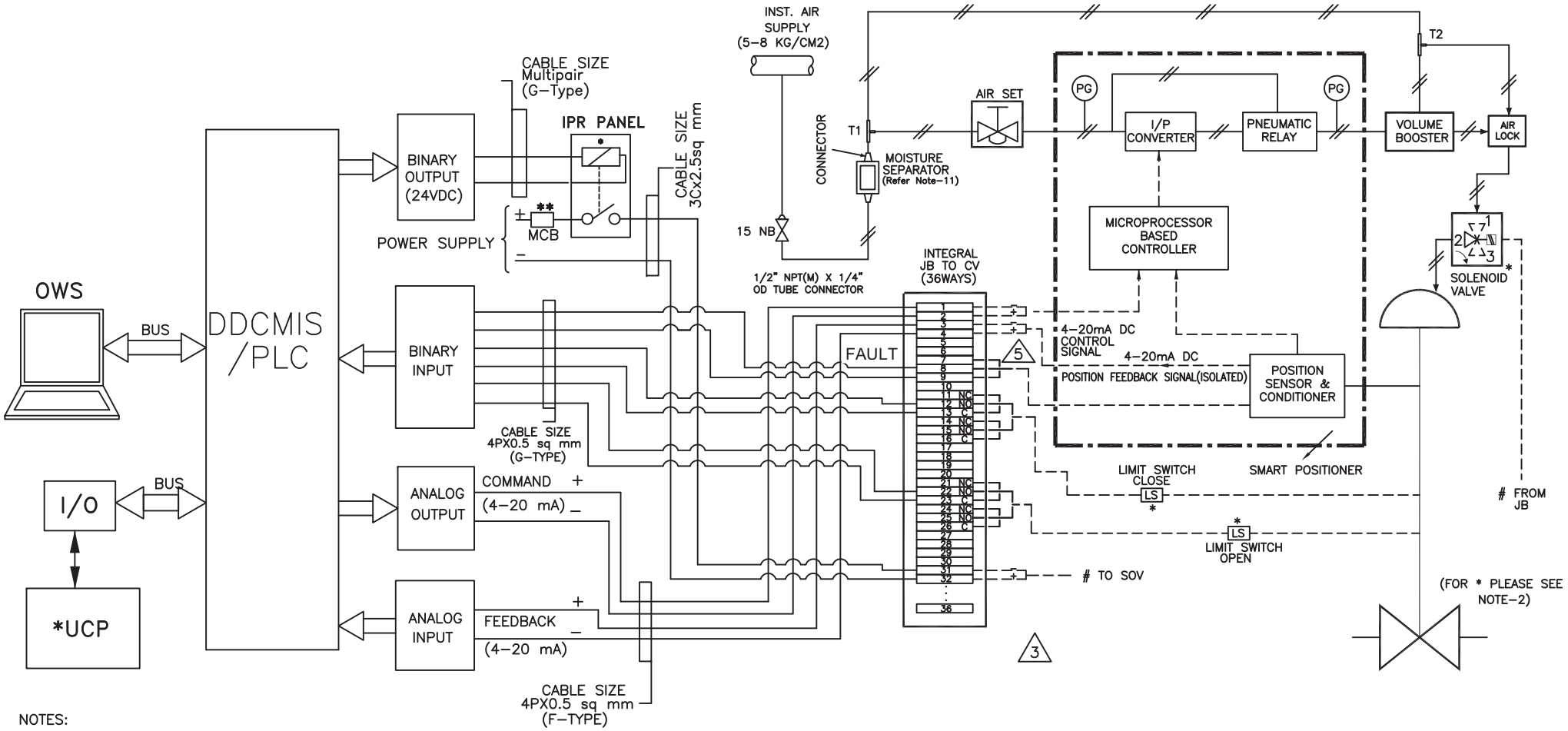
# VIBRATION, WINDING & BEARING SIGNALS SHALL BE INTERFACED WITH DDCMIS AND INCLUDED IN EDN'S DOCUMENT.

I/O REDUNDANCY SHALL BE AS PER SPECIFICATION REQUIREMENTS. 3

| | | |
|---|---|---|
| PROJECT: 2X660 MW ENNORE SEZ STPP | DRG.NO. | PE-DM-412-145-I002 |
| | DATE | 20.10.2016 |
| TITLE: DDCMIS INTERFACE FOR UNIDIRECTIONAL HT DRIVE | REV.NO. | 05 |
| | SHT | 11 OF 12 |

Anshul S A Khan Praveen Kishore

# 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.

4 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.

| | | | |
|---|---|---|---|
| भेल BHEL | PROJECT: 2X660 MW ENNORE SEZ STPP | DRG.NO. | PE-DM-412-145-I002 |
| | | DATE | 20.10.2016 |
| | TITLE: TYPICAL HOOK-UP DIAGRAM ANALOG DRIVE (WITH SMART POSITIONER) | REV.NO. | 05 |
| | | SHT | 12 OF 12 |

Anshul S A Khan Praveen Kishore

**Cable Type**

Bidder to use the following below mentioned cables while preparing cable schedule of AC system :-

| 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 |

# 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) Electromgnetic 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 semi-conductor 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 - ASTMD-2843 and ASTME-662.
8. Acid gas generation test - IEC-754-1.
9. Swedish chimney test - SEN - 4241475 (F3)
10. Instrumentation cables and internal wiring IS-1554 (Part-I, 1976) and IS-5831(1984).
11. Standard for Control, Thermocouple Extension and Instrumentation cable - NEMA WC57-2004 ICEA S-73-532, 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 Level3 or higher (American Software Engineering Institute - Capability Maturity Model)

Where:

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

# 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'' 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 tests equipment shall be of reputed make, required accuracy class and shall be recently calibrated. The record of calibration of test equipment shall be made available to the Owner on demand.

**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 normal voltage for 30 minutes followed by 90 percent of nominal voltage for 30 minutes.

The 48 hours elevated temp test shall be followed by 120 hours of burn in test as specified in the above paragraphs except that the temperature is reduced to ambient temperature prevalent at that time. Alternatively copy of type test certificate for burn-in test shall be submitted.

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 through out 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 NEEA/IS/IEC/ANSI/BS/ISA standards, in addition to the requirements of Owner approved Quality Plans. Six (6) copies of test reports shall be submitted to the Owner for approval prior to dispatch of respective equipment

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 REQUIRMENTS | 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 HOURES | ✓ |
| | 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 CONFIGARATION DRAWINGS | |
| | 19 | FAT PROCEDURE CONSITING 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 EQIPMENT / SYSTEM | |
| | 28 | - | |
| | 29 | - | |
| PRELIMINARY 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 | ✓ |
| TEM | 1 | POWER SUPPLY UNDER VOLTAGE AND OVER VOLTAGE CHECK (± 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 | - | |
| CONTROLLER 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 INTERCHANGEBILITY 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 | ✓ |
| MAINTENANCE | 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 | ✓ |
| 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, 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 PERIPHERIALS 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

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 tests cases for calculations (3 for each calculation at low, mid and upper ranges of inputs) and submit them for the owner's approval. Test cases shall include performance calculations, flow and level calculations, pressure and temperature compensations, etc.

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, snap shots, 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, Keyboard

   Note-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, Keyboard

   Note-1: Test to be witnessed by Owner.

7. ERP System

   i. Simulated functional test (Note-1)
   ii. Tests for server, LED monitor, Printer, Keyboard

   Note-1: Test to be witnessed by Owner.

8. MIS System

   i. Simulated functional test (Note-1)
   ii. Tests for server, LED monitor, Printer, Keyboard

   Note-1: Test to be witnessed by Owner.

9. HMS System

   i. Simulated functional test (Note-1)
   ii. Tests for server, LED monitor, Printer, Keyboard

   Note-1: Test to be witnessed by Owner.

**NOTES:**

1. The intent of the FAT is to demonstrate and ensure that the I&C system meets all the functional requirements as intended in the specification / contract. A completed integrated test of the system shall be carried out at vendor's works in the presence of Owner or Owner's representative, on

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 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<br>b) Hydrostatic test : ANSI B 16.34<br>c) Seat leakage test : As per ANSI B 16-104<br>d) CV test: As per ISA procedure<br>e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC)<br>f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC)<br>g) Radiography test: ANSI B 16.34 special class<br>h) Calibration and Hysteresis test<br>i) Actuator leakage test |
| 36. | Pressure Regulating Valve |

| | |
|---|---|
| | a) IBR certificate form III C<br>b) Hydrostatic test : ANSI B 16.34<br>c) Seat leakage test : As per ANSI B 16-104<br>d) CV test: As per ISA procedure<br>e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC)<br>f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC)<br>g) Radiography test: ANSI B 16.34 special class<br>h) Calibration and Hysteresis test<br>i) Actuator leakage test |
| 37. | Local Panels :<br>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.<br>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/manufacturer is required

to conduct certain type test specifically for this contract (and witnessed by employer or his authorized representative). Even if the same have been conducted earlier as clearly indicated subsequently such tests.

B. For the rest, submission of type test , results, and certificates shall be acceptable provided following points

i. 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).
ii. There has been no change in the components from the offered equipments and tested equipments.
iii. The test has been carried out as per the latest standards along with amendemends 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 th 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 O2 analyser, other Flue gas Analysers | Degree of protection test | IS 13947 | No | YES |
| 18 | Flow nozzles & Orifice plates | calibration | ASME PTC 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.

# K.LIST

# OF

# MANDATORY

# SPARES

| 2x660 MW ENNORE SEZ PROJECTOF TANGEDCO | | | | | |
|---|---|---|---|---|---|
| MANDATORY SPARES | | | | | |
| III. | CONTROL & INSTRUMENTATION PACKAGES | | | | |
| TANGEDCO | | | | Total Ex-Works price | *Remarks |
| Sl 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** | | | | |

1. C&I Mandatory spares are indicated in above list. These spares shall be considered as per the applicable items in main supply

2.The spares shall be considered as unit wise except for any item/equipment supplied as common for both units.



Anshul S A Khan Praveen Kishore

| TANGEDCO | | | | Total Ex-Works price | *Remarks |
|---|---|---|---|---|---|
| Sl 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) | | | | |

1. C&I Mandatory spares are indicated in above list. These spares shall be considered as per the applicable items in main supply

2.The spares shall be considered as unit wise except for any item/equipment supplied as common for both units.



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| TANGEDCO | | | | Total Ex-Works price | *Remarks |
|---|---|---|---|---|---|
| Sl 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. | | |
| b) | Cooling and purging air blower unit | Nos. | One No. for each analyser type | | |
| c) | Light source and detector unit for smoke density analyser. | Set | One set for each analyser type | | |
| d) | Infrared source and detector unit for CO analyser | set | One set for each analyser type | | |
| e) | Zirconia Cell, ceramic filters, heater & thermo couple assembly for flue gas oxygen analyzer. | Nos. | Two Nos. of each type | | |
| f) | of chopper motor, two nos. protection window, one no. of heater cartridge for CO analyser | Nos. | Two No. of each type | | |
| g) | Power supply module | Nos. | 1 no. of each type for each analyser type. | | |
| h) | UV Lamp with adopter with SO2 analyser | Nos. | 2 no. of each type. | | |
| i) | Light source and detector unit for SPM, and NOX/SOX analyser. | Nos. | 1 no. of each type for each analyser type. | | |
| j) | Set of filters | Nos. | 1 No. of each type for each analyser type. | | |
| 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. | | |
| 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.** | | | | |

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| TANGEDCO | | | | Total Ex-Works price | *Remarks |
|---|---|---|---|---|---|
| Sl 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) | | |

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| TANGEDCO | | | | Total Ex-Works price | *Remarks |
|---|---|---|---|---|---|
| Sl 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. | 5 nos. of each type/model | | |
| 1.00.02.09 | OEWS with 24" LED monitor | | 1 no. of each type/ model | | |
| 1.00.02.10 | OWS | | 1 no. of each type/model | | |
| 1.00.02.11 | DVD/CD | Nos. | 10 boxes | | |
| 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. | 5 nos. of each type/model | | |
| 1.00.02.14 | Prefab cable connectors | Nos. | 10% or 5 nos (whichever is more) of each type of Installed | | |
| 1.00.02.15 | Cubicle power supply power supply modules | Nos. | Ten (10) percent or 5 nos (whichever is more) of Installed of each type and rating | | |
| 1.00.02.16 | Interposing/coupling relays. | Nos. | Ten (10) percent Installed of each type and rating | | |

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| 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. | 1 no. (A3)Tonner | | |
| 1.00.02.20 | DMP printer head of the total quantity | Nos. | Not Applicable for this package | | |
| 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. | | | |
| 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. | 5 nos. | | |

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| TANGEDCO | | | | Total Ex-Works price | *Remarks |
|---|---|---|---|---|---|
| Sl no | Name of spares | Unit | Qty | in INR | |
| 1.00.02.30 | Mouse | Nos. | 5 nos. of each type/model | | |
| 1.00.03 | **Steam and Water Analysis System (SWAS)** | | | | |
| 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. | | |

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| TANGEDCO | | | | Total Ex-Works price | *Remarks |
|---|---|---|---|---|---|
| Sl no | Name of spares | Unit | Qty | in INR | |
| 1.00.05 | **Alarm Annunciation System** | | | | |
| 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 | | |

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| TANGEDCO | | | | Total Ex-Works price | *Remarks |
|---|---|---|---|---|---|
| Sl 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 : | Set | Two sets | | |
| | 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. | | | | |
| 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 | | |

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| TANGEDCO | | | | Total Ex-Works price | *Remarks |
|---|---|---|---|---|---|
| Sl 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** | | | | |
| 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** | | | | |
| (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 survillance system** | | | | |

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| 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 surveilance 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** | | | | |
| 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** | | | | |
| 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 | | |

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| 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. | | | | |

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| 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 | | | | |
| C) | | | | | |

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| TANGEDCO | | | | Total Ex-Works price | *Remarks |
|---|---|---|---|---|---|
| Sl no | Name of spares | Unit | Qty | in INR | |
| a. | Soft Goods Kit Valve | 1 set | | | |
| 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 | | | | |
| 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: | | | | |

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| TANGEDCO | | | | Total Ex-Works price | *Remarks |
|---|---|---|---|---|---|
| Sl no | Name of spares | Unit | Qty | in INR | |
| i) | Feedback transmitter | 2 NOS. | | | |
| 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. | | | |
| vi) | Filters for Oil Units | 1 set | | | |
| vii) | Supply manifold for oil units | 1 No | | | |
| viii) | Hose for each service | 1 each | | | |
| ix) | Seal set for oil unit | 1 Set | | | |
| x) | 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. | | | | |
| 1.00.14 | **Mandatory Spares for Boiler Tube leak Detection System** | | | | |
| | Following mandatory spares along with their individual price required for maintaining boiler tube leak detection system to supply along with the package. | | | | |
| 1) | 2nos. acoustic transducer with rear connector sealed to IP-65 | | | | |
| 2) | 2 nos. flexible high temperatures lead, 3metre long for acoustic transducer. | | | | |
| 3) | 2 nos. acoustic s field amplifier / processor mounted in a die cast aluminum or polycarbonate box sealed to IP-65 with mounting brackets, pairs. | | | | |
| 4) | 1 no. A/D Convertor cards/field signal interface module for 32 or more channels. | | | | |
| 5) | 1 no. Alarm relay output card. | | | | |

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| 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. | | | |
| (ii) | Flame Scanner Lens. | 100% | | | |
| (iii) | Electronic cards for scanners | 10% or 2 nos. of each type whichever is more. | | | |
| (iv) | Power Supply Modules | 10% or 2 nos. of each type whichever is more. | | | |
| 2 | **Coal Feeders** | | | | |
| (i) | Calibration Motor | 10% or 2 nos. whichever is more. | | | |
| (ii) | Correction Motor | 10% or 2 nos. whichever is more. | | | |

1. C&I Mandatory spares are indicated in above list. These spares shall be considered as per the applicable items in main supply

2.The spares shall be considered as unit wise except for any item/equipment supplied as common for both units.



Anshul S A Khan Praveen Kishore

| TANGEDCO | | | | Total Ex-Works price | *Remarks |
|---|---|---|---|---|---|
| Sl no | Name of spares | Unit | Qty | in INR | |
| (iii) | Motion monitor | 10% or 2 nos. whichever is more. | | | |
| (iv) | Speed pick-up | 10% or 2 nos. whichever is more. | | | |
| (v) | Torque switch | 10% or 2 nos. whichever is more. | | | |
| (vi) | Load Cell | 10% or 2 nos. whichever is more. | | | |
| (vii) | Electronic cards & Power Supply cards | 10% or 2 nos. whichever is more. | | | |
| (viii) | Clutch (if applicable) | 10% or 2 nos. whichever is more. | | | |
| (ix) | Local indication lamps | 200% . | | | |
| (x) | Panel meters | 10% or 2 nos. whichever is more. | | | |
| (xi) | Limit switch assembly for coal-on-belt, no coal flow, shear pin failure, etc. | 10% or 2 nos. whichever is more. | | | |
| (xii) | Coupling (eddy current type etc., if applicable) | 10% or 2 nos. whichever is more. | | | |
| 3 | **Electromatic Safety Valves** | | | | |
| (a) | Pressure switches, local PB stations and solenoid Valves. | 10% or 2 nos. of each type whichever is more. | | | |
| 4 | **Furnace Temperature Probes** | | | | |
| (a) | Thermocouple | 2 Nos. of each type | | | |
| | | | | | |
| 5 | **Acoustic Pyrometers** | | | | |
| (a) | Signal Processor and interface modules | 10% or 2 nos. of each type and model whichever is more | | | |
| (b) | Sensors and Transceivers | 20% or 2 nos. of each type and model which is more. | | | |
| 6 | **Furnace and Flame Viewing System** | | | | |
| (a) | Flame Cameras | 10% or 2 nos. of each type whichever is more. | | | |
| (b) | Electronic Modules | 10% or 2 nos. of each type whichever is more. | | | |
| 7 | **Coal Bunker Level Indicating System** | | | | |
| (i) | Sensors of each type | 20% or 2 nos. of each type whichever is more. | | | |

1. C&I Mandatory spares are indicated in above list. These spares shall be considered as per the applicable items in main supply

2.The spares shall be considered as unit wise except for any item/equipment supplied as common for both units.



Anshul S A Khan Praveen Kishore

| TANGEDCO | | | | Total Ex-Works price | *Remarks |
|---|---|---|---|---|---|
| Sl no | Name of spares | Unit | Qty | in INR | |
| (ii) | Electronic Cards of each types, model | 10% or 2 nos. of each type and model whichever is more. | | | |
| (iii) | Panel indicators/displaysfor Bunker Level | 20% or 2 nos. of each type whichever is more. | | | |
| 8 (i) | Solenoids for SG pneumatic drives/valves. | 20% or 2 nos. of each type whichever is more. | | | |
| (ii) | Solenoid valves. | 20% or 2 nos. of each type whichever is more. | | | |
| (iii) | Diaphragms | 20% or 2 nos. of each type whichever is more. | | | |
| 9 | **Conductivity type level monitoring system** | | | | |
| (i) | Electrodes | 50% of population of each type and model. | | | |
| (ii) | Electronic Cards | 20% or 2 nos. of each type and model whichever is more. | | | |
| (iii) | Lamps/LEDs of display units | 100% | | | |
| | | | | | |
| 10 | Mill and Air heater Fire detection system. | | | | |
| (a) | Thermocouple | 10% or 2 nos. whichever is more | | | |
| (b) | Process actuated switches | 10% or 1 no. whichever is more | | | |
| (c) | Electronic cards | 20% or 2 nos. whichever is more | | | |
| 1.00.16.02 | **Other TG Related Sub-Systems** | | | | |
| | **Turbine Supervisory System/EHTC/TSC/ATT/ATRS/GSPC/TDBFP etc.** | | | | |
| | | | | | |
| (i) | Power Supply assemblies of all types | 10% or 2 nos. of each type whichever is more | | | |
| | Temperature Sensing elements | 10% or 2 nos. of each type whichever is more | | | |
| (iii) | CJC assemblies of all types | 10% or 2 nos. of each type whichever is more | | | |
| (iv) | Local gauges/transmitters of all types, range, model no. etc. For Temperature, pressure, DP, differential expansion, axial shift etc. | 5% or 1 no. of each type whichever is more | | | |

1. C&I Mandatory spares are indicated in above list. These spares shall be considered as per the applicable items in main supply

2.The spares shall be considered as unit wise except for any item/equipment supplied as common for both units.



Anshul S A Khan Praveen Kishore

| TANGEDCO | | | | Total Ex-Works price | *Remarks |
|---|---|---|---|---|---|
| Sl no | Name of spares | Unit | Qty | in INR | |
| (v) | Process Actuated Switch Devices of all types, range, model no. etc. for pressure, DP, temperature, flow, level, proximity/speed etc. | 5% or 1 no. of each typewhichever is more | | | |
| (vi) | Electronic Cards/PCB's/interface units/special cables etc. of each type of measurement used in TSI. | 10% or 2 nos. of each type whichever is more. | | | |
| (vii) | Instrument valves of all types like isolating, 2/3/5 way valve manifolds, hi pressure reducing, safety relief, each type of solenoid valves etc. | 5% or 2 nos. of each type, model etc.; whichever is more. | | | |
| (viii) | Sensors of all types, range, model etc. for vibration, eccentricity, proximity, differential expansion, axial shift , EHC position, Stop/Control valve position and any other measurements etc. | 10% or 2 nos. of each type whichever is more. | | | |
| (ix) | Electro Hydraulic Converter. | 1 complete unit of each type. | | | |
| | | | | | |
| | | | C& I TOTAL | | |

1. C&I Mandatory spares are indicated in above list. These spares shall be considered as per the applicable items in main supply
2.The spares shall be considered as unit wise except for any item/equipment supplied as common for both units.



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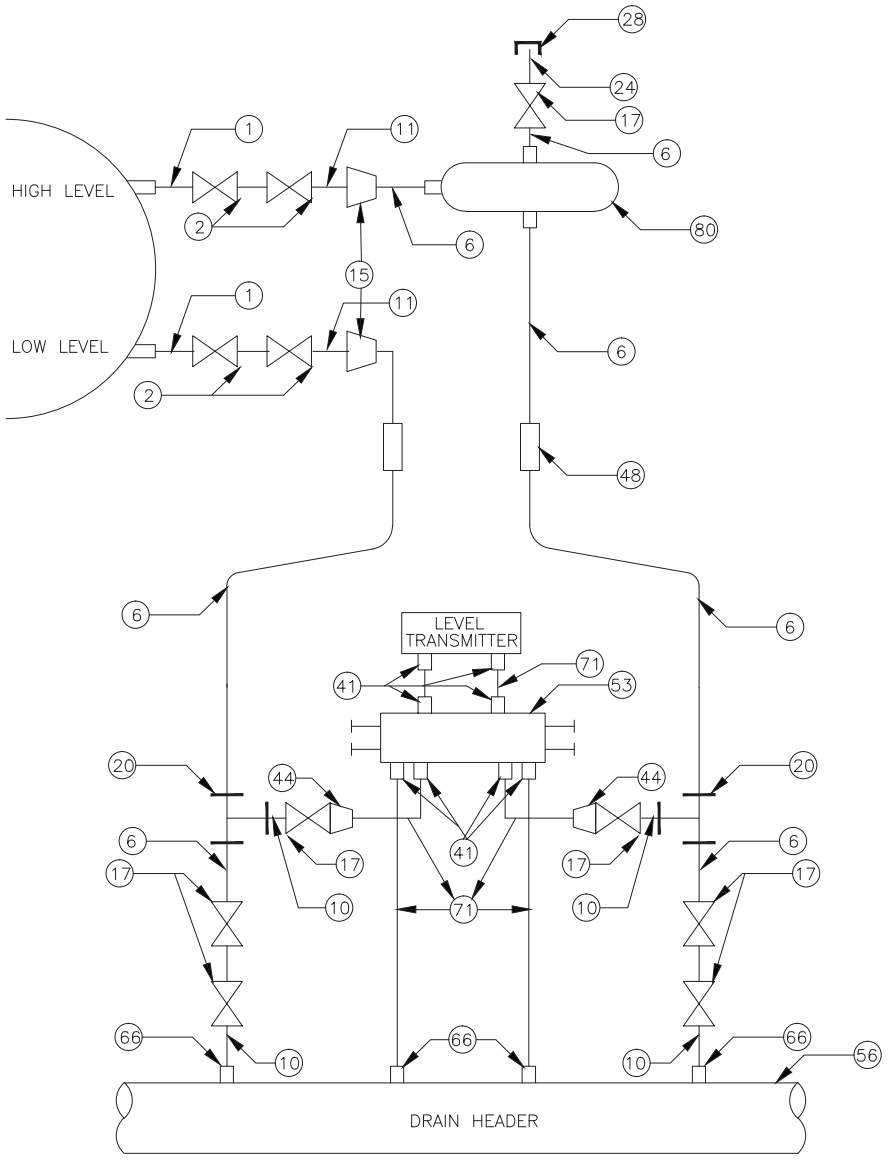
# L.DRAWINGS




TRANSMITTER MOUNTED BELOW INST. SOURCE POINT

| TAG NO. | DESCRIPTION | BOM |
|---|---|---|
| 80 | CONDENSATION CHAMBER | 1 |
| 71 | 1/2"OD IMPULSE TUBE, SS-316 | AS REQD. |
| 66 | 1/2" GI SOCKET / FUNNEL | 4 |
| 56 | 2"NB GI DRAIN HEADER | AS REQD. |
| 53 | 5-VALVE MANIFOLD, SS-316 | 1 |
| 48 | 1/2" SW, CS/AS BULK HEAD PIPE UNION | 2 |
| 44 | 1/2"BWX1/2"OD COMPRESSION TUBE FITTING,SS-316 | 2 |
| 41 | 1/2"NPT(M)X1/2"OD TUBE COMPRESSION FITTING,SS-316 | 8 |
| 28 | 1/2" NPT (F) CS CAP | 1 |
| 24 | 1/2" NPS SCH-80/160X1/2"NPT(M) CS/AS NIPPLE | 1 |
| 20 | 1/2" SOCKET WELDED EQUAL TEE CS/AS | 2 |
| 17 | 1/2" SOCKET WELDED CS GLOBE VALVE | 7 |
| 15 | 1"TO 1/2" SOCKET WELD REDUCER | 2 |
| 11 | 1" NPS SCH 80/160 CS/AS NIPPLE | 2 |
| 10 | 1/2" NPS SCH 80/160,CS/AS NIPPLE | 4 |
| 6 | 1/2" NPS SCH 80/160 CS/AS PIPE | AS REQD. |
| 2 | 1/2"/3/4"/1" SOCKET WELDED GLOBE VLV/ROOT VLV. | 4 |
| 1 | 1/2" NPS SCH 80 NIPPLES OF MATERIAL SAME AS MAIN PIPE WITH NECESSARY ATTACH TO FLANGES | AS REQD. |

NOTE:-
1. FOR HIGH TEMP. SERVICE (MORE THAN 80°C) A 'U' TUBE(REF. DWG NO. 114-04-0100) SHALL BE PROVIDED BETWEEN THE MANIFOLD AND THE TRANSMITTER
2. FOR HIGH PR.(MORE THAN 40kg/sqcm) ONE NO. OF ISOLATING VLV. IS PROVIDED IN EACH LINE BETWEEN VLV. MANIFOLD AND 1/2"SW EQUAL TEE AND 2NO. DRAIN VLV. ARE ALSO

**REFERENCE DRAWINGS.**

**NOTES**

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. BULK HEAD FITTING SW TYPE SHALL BE PROVIDED AT I/E/UR
4. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
5. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
6. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

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| | A | PRELIMINARY | 25.04.13 | | | | SLN | |

REVISIONS

APPROVED

DESEIN
CONSULTING ENGINEERS
NEW DELHI - INDIA

CLIENT: TAMILNADU GEN. & DIST. CORPORATION

PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE :- INST. DRAWING FOR LEVEL TRANSMITTERS

FOR BID PURPOSE ONLY:

| | NAME | SIGN. | DATE |
|---|---|---|---|
| CAD/DRAWN | VIKAS | | 23.04.13 |
| DESIGNED | SKM/SN | | 23.04.13 |
| CHECKED | S.K.M. | | 24.04.13 |
| SCALE | N.T.S. | | |

JOB. No. D-4027

DWG.No. 114-04-0110 REV. 0

Sheet No. 13of 19

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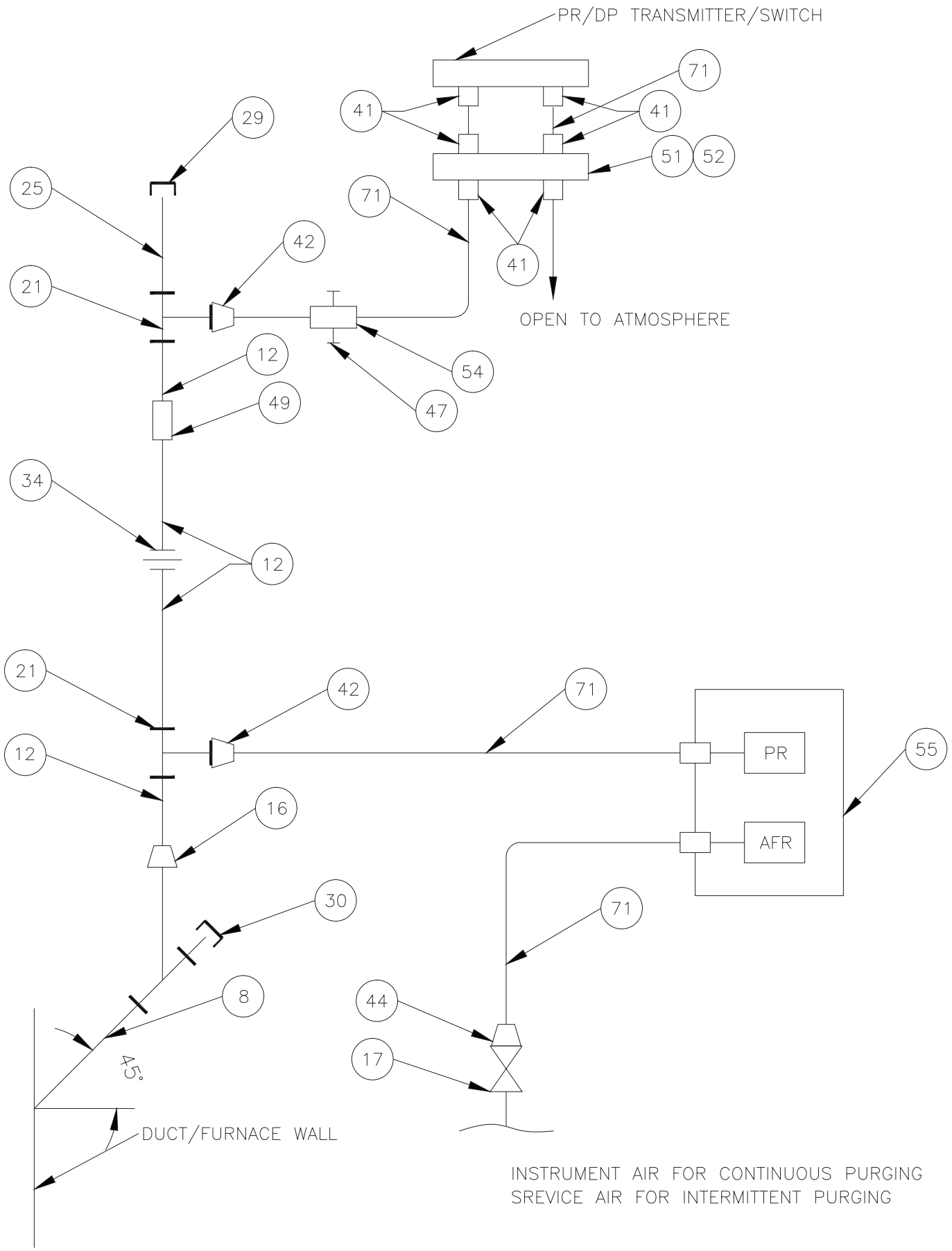


| TAG NO. | DESCRIPTION | QTY. |
|---|---|---|
| | BILL OF MATERIAL | |
| 71 | 1/2"OD IMPULSE TUBE,SS-316 | |
| 55 | CONTINOUS PURGING ARRENGEMENT | 1 |
| 54 | 3-WAY VALVE WITH 1/2" SWAGE LOCK CONNECTION | 1 |
| 51or52 | 5-VALVE MANIFOLDS/3-VALVE MANIFOLDS/2-VALVE MANIFOLDS,SS-316 | 1 |
| 49 | 3/4"SW,CS/AS BULK HEAD PIPE UNION | 1 |
| 47 | QUICK DISCONNECT FITTING,CS | 1 |
| 44 | 1/2"BW X 1/2"OD TUBE FITTING,SS-316 | 1 |
| 42 | 3/4"BW X 1/2"OD TUBE FITTING,SS-316 | 1 |
| 41 | 1/2"NPT(M) X 1/2"00 TUBE COMPRESSION FITTING,SS-316 | 6 |
| 34 | 3/4" SW,CS PIPE UNION | 1 |
| 30 | MS BLACK PIPE CAP | 1 |
| 29 | 3/4"NPT(F) CS CAP | 1 |
| 25 | 3/4"NPS,SCH-80 X 3/4"NPT(M)CS NIPPLE | 2 |
| 21 | 3/4" EQUAL TEE,CS | 2 |
| 17 | 1/2" SW GLOBLE VALVE, CS | 1 |
| 16 | MS BLACK PIPE TO 3/4" SW,CS REDUCER | 1 |
| 12 | 3/4" NPS SCH-80 CARBON STEEL PIPE | AS REQD. |
| 8 | MS BLACK PIPE | AS REQD. |

NOTE:-

FOR DP TRANSMITTER THE SECOND IMPULSE LINE SHALL BE CONNECTED SIMILAR TO FIRST IMPULSE LINE (TAG NO-12)

AFR- AIR FILTER REGULATOR

PR- PURGE ROTAMETER

**REFERENCE DRAWINGS.**

**NOTES**

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. BULK HEAD FITTING SW TYPE SHALL BE PROVIDED AT LIE/LIR
4. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
5. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
6. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

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APPROVED

Anshul | S A Khan | Praveen Kishore

DESEIN
CONSULTING ENGINEERS
NEW DELHI - INDIA

CLIENT: TAMILNADU GEN. & DIST. CORPORATION

PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE :- INST. DRAWING FOR AIR PURGING

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| DESIGNED | SKM/SN | | 23.04.13 |
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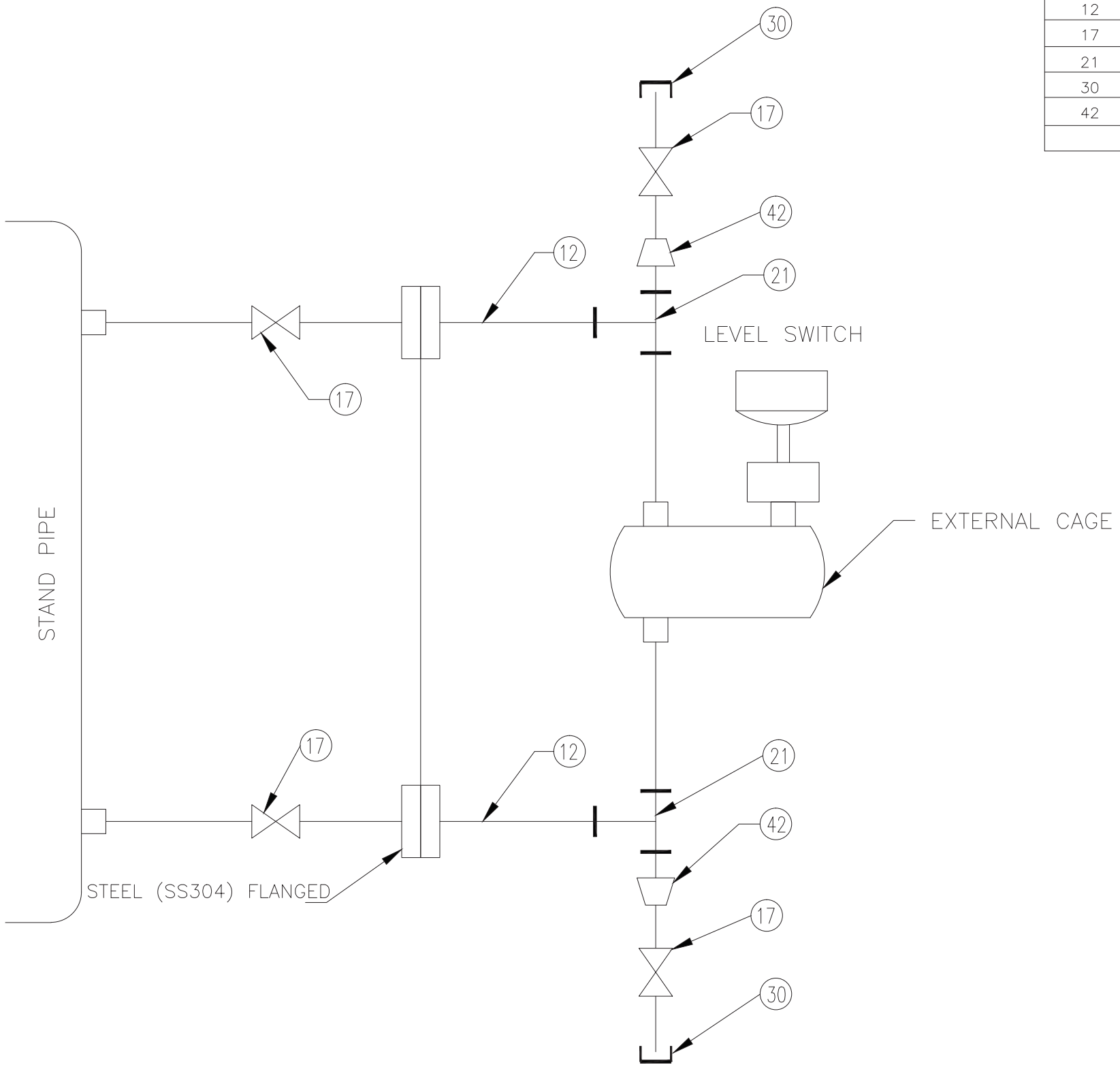
| JOB. No. | D-4027 | | |
| DWG.No. | 114-04-0112 Sheet No. 16 of 19 | | REV. 0 |

PRINT DISTRIBUTION

| | BILL OF MATERIAL | |
|---|---|---|
| TAG NO. | DESCRIPTION | QTY. |
| 12 | 3/4" NPS SCH-80 CARBON STEEL PIPE | AS REQD. |
| 17 | 1/2"/3/4"/1" SOCKET WELDED GLOBE VLV/ROOT VLV. | 4 |
| 21 | 3/4" EQUAL TEE,CS | 2 |
| 30 | 1/2" NPT (F) CS CAP | 2 |
| 42 | 3/4"BW X 1/2"OD TUBE FITTING,SS-316 | 2 |
| | | |




| REFERENCE DRAWINGS. |
|---|
| |

**NOTES**

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. FLANGED CONNECTION ARE FOR LOW PRESSURE APPLICATION IN BOP PACKAGE ONLY.
4. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

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Anshul

S A Khan

Praveen Kishore

DESEIN
CONSULTING ENGINEERS
NEW DELHI – INDIA

CLIENT: TAMILNADU GEN. & DIST. CORPORATION

PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE :- INST. DRAWING FOR LEVEL SWITCH OPTION-1 WITH FLANGED CONNECTION

FOR BID PURPOSE ONLY:

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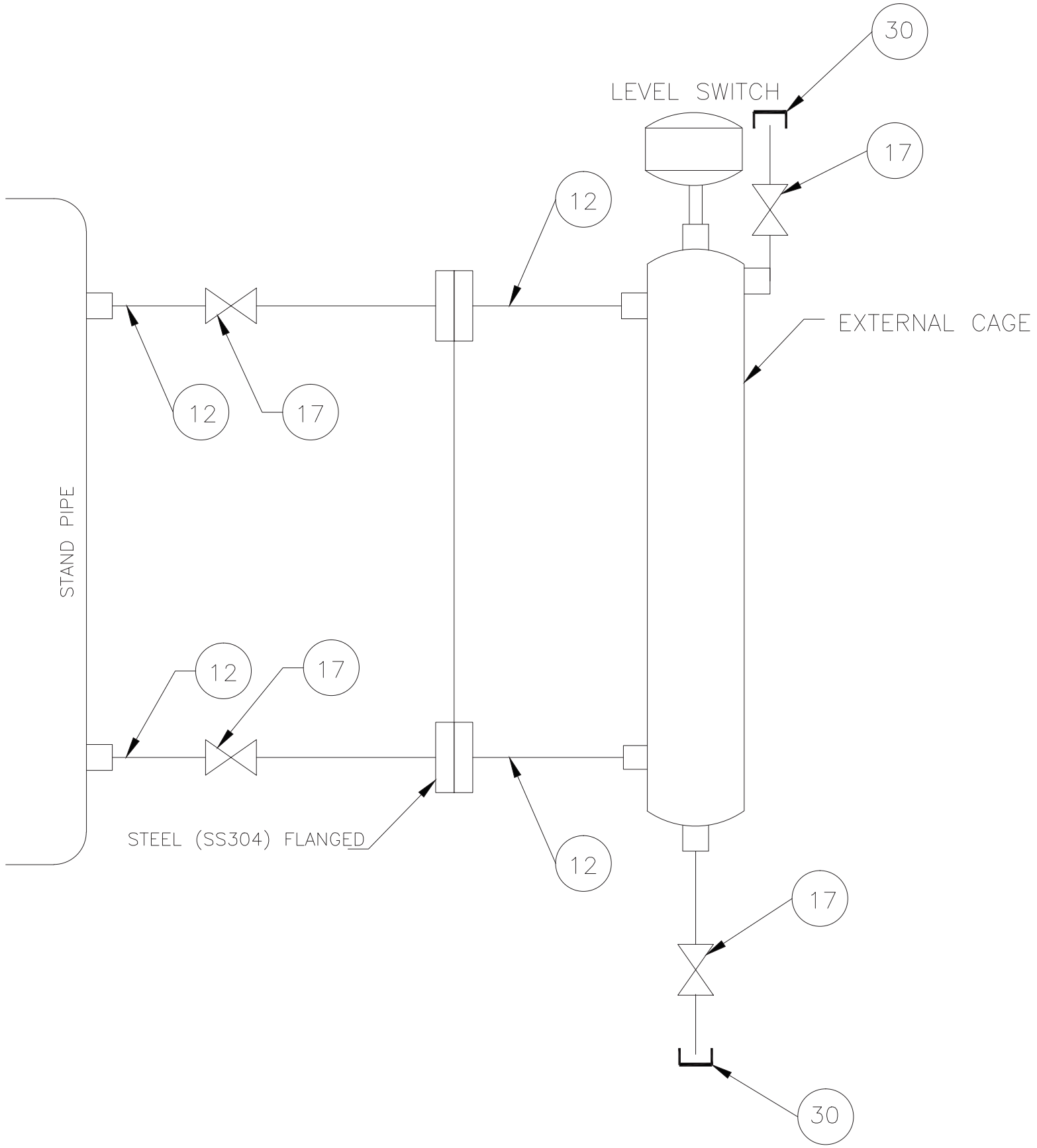
JOB. No. D-4027

DWG.No. 114-04-0113 REV. 0

Sheet No. 17 of 19




| BILL OF MATERIAL | | |
|---|---|---|
| TAG NO. | DESCRIPTION | QTY. |
| 12 | 3/4" NPS SCH-80 CARBON STEEL PIPE | AS REQD. |
| 17 | 1/2"/3/4"/1" SOCKET WELDED GLOBE VLV/ROOT VLV. | 4 |
| 21 | 3/4" EQUAL TEE,CS | 2 |
| 30 | 1/2" NPT (F) CS CAP | 2 |
| 42 | 3/4"BW X 1/2"OD TUBE FITTING,SS-316 | 2 |
| | | |

**REFERENCE DRAWINGS.**

**NOTES**

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. FLANGED CONNECTION ARE FOR LOW PRESSURE APPLICATION IN BOP PACKAGE ONLY.
4. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

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| | 6 | | | | | | | |
| | 5 | | | | | | | |
| | 4 | | | | | | | |
| | 3 | | | | | | | |
| | 2 | | | | | | | |
| | 1 | | | | | | | |
| | 0 | | | | | | | |
| | A | PRELIMINARY | 25.04.13 | | | | SLN | |

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Anshul — S A Khan — Praveen Kishore

DESEIN
CONSULTING ENGINEERS
NEW DELHI – INDIA

CLIENT: TAMILNADU GEN. & DIST. CORPORATION

PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE :- INST. DRAWING FOR LEVEL SWITCH OPTION-2 WITH FLANGED CONNECTION

FOR BID PURPOSE ONLY:

| | NAME | SIGN. | DATE |
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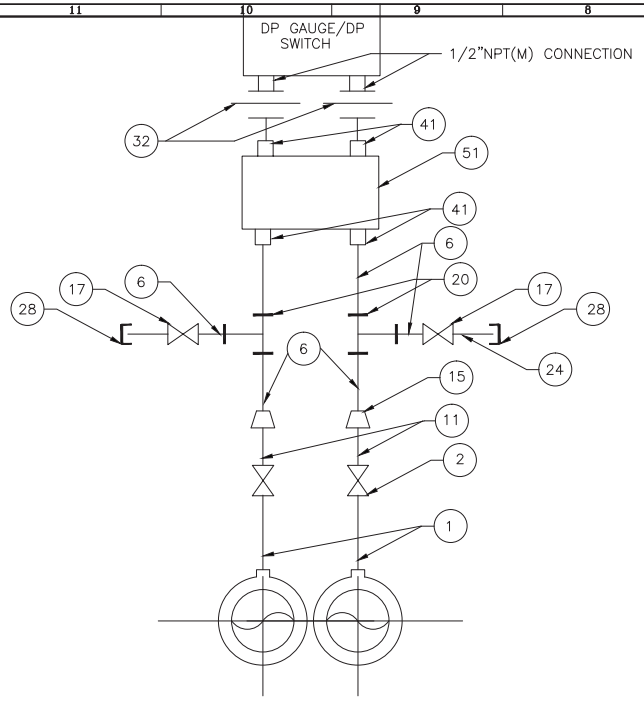
| DESIGNED | SKM/SN | | 23.04.13 |
| CHECKED | S.K.M. | | 24.04.13 |
| SCALE | N.T.S. | | |

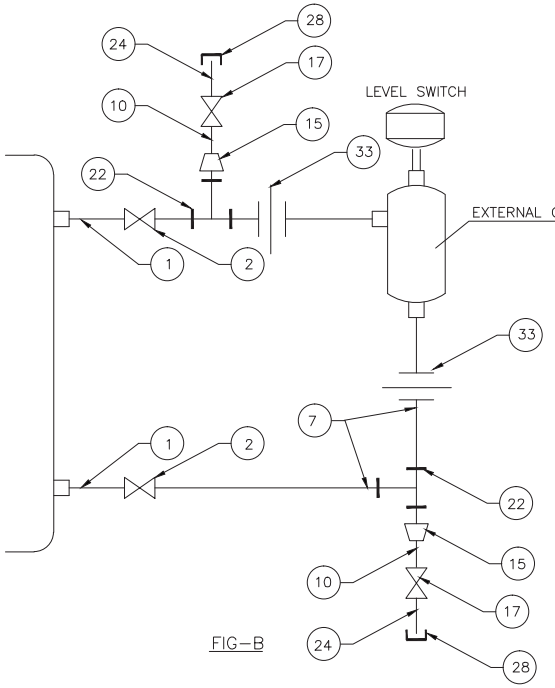
JOB. No. D-4027

DWG.No. 114-04-0113 — REV. 0

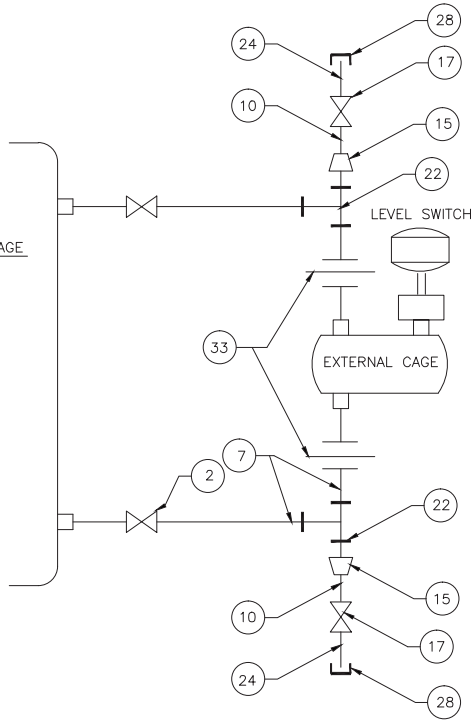
Sheet No. 18 of 19




FIG–A




FIG–B




FIG–C

| TAG NO. | DESCRIPTION | A | B | C |
|---|---|---|---|---|
| | | QTY. | | |
| 78 | 1/2" NPT(F) X 1/2" NPT(M) SNUBBER/PULSATION DAMPNER | 1 | – | – |
| 51 | 5 VALVE MANIFOLDS, SS–316 | – | – | – |
| 41 | 1/2" NPT(M) X 1/2" OD TUBE COMPRESSION FITTING,SS–316 | – | – | – |
| 38 | 3 WAY GAUGE VALVE 1/2"NB SW | 1 | – | – |
| 33 | 1" SW EQUAL PIPE UNION | – | 2 | 2 |
| 32 | 1/2" NPS,3 PIECE PIPE UNION 1/2" NPT(F) SCREWED AND 1/2" SW CONNECTION | 1 | – | – |
| 28 | 1/2" NPT(F) CS. CAP | 1 | 2 | 2 |
| 24 | 1/2" NPS,SCH 80/160 X 1/2" NPT(M) CS/AS NIPPLE | 1 | 2 | 2 |
| 22 | 1" SW EQUAL TEE CS/AS | – | 1 | 2 |
| 20 | 1/2"SW EQUAL TEE CS/AS | 1 | – | – |
| 17 | 1/2" SW,CS/AS, GLOBE VALVE | 1 | 2 | 2 |
| 15 | 1" TO 1/2" SOCKET WELD REDUCER | 1 | 2 | 2 |
| 11 | 1"NPS SCH 80/160 CS/AS NIPPLE | 1 | – | – |
| 10 | 1/2"NPS,SCH 80/160 CA/AS NIPPLE | – | 2 | 2 |
| 6 | 1/2"NPS,SCH 80/160 CARBON/ALLOY STEEL PIPE | AS REQD. | | |
| 7 | 1" NPS,SCH 80/160 CS/AS STEEL PIPE | AS REQD. | | |
| 2 | 1/2"3/4"/1" ROOT VALVE – SW GLOBE VALVE | 2 | 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. | | |

NOTE:–
WITH VALVE OF SIZE 1/2"SW NIPPLE PIECE IS NOT REQUIERED

**REFERENCE DRAWINGS.**

**NOTES**

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
4. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
5. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

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NEW DELHI – INDIA

CLIENT: TAMILNADU GEN. & DIST. CORPORATION

PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI

TITLE :– INST. DRAWING FOR DIFF. PRESS. SWITCH/GAUGE/LEVEL SWITCHES

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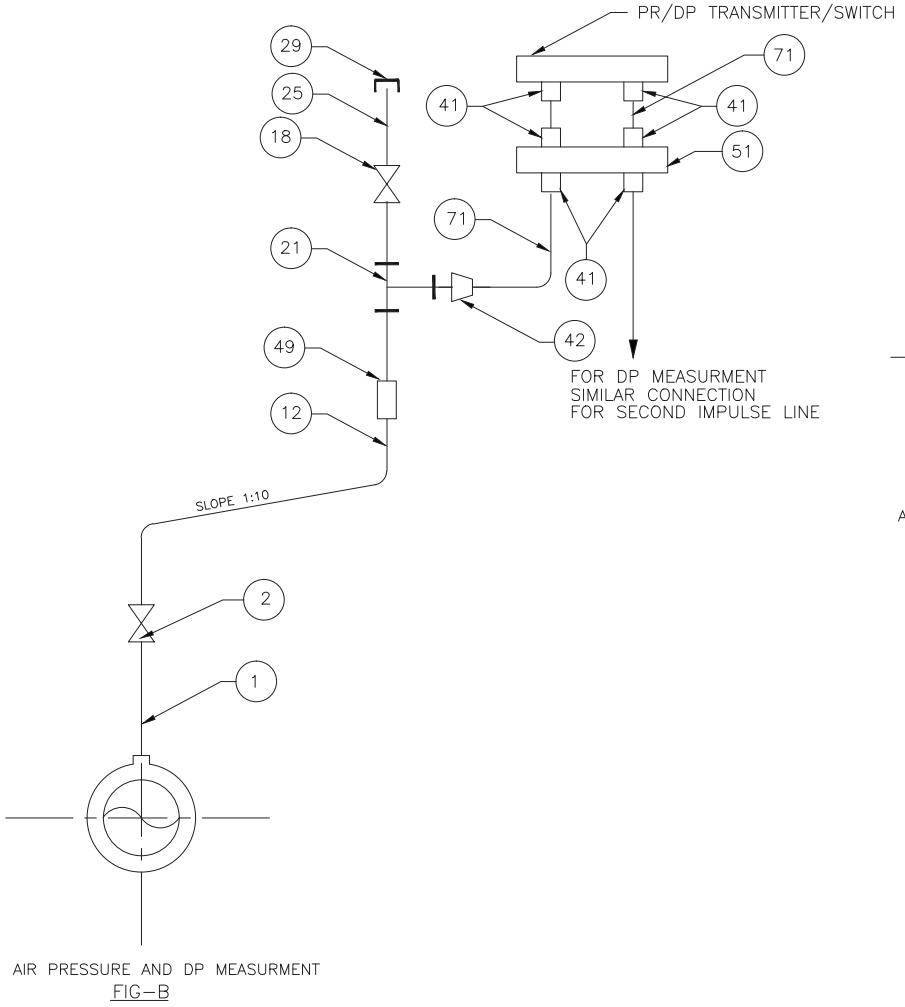
DWG.No. 114–04–0108 Sheet No. 11 of 19

REV. 0

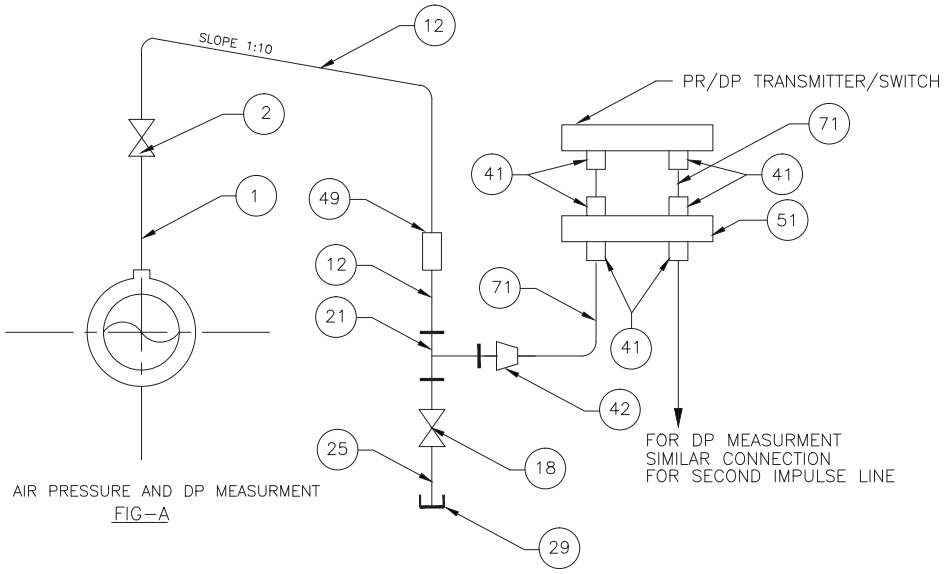
Anshul

S A Khan

Praveen Kishore




AIR PRESSURE AND DP MEASURMENT
FIG–B




AIR PRESSURE AND DP MEASURMENT
FIG–A

| TAG NO. | DESCRIPTION | QTY. A | QTY. B |
|---|---|---|---|
| 71 | 1/2"OD IMPULSE TUBE,SS–316 | AS REQD. | |
| 51 | 5/3/2–VALVE MANIFOLDS,SS–316 | 1 | 1 |
| 49 | 3/4"SW,CS/AS BULK HEAD PIPE UNION | 1 | 1 |
| 42 | 3/4"BW X 1/2"OD TUBE FITTING,SS–316 | 1 | 1 |
| 41 | 1/2"NPT(M) X 1/2"00 TUBE COMPRESSION FITTING,SS–316 | 6 | 6 |
| 29 | 3/4"NPT(F) CS CAP | 1 | 1 |
| 25 | 3/4"NPS,SCH–80 X 3/4"NPS(M)CS NIPPLE | 1 | 1 |
| 21 | 3/4" EQUAL TEE,CS | 1 | 1 |
| 18 | 3/4" SW,CS GLOBE VALVE | – | 1 |
| 12 | 3/4" NPS. SCH–80 CARBON STEEL PIPE | AS REQD. | |
| 2 | 1/2"/3/4"/1" ROOT VALVE – SW GLOBE VALVE | 1 | 1 |
| 1 | 1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.) | AS REQD. | |

BILL OF MATERIAL

NOTE:–

QUANTITY IN COLUMN A&B TO BE DOUBLED
FOR DP TAPPING EXCEPT ITEM NO. 51

**REFERENCE DRAWINGS.**

**NOTES**

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2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
4. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
5. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

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NEW DELHI – INDIA

CLIENT: TAMILNADU GEN. & DIST. CORPORATION

PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE :– INST. DRAWING FOR PRESS. & DIFF. PRESS. TRANSMITTERS/SWITCH (AIR SERVICE)

FOR BID PURPOSE ONLY:

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DWG.No. 114–04–0103 REV. 0

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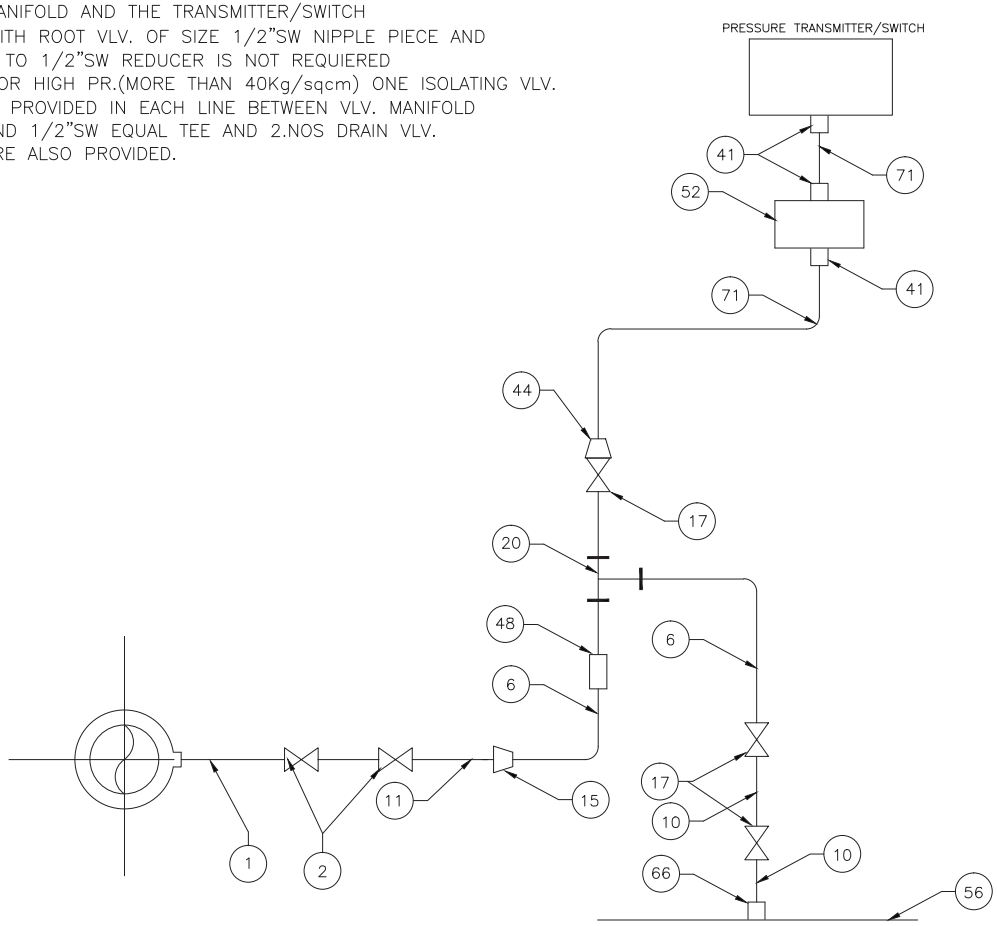
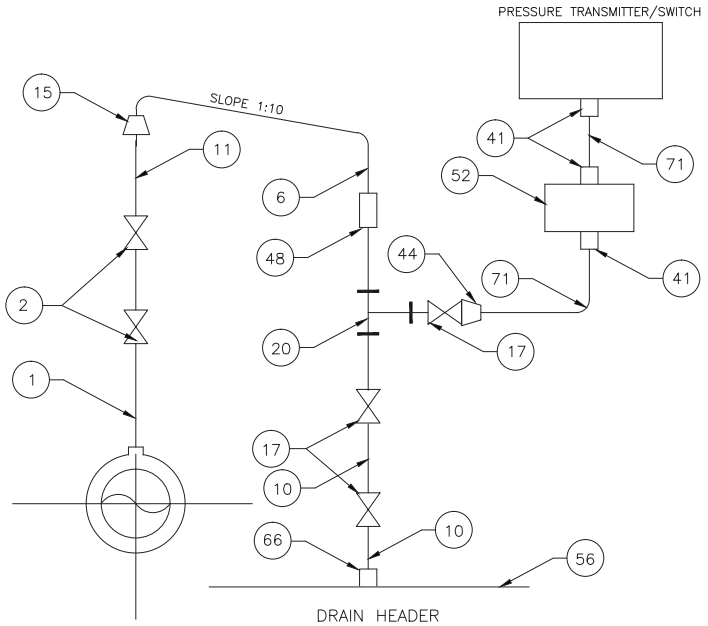
NOTE:–

1. FOR HIGH TEMP. SERVICE (MORE THAN °80C) 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 REQUIERED
3. FOR HIGH PR.(MORE THAN 40Kg/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.




TRANSMITTER MOUNTED ABOVE INSTRUMENT SOURCE POINT

FIG–D




TRANSMITTER MOUNTED ABOVE INSTRUMENT SOURCE POINT

FIG–C

| TAG NO. | DESCRIPTION | C | D |
|---|---|---|---|
| | | QTY. | |
| 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 COMRESSION TUBE FITTING,SS–316 | 1 | 1 |
| 41 | 1/2"NPT(M) X 1/2"00 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. | |

BILL OF MATERIAL

**REFERENCE DRAWINGS.**

**NOTES**

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. BULK HEAD FITTING SW TYPE SHALL BE PROVIDED AT LIE/LIR
4. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
5. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
6. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

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TITLE :– INST. DRAWING FOR PRESS. & DIFF.PRESS. TRANSMITTERS/SWITCH (STEAM & LIQUID SERVICE)

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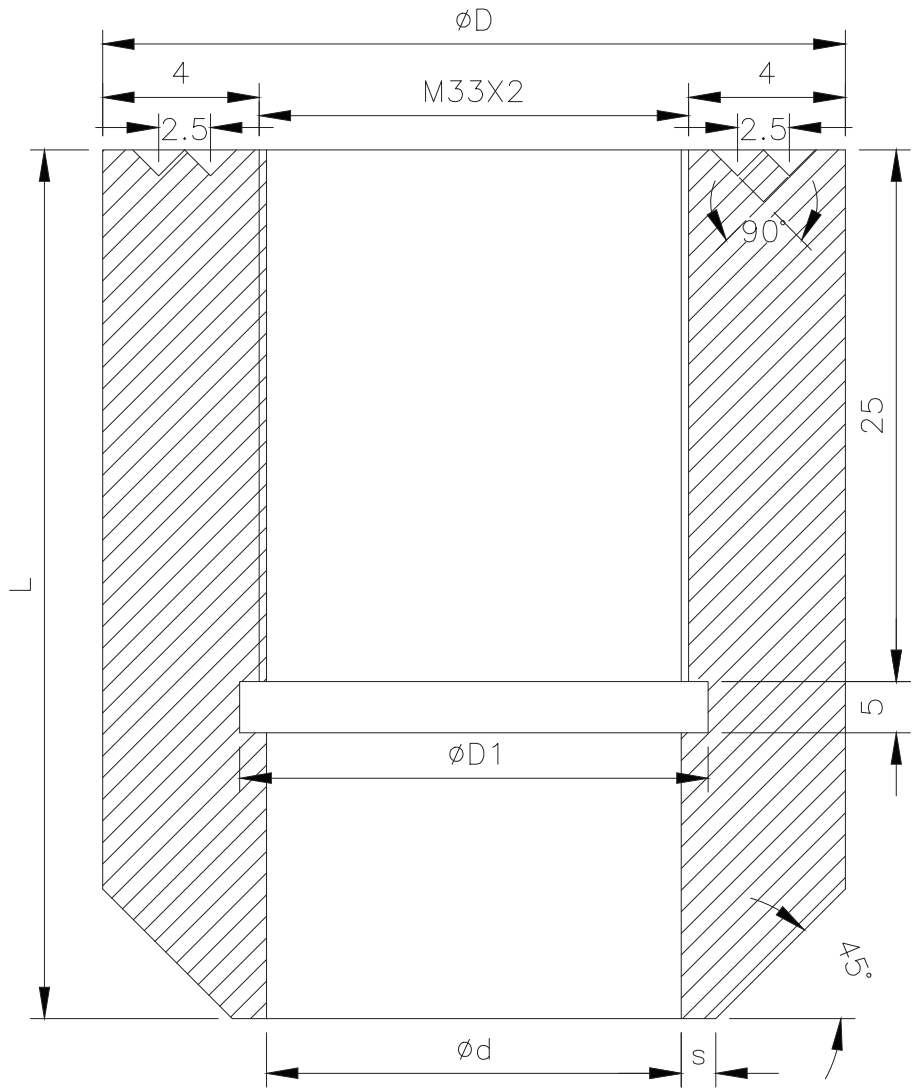
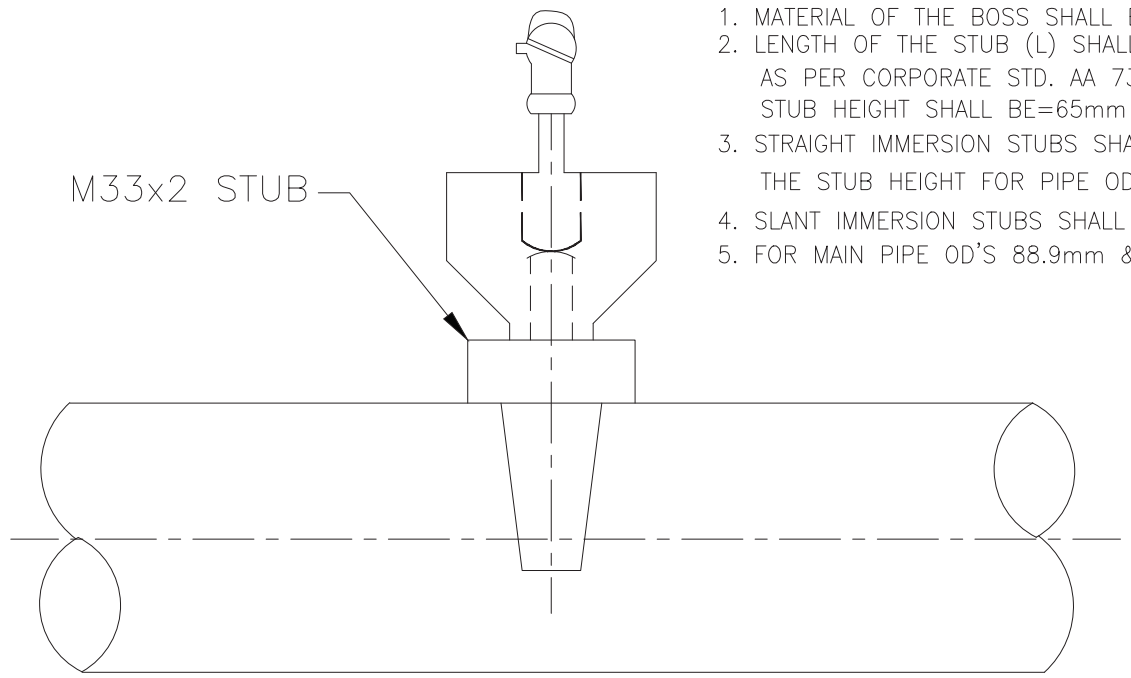


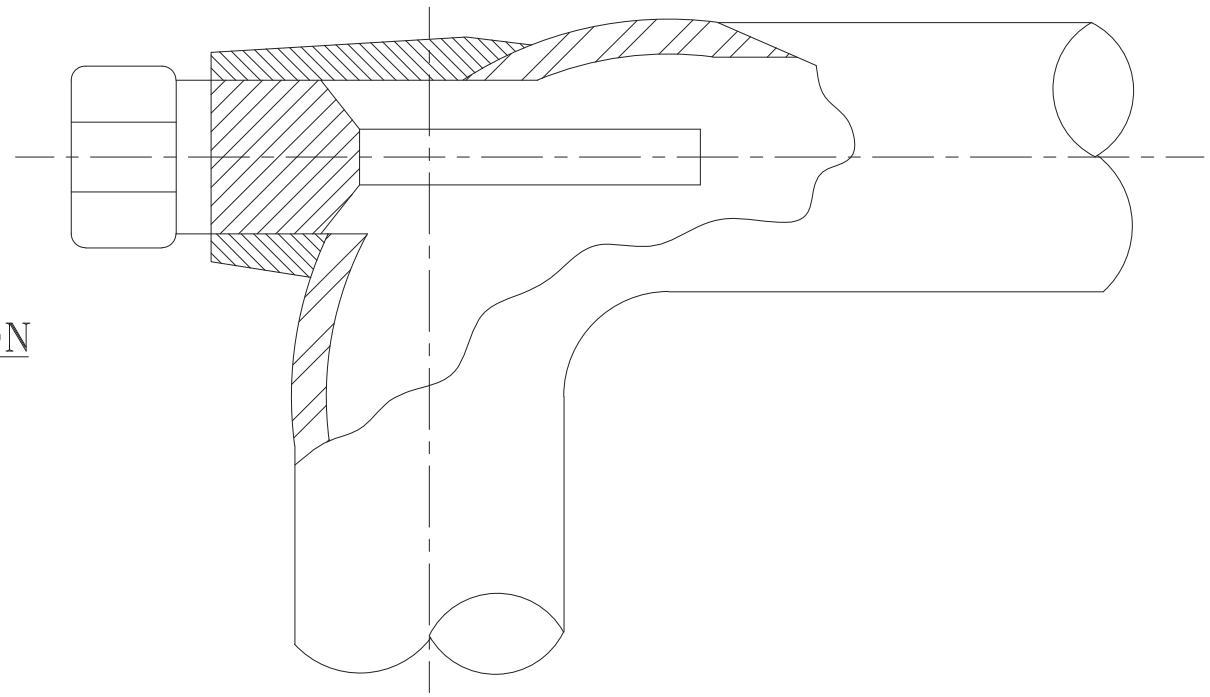

## TEMPERATURE STUB FOR STRAIGHT IMMERSION

| | | | | | |
|---|---|---|---|---|---|
| FOR PIPE OD BELOW 219.1mm | 29 | 55 | 33.5 | 1.5 | 65 |
| FOR PIPE OD 219.1mm & ABOVE | 29 | 55 | 33.5 | 1.5 | 45 |
| MAIN PIPE SIZES | d | D | D1 | S | L |




## INSTALLATION TYPE-1

(FOR MAIN PIPE OD 168.3mm & ABOVE)



## INSTALLATION TYPE-2

(FOR MAIN PIPE OD 88.9mm & BELOW)

NOTE :-

1. MATERIAL OF THE BOSS SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED.
2. LENGTH OF THE STUB (L) SHALL BE 65/45 mm DEPENDING UPON PIPE SIZE, AS PER CORPORATE STD. AA 7326102.(FOR PIPE OD 88.9mm TO 159mm STUB HEIGHT SHALL BE=65mm & FOR PIPE OD >219.1mm STUB HEIGHT SHALL BE=45mm)
3. STRAIGHT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 168.3mm & ABOVE. THE STUB HEIGHT FOR PIPE OD, 168.3mm TO <219.1mm SHALL BE 65mm.
4. SLANT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 88.9mm TO 159mm.
5. FOR MAIN PIPE OD'S 88.9mm & bELOW SUITABLE EXPANDER SHALL BE USED.

REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. BULK HEAD FITTING SW TYPE SHALL BE PROVIDED AT LIE/LIR
4. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
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6. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

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TITLE :- INST. DRAWING FOR TEMPERATURE STUB

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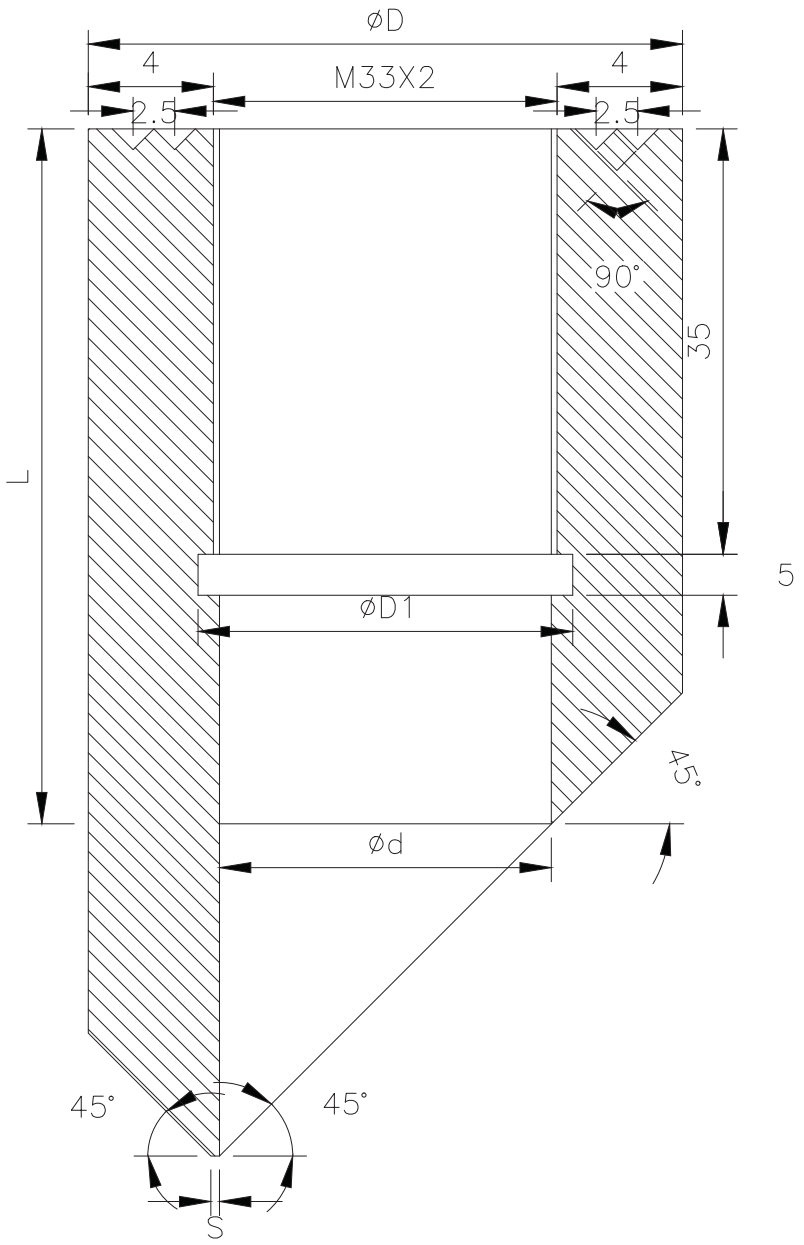
Sheet No. 14 of 19

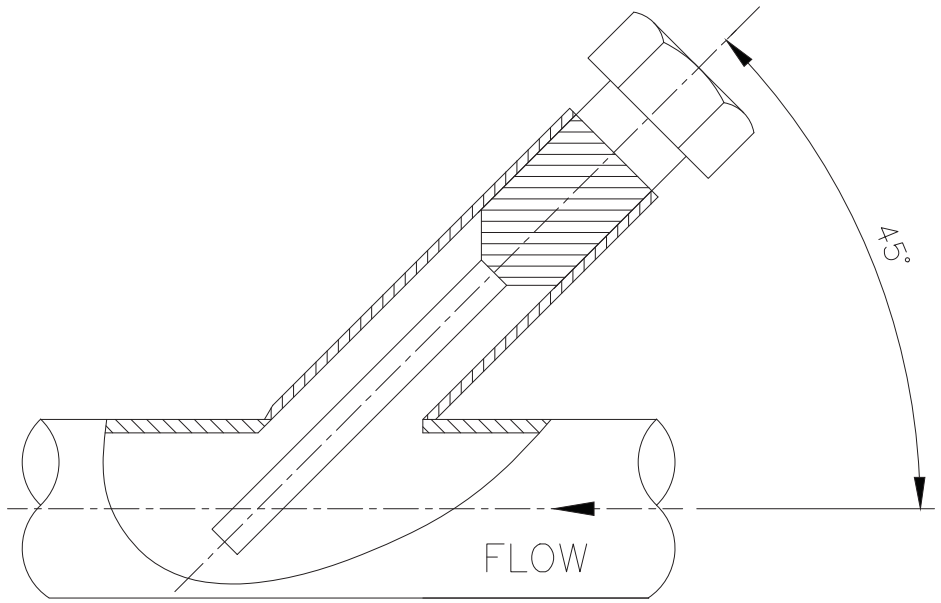



## TEMPERATURE STUB FOR SLANT IMMERSION

| | | | | | |
|---|---|---|---|---|---|
| FOR PIPE OD BELOW 219.1mm | 29 | 55 | 33.5 | 1.5 | 65 |
| FOR PIPE OD 219.1mm & ABOVE | 29 | 55 | 33.5 | 1.5 | 45 |
| MAIN PIPE SIZES | d | D | D1 | S | L |

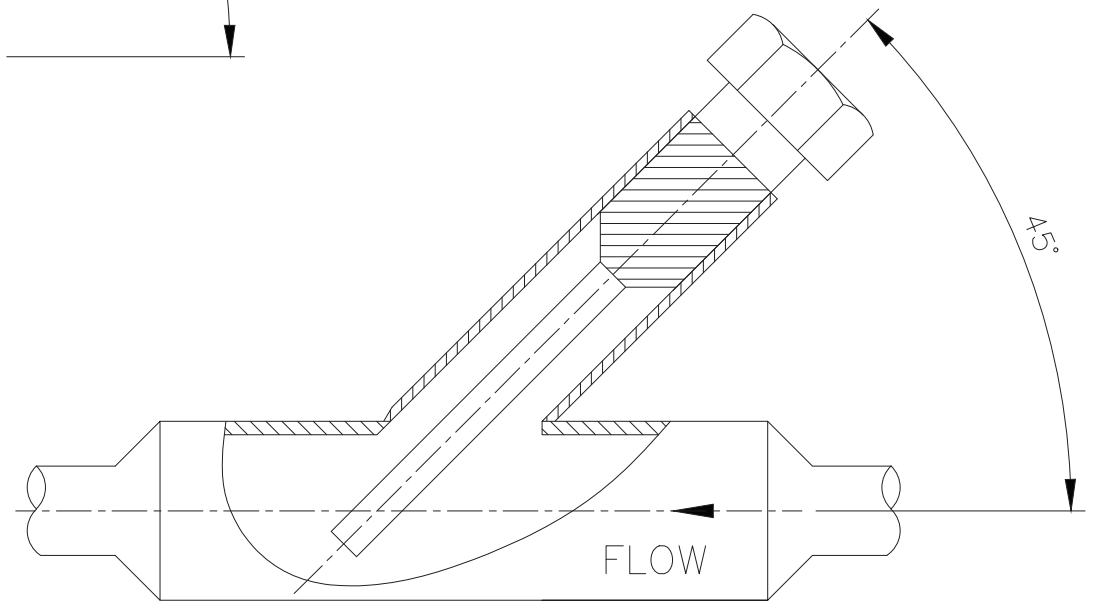
NOTE :–

1. MATERIAL OF THE BOSS SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED.
2. LENGTH OF THE STUB (L) SHALL BE 65/45 mm DEPENDING UPON PIPE SIZE, AS PER CORPORATE STD. AA 7326102.(FOR PIPE OD 88.9mm TO 159mm STUB HEIGHT SHALL BE=65mm & FOR PIPE OD >219.1mm STUB HEIGHT SHALL BE=45mm)
3. STRAIGHT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 168.3mm & ABOVE. THE STUB HEIGHT FOR PIPE OD, 168.3mm TO <219.1mm SHALL BE 65mm.
4. SLANT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 88.9mm TO 159mm.
5. FOR MAIN PIPE OD'S 88.9mm & bELOW SUITABLE EXPANDER SHALL BE USED.




## INSTALLATION TYPE–3

(FOR MAIN PIPE OD 88.9mm TO 159mm)




## INSTALLATION TYPE–4

(FOR MAIN PIPE OD 88.9mm & BELOW)

REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
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3. BULK HEAD FITTING SW TYPE SHALL BE PROVIDED AT LIE/LIR
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PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE :– INST. DRAWING FOR TEMPERATURE STUB

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