# THDC INDIA LIMITED

## KHURJA STPP (2 X 660 MW)
## TURBINE GENERATOR AND ASSOCIATED PACKAGES

**CONSULTANT**
**NTPC LIMITED**

# ***TECHNICAL SPECIFICATION***
# ***FOR***
# ***VENTILATION SYSTEM***

**SPECIFICATION NO.: - PE-TS-475-554-A001 (REV0)**


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

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**This Technical specification consists of two sections:**

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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 (i.e. Preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles (as applicable) fill of lubricants & consumables till handing over, mandatory spares along with spares for erection, start-up and commissioning as required, forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation & storage at site, in-site transportation, assembly, erection & commissioning, final painting at site, minor civil work, trial run at site and carrying out Performance guarantee / Functional / Demonstration tests at site (As applicable), training of customer/client O&M staff (as applicable) and handover in flawless condition of the package to BHEL'S customer complete with all accessories of **VENTILATION SYSTEM** as per details in different sections / volumes of this specification and various pre award agreements for **2X660 MW KHURJA STPP TURBINE GENERATOR AND ASSOCIATED PACKAGES** at village Dushahara, tehsil Khurja, distt. Bulandshehar, Uttar Pradesh.

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

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

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

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

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 section II 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 section II); otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification.

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 of GCC

# SECTION: I

# SUB-SECTION: B

# PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA

# SUB–SECTION – A-0

# PROJECT INFORMATION

## KHURJA STPP (2X660 MW)

**1.00.00 BACKGROUND**

THDC India Limited (Formerly Tehri Hydro Development Corporation), is a joint venture of Govt. of India & Govt. of Uttar Pradesh. THDC India Limited has been entrusted to execute a Thermal Power Project in Khurja at district Bulandshahar, Uttar Pradesh (UP) along with various other hydro projects.

THDC has placed a Consultancy order to NTPC Ltd for Pre-award to Commissioning activities (consultancy) of Khurja Coal based power project (2x660 MW).

The present proposal is to establish 2X660 MW coal based Khurja Super Thermal Power Project for the benefit of Uttar Pradesh, Rajasthan, Uttarakhand, Himachal Pradesh & Delhi.

**2.00.00 CAPACITY**

PRESENT PROPOSAL: 2 x 660 MW

**3.00.00 MODE OF OPERATION**

Base Load

**4.00.00 LOCATION AND APPROACH**

Khurja Super Thermal Power Project is located in Bulandshahar district of Uttar Pradesh, between 28°08’35” to 28°10’25” Northern latitude and 77°53’47” to 77°55’22” Eastern longitude. The site is situated near villages Dushhara-kherli, Jahanpur, Naiphal (Unchagaon) and Rukunpur. The district Headquarters Buland Shahar is about 32 kms. The nearest railway station Danwar on Delhi-Kolkata Section (via Aligarh) is approximately 5 km away from the project site. The nearest major railway station is Khurja at a distance of about 11 kms.

Vicinity Plan of the proposed project is placed at **Annexure-I**.

**Distance of the project site from nearest cities**

| | |
|---|---|
| Khurja | 11 kms |
| Aligarh | 36 kms |
| Delhi | 90 kms |
| Bulandshaher | 32 kms |

For further information, bidders are also advised to visit the project site and collect data regarding local site conditions.

4.03.00 **AIRPORT**

The nearest commercial airport at Delhi is located at a distance of approximately 120 kms from the project site.

**5.00.00 LAND**

The land requirement for the project has been estimated as 1400 Acres for Main Plant, Balance of Plant including Coal Handling Plant, Ash Disposal Area, Ash Disposal Pipeline Corridors, Construction Stores & Offices, Laydown & Fabrication Yard, and Labor Colony etc. Land has already been acquired through UPSIDC. Additional patches of required land shall be acquired.

**6.00.00 WATER**

The Upper Ganga Canal passes near by the Khurja STPP. The makeup water for the project is proposed to be drawn from Upper Ganga Canal at a distance of about 13 kms.

Quantity of make-up water required for 2X660MW would be about 3265 Cum/hr with ash water recirculation system and 4415 Cum/hr with once through ash water system. Make-up water is proposed to be used for condenser cooling, ash sluicing, coal dust suppression and other plant processes. Make up water shall be drawn from the canal by constructing suitable intake structures. A Raw Water Reservoir is envisaged.

Govt. of UP has conveyed commitment for supply of required quantity of water for the project.

**7.00.00 COAL**

7.01.00 **Coal Requirement, Availability and Linkage**

The daily coal requirement for 2x660 MW units shall be about 15261 tonnes based on Gross Calorific Value of 4200 Kcal/kg and 2248 Kcal/KWh unit heat rate, considering 90% plant load factor.

Annual coal requirement for the plant shall be about 5.57 MTPA considering PLF of 90% and the same is proposed to be met from Amelia Coal Mine in District Singrauli, Madhya Pradesh, allotted to THDCIL by Ministry of Coal, Govt. of India. THDCIL has entered into an agreement with Nominated Authority, Ministry of Coal for the development of Amelia Coal Mine in Synchronization with the implementation of Khurja STPP. The distance between Khurja STPP plant site and Allotted Amelia Mine at Singrauli, Madhya Pradesh is around 900 Kms.

7.02.00 **Coal Transportation**

The envisaged mode of coal transportation from the coal mine to the power plant is through Indian Railways**.**

7.03.00 **Coal Quality**

The primary fuel for the main steam generator shall be coal. The coal quality parameters indicated in **Annexure-II** are to be considered for steam generator design.

**8.00.00 Fuel Oil**

The fuel oils to be used for start-up, coal flame stabilization and low load operation of the steam generator shall be Light Diesel Oils having the characteristics & and High Speed Diesel Oil having the characteristics given at **Annexure-III & Annexure-IV** respectively.

**9.00.00 STEAM GENERATOR TECHNOLOGY**

The steam generators shall be based on super critical technology, once through type, water tube, direct pulverized coal fired, top supported, balanced draft furnace, single reheat, radiant, dry bottom type, suitable for outdoor installation. The gas path arrangement shall be single pass (Tower type) or two pass type.

**10.00.00 FLUE GAS DESULPHURIZATION SYSTEM (FGD) & SCR:**

The project is envisaged with Flue Gas Desulfurization (FGD) system and Selective Catalytic Reduction (SCR) in compliance to the notification dated 07.12.2015 by Ministry of Environment, Forest & Climate Change. The Tentative Limestone characteristic to be used for design of FGD system shall be as per the characteristic given at **Annexure-V.**

**11.00.0** **POWER EVACUATION SYSTEM**

Power Generated from each 660 MW unit would be stepped up to the evacuation voltage level through suitably rated Generator Transformer and will be evacuated through 400kV transmission systems. Associated Transmission System (ATS) of the project has already taken-up with PGCIL/CEA/UPPTCL and will be finalized soon.

**12.00.00** **METEOROLOGICAL DATA**

The meteorological data from nearest observatory (Aligarh) is placed at **Annexure - VI.**

**13.00.00** **PLANT WATER SCHEME**

The Plant water scheme is described below.

13.01.00 **Condenser Cooling (CW) Water System**

It is proposed to adopt a recirculating type cooling water system with cooling towers for the project. For the re-circulating type CW system it is proposed to supply clarified water as make up. Circulating water from CW pumps to TG area and from TG area to cooling tower will be carried through pipes/ducts. Cooled water from cooling tower will be led to CW pump house through the cold water channel by gravity.

13.02.00 **Equipment Cooling Water (ECW) System (Unit Auxiliaries)**

The plant auxiliaries of Steam Generator and Turbine Generator shall be cooled by Demineralized (DM) water in a closed circuit. The primary circuit DM water shall be cooled through plate type heat exchangers by Circulating Water tapped from CW system in a secondary circuit. The station auxiliaries such as Air compressors, Compressors of ash handling plant, compressor of mill reject system, FGD & SCR system etc. shall also be cooled by Demineralized (DM) water in a closed circuit. The hot secondary circuit cooling water shall be cooled in the cooling towers and shall be returned back to the system. It is proposed to provide independent primary cooling water circuit for Steam Generator & auxiliaries and TG & its auxiliaries.

13.03.00 **Other Miscellaneous Water Systems**

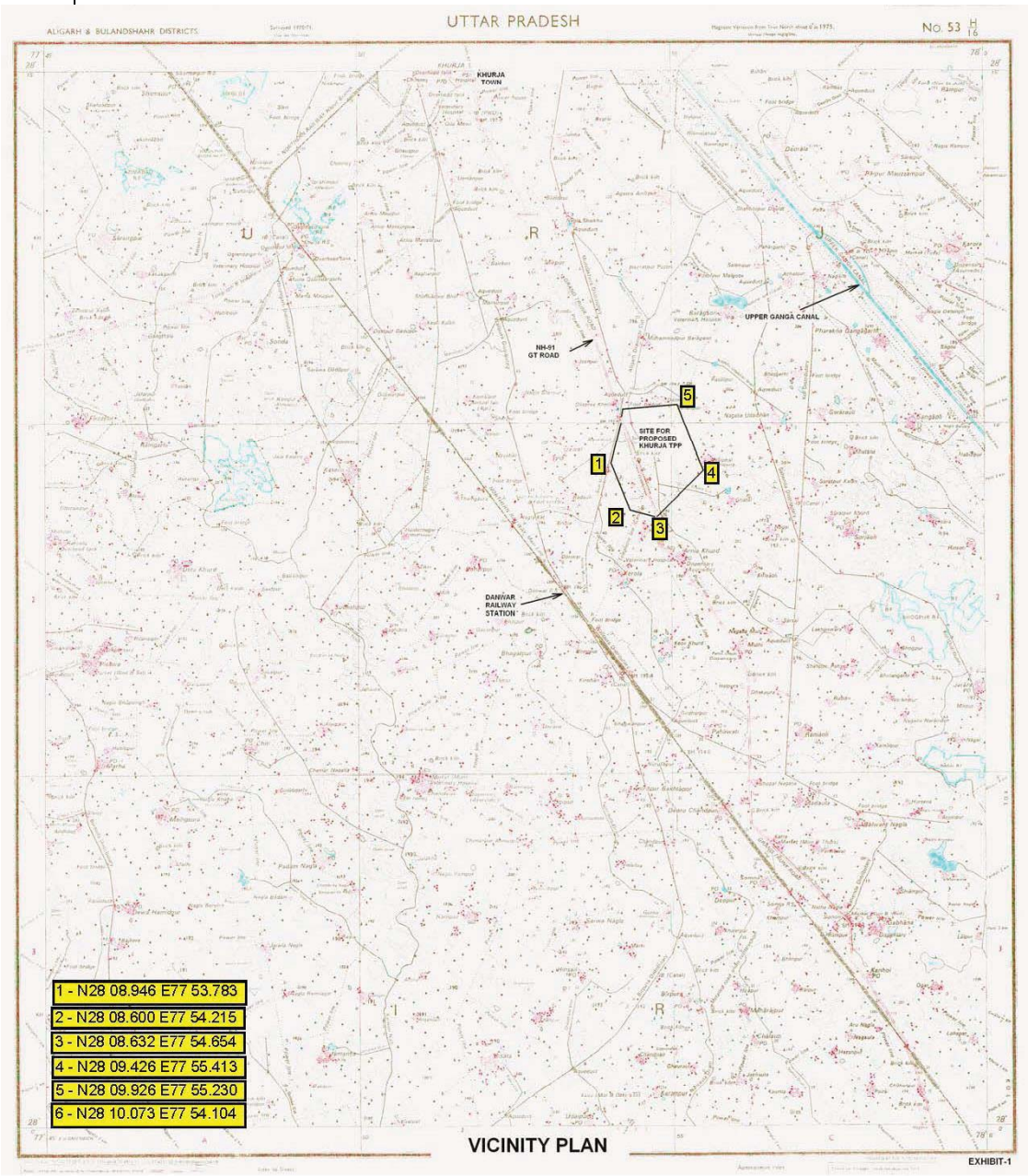
CW system blow down water shall be used for the plant service water requirement, dust suppression system of coal handling plant, ash slurry pumps sealing, sealing of Vacuum pumps (if applicable) of Ash Handling plant, FGD system, make-up to fire water system. The service (wash water) water collected from various areas and coal handling plant shall be treated as per requirement and reused.

FGD waste water shall be diverted to ash system after neutralization.

The quality of clarified water & DM water is given in this sub-section at **Annexure-VII-1 & VII-2.**

ANNEXURE-I

## VICINITY PLAN



ANNEXURE-II

## COAL & ASH CHARACTERISTICS

### PROPOSED COAL CHARACTERISTICS FOR KHURJA (2X660 MW)

| S.No. | Characteristics (as received basis) | Range of 95 % coal supplies Column - 1 Design | Column - 2 Worst | Column - 3 Best | Range of 5 % coal supplies | |
|---|---|---|---|---|---|---|
| 1.0 | PROXIMATE ANALYSIS | | | | | |
| 1.1 | Total Moisture (%) | 12 | 14 | 11.0 | 11-15 | |
| 1.2 | Ash (%) | 32 | 35 | 28 | 28-36 | |
| 1.3 | Volatile Matter (%) | 24 | 23 | 25 | 22-26 | |
| 1.4 | Fixed Carbon (%) | 32 | 28 | 36.0 | 28-36 | |
| 1.5 | Total (%) | 100 | 100 | 100 | | |
| 2.0 | ULTIMATE ANALYSIS | | | | | |
| 2.1 | Carbon (%) | 42.9 | 37.81 | 48.01 | 35.21-45.4 | |
| 2.2 | Hydrogen (%) | 3.2 | 2.8 | 3.3 | 2.9-4.2 | |
| 2.3 | Sulphur (%) | 0.4 | 0.6 | 0.3 | 0.52 | |
| 2.4 | Nitrogen(%) | 1 | 0.58 | 1.2 | 6.86 | |
| 2.5 | Oxygen(%)(By difference) | 8.17 | 8.77 | 7.7 | 0.28 | |
| 2.6 | Carbonates (%) | 0.27 | 0.38 | 0.45 | 0.3 | |
| 2.7 | Phosphorous(%) | 0.06 | 0.06 | 0.04 | 0.04 | |
| 2.8 | Total Moisture (%) | 12 | 14 | 11.0 | 22 | |
| 2.9 | Ash (%) | 32 | 35 | 28 | 39 | |
| | Total | 100 | 100 | 100 | | |
| 2.10 | GCV (Kcal/Kg) | 4200 | 3650 | 4700 | 3600-4800 | |
| 2.11 | Hard Grove Index | 60 | 52 | 65 | 50-65 | |
| 2.12 | YGP (mg/kg) | 70 | 75 | 70 | 85-70 | |
| 3.0 | ASH ANALYSIS | | | | | |
| 3.1 | Silica (%) | 58.2 | 59.54 | 58.00 | 58.1-63 | |
| 3.2 | Alumina(%) | 28 | 26.3 | 27.20 | 22.2-26.1 | |
| 3.3 | Iron Oxide (%) | 6.1 | 6.4 | 7.60 | 8.3-11.5 | |
| 3.4 | Titania | 1.85 | 1.72 | 1.80 | 0.82-1.2 | |
| 3.5 | Phosphoric Anhydride (%) | 1.91 | 1.57 | 0.48 | 0.48-191 | |
| 3.6 | Lime (%) | 1.7 | 3.2 | 3.30 | 1.78-3.5 | |
| 3.7 | Magnesia (%) | 0.7 | 0.6 | 0.50 | 0.5-0.9 | |
| 3.8 | Sulphuric Anhydride (%) | 0.29 | 0.25 | 0.40 | 0.12-0.43 | |
| 3.9 | Sodium Oxide (%) | 0.3 | 0.1 | 0.30 | 0.1-0.32 | |
| 3.10 | Potassium oxide | 0.95 | 0.32 | 0.42 | 0.1-0.43 | |
| | Total | 100 | 100.00 | 100.00 | | |
| 4.0 | ASH FUSION RANGE | | | | | |
| | REDUCING ATMOSPHERE | | | | | |
| 4.1 | Initial Deformation Temp.(oC) | 1200 | 1100 | 1150 | 1100 | 1200 |
| 4.2 | Hemispherical Temp. (oC) | 1400 | 1300 | 1350 | 1200 | 1400 |
| 4.3 | Fusion Temperature (cC) | 1400 | 1400 | 1350 | 1400 | 1450 |

**ANNEXURE-III**

## LIGHT DIESEL OIL CHARACTERISTICS

AS PER IS 15770-2008

| Characteristics | | LDO |
|---|---|---|
| 1. | Pour Point (max) | 21 °C & 12°C for Summer and Winter respectively |
| 2. | Kinematic viscosity in centistokes at 40 deg.C | 2.5 to 15.0 |
| 3. | Sediment percent by mass (max) | 0.10 |
| 4. | Total sulphur percent by mass (max) | 1.5 |
| 5. | Ash percentage by mass (max) | 0.02 |
| 6. | Carbon residue (Rams bottom) percent by pass (max.) | 1.50 |
| 7. | Acidity inorganic | Nil |
| 8. | Flash point (Min.) - Pensky Martens | 66 deg.C |
| 9. | Copper strip corrosion for 3 hours at 100°C | Not worse than No. 2 |
| 10. | Water content, % by volume (max) | 0.25 |
| 11. | GCV(kcal/kg) | 10,000 |

ANNEXURE-IV

**HIGH SPEED DIESEL OIL CHARACTERISTICS**

[AS PER IS **1460-2005 (BS-II)**]

| S. No. | Particulars | Unit | Value |
|---|---|---|---|
| 1. | PHYSICAL PROPERTIES | | |
| | a. Distillation volume recovery @ $350^0$C | % vol. (min) | 85 |
| | b. Distillation volume recovery @ $370^0$C | % vol. (min) | 95 |
| | c. Kinematic Viscosity @ 40 Degree C | cSt | 2.0 – 5.0 |
| | d. Density @ 15 Degree C | $kg/m^3$ | 820 – 860 |
| | e. Pour Point | | |
| | - Summer | Degree C (max) | 15 |
| | - Winter | Degree C (max) | 03 |
| | f. Cold Filter Plugging Point | | |
| | - Summer | Degree C (max) | 18 |
| | - Winter | Degree C (max) | 06 |
| | g. Flash Point (Abal) | Degree C (max) | 35 |
| | h. Lubricity WSD 1.4 @ 60 Degree C | Microns (max) | 460 |
| 2. | HEATING VALUE | | |
| | a. Higher Heating Value (HHV) | Kcal/Kg | 11,000 |
| | b. Lower Heating Value (LHV) | Kcal/Kg | 10,300 |
| 3. | ACIDITY | | |
| | a. Inorganic | mg KOH/g | Nil |
| | b. Total | mg KOH/g | 0.2 (max.) |
| 4. | Copper Strip Corrosion 3 hours @$100^0$C | No. | 1 (max) |
| 5. | RCR on 10% residue | % wt. | 0.3 (max) |
| 6. | CONTAMINANTS | | |
| | a. Ash | ppm (wt.) | 100 (max) |
| | b. Sediments | % wt | 0.05 (max) |
| | c. Total Sulphur | % wt | 0.05 (max) |
| | d. Water Content | % volume | 0.05 (max) |
| | e. Trace Metals | | |
| | - Na + K | ppm (wt) | 0.30 (max) |
| | - Vanadium | ppm (wt) | 0.50 (max) |
| | - Lead | ppm (wt) | 0.50 (max) |
| | - Calcium | ppm (wt) | 2.0 |
| | - Ni + Zn | ppm (wt) | Nil |
| 7. | Nitrogen content (FBN) | % wt. | 0.015 |

**ANNEXURE-V**

**LIMESTONE CHARACTERISTICS**

| **Chemical Analysis(% by mass)** | | | |
|---|---|---|---|
| 1. | CaO | % | 47-51.0* |
| 2. | MgO | % | 0.9-3.8 |
| 3. | $Fe_2O_3$ | % | 0.45-1.0 |
| 4. | $Al_2O_3$ | % | 1.19-2.1 |
| 5. | $Si_2O_3$ | % | 2.1-4.5 |
| 6. | $Mn_2O_3$ | % | <0.12 |
| 7. | $P_2O_5$, | % | Traces |
| 8. | $Cl_2$ | % | <0.015 |
| 9. | $Na_2O$ | % | <0.16 |
| 10. | $K_2O$ | % | <0.01 |
| 11. | $TiO_2$ | % | <0.02 |
| 12. | Total Sulphur | % | <0.1 |
| 13. | LOI | % | 39.0-41.3 |
| **Physical properties** | | | |
| 1 | Bond Index | kWh/t | 13 |
| 2 | Granule size | | Medium |

## METEOROLOGICAL DATA

ANNEXURE-VI

BACK

### जलवायवी सारणी
### CLIMATOLOGICAL TABLE

स्टेशन : अलीगढ़ STATION : Aligarh

अक्षांश LAT. 27°53' देशांतर LONG. 78°04' समुद्री तल माध्य से ऊंचाई HEIGHT ABOVE M.S.L. 187 मीटर METRES

प्रेक्षणों पर आधारित BASED ON OBSERVATIONS 1971-2000

| माह / MONTH | | स्टेशन का सतह दाब / STATION LEVEL PRESSURE एच.पी.ए. hPa | वायु तापमान / AIR TEMPERATURE — माध्य / MEAN: शुष्क बल्ब / DRY BULB डि. से °C | नम बल्ब / WET BULB डि. से °C | दैनिक अधिक तम / DAILY MAX. डि. से °C | दैनिक न्यून तम / DAILY MIN डि. से °C | माह में उच्चतम / HIGHEST IN THE MONTH डि. से °C | माह में निम्नतम / LOWEST IN THE MONTH डि. से °C | चरम / EXTREMES: उच्चतम / HIGHEST डि. से °C | दिनांक और वर्ष / DATE AND YEAR | निम्नतम / LOWEST डि. से °C | दिनांक और वर्ष / DATE AND YEAR | आर्द्रता / HUMIDITY: सापेक्ष आर्द्रता / RELATIVE HUMIDITY प्रतिशत % | वाष्प दाब / VAPOUR PRESSURE एच.पी.ए. hPa | मेघ की मात्रा / CLOUD AMOUNTS (आकाश के अष्टमांश / Oktas of sky): समस्त मेघ / ALL CLOUDS | निम्न मेघ / LOW CLOUDS | वर्षा / RAINFALL: मासिक योग / MONTHLY TOTAL मि.मि. mm | वर्षा के दिनों की संख्या / NO. OF RAINY DAYS | वर्षसहित सबसे नम महीने का योग / TOTAL IN WETTEST MONTH WITH YEAR मि.मि. mm | वर्षसहित शुष्कतम महीने का योग / TOTAL IN DRIEST MONTH WITH YEAR मि.मि. mm | 24 घंटों की सबसे भारी वर्षा / HEAVIEST FALL IN 24 HOURS मि.मि. mm | दिनांक और वर्ष / DATE AND YEAR | माध्य पवन गति / MEAN WIND SPEED कि.मी. प्र. घं. Kmph |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| जनवरी JAN | I | 996.0 | 10.8 | 9.2 | 20.6 | 7.4 | 25.1 | 3.8 | 30.7 | 28 1991 | 0.6 | 16 1935 | 80 | 10.5 | 2.5 | 2.3 | 15.2 | 1.5 | 71.9 1883 | 0.0 | 53.8 | 12 1994 | 3.1 |
| | II | 993.3 | 18.2 | 13.8 | | | | | | | | | 60 | 12.4 | 2.3 | 2.0 | | | | | | | |
| फरवरी FEB | I | 993.7 | 13.3 | 11.1 | 23.6 | 9.5 | 28.8 | 5.0 | 33.3 | 26 1989 | 1.7 | 11 1950 | 75 | 11.6 | 2.5 | 2.2 | 13.9 | 1.4 | 141.0 1928 | 0.0 | 71.1 | 2 1928 | 3.5 |
| | II | 991.0 | 21.2 | 15.4 | | | | | | | | | 52 | 13.0 | 2.3 | 2.1 | | | | | | | |
| मार्च MAR | I | 990.9 | 19.3 | 15.2 | 30.0 | 14.1 | 35.5 | 8.9 | 41.7 | 31 1945 | 3.9 | 6 1945 | 63 | 14.1 | 2.3 | 1.9 | 8.5 | 1.0 | 106.7 1870 | 0.0 | 63.5 | 18 1870 | 4.2 |
| | II | 988.1 | 27.2 | 18.7 | | | | | | | | | 41 | 14.8 | 2.6 | 2.1 | | | | | | | |
| अप्रैल APR | I | 986.6 | 26.8 | 18.9 | 36.8 | 20.1 | 41.5 | 14.3 | 44.5 | 29 1999 | 10.9 | 9 1957 | 45 | 15.5 | 1.5 | 1.2 | 8.8 | 0.9 | 68.1 1909 | 0.0 | 30.6 | 29 1997 | 4.8 |
| | II | 982.9 | 34.3 | 21.3 | | | | | | | | | 28 | 14.7 | 2.0 | 1.6 | | | | | | | |
| मई MAY | I | 982.5 | 30.6 | 21.9 | 40.1 | 24.5 | 43.9 | 19.9 | 47.2 | 28 1988 | 15.5 | 3 1987 | 45 | 19.2 | 1.5 | 1.3 | 21.0 | 2.2 | 75.7 1913 | 0.0 | 41.1 | 20 1913 | 4.9 |
| | II | 979.1 | 37.6 | 24.0 | | | | | | | | | 30 | 18.8 | 1.6 | 1.4 | | | | | | | |
| जून JUN | I | 978.7 | 31.2 | 24.8 | 39.3 | 26.6 | 44.4 | 22.3 | 46.7 | 7 1995 | 18.6 | 2 1957 | 59 | 26.1 | 2.8 | 2.6 | 68.5 | 4.1 | 544.8 1933 | 0.0 | 327.2 | 30 1981 | 5.6 |
| | II | 975.3 | 36.5 | 26.0 | | | | | | | | | 44 | 25.1 | 3.0 | 2.8 | | | | | | | |
| जुलाई JUL | I | 978.4 | 29.2 | 26.3 | 34.6 | 26.0 | 39.4 | 23.0 | 44.5 | 2 1987 | 19.9 | 12 1988 | 79 | 31.9 | 6.1 | 5.9 | 217.7 | 10.2 | 576.1 1958 | 1.5 1941 | 164.6 | 3 1942 | 4.7 |
| | II | 975.4 | 32.2 | 27.3 | | | | | | | | | 69 | 32.0 | 6.1 | 5.8 | | | | | | | |
| अगस्त AUG | I | 980.0 | 28.3 | 26.1 | 33.2 | 25.4 | 36.9 | 22.9 | 42.1 | 11 1987 | 20.1 | 13 1957 | 84 | 32.1 | 6.1 | 5.7 | 247.4 | 11.6 | 529.8 1940 | 0.0 | 183.6 | 15 1964 | 4.3 |
| | II | 977.3 | 30.7 | 27.0 | | | | | | | | | 75 | 32.7 | 6.1 | 5.9 | | | | | | | |
| सितम्बर SEP | I | 984.6 | 27.4 | 24.5 | 33.8 | 23.8 | 36.9 | 20.7 | 40.2 | 1 1979 | 14.8 | 16 1994 | 78 | 28.6 | 3.2 | 2.9 | 104.1 | 5.2 | 590.5 1884 | 0.0 | 220.6 | 26 1964 | 3.7 |
| | II | 981.5 | 31.0 | 25.6 | | | | | | | | | 65 | 28.6 | 3.2 | 3.0 | | | | | | | |
| अक्तूबर OCT | I | 990.4 | 23.5 | 19.8 | 33.0 | 18.8 | 36.2 | 14.4 | 41.7 | 4 1952 | 11.0 | 9 1983 | 69 | 20.2 | 1.0 | 0.9 | 31.4 | 1.4 | 231.1 1955 | 0.0 | 138.7 | 13 1955 | 2.2 |
| | II | 987.2 | 29.1 | 21.8 | | | | | | | | | 51 | 20.4 | 1.0 | 0.8 | | | | | | | |
| नवम्बर NOV | I | 994.5 | 17.5 | 14.4 | 28.3 | 12.9 | 32.1 | 9.4 | 36.1 | 3 1944 | 5.0 | 30 1937 | 69 | 14.0 | 0.8 | 0.7 | 4.2 | 0.5 | 34.8 1904 | 0.0 | 26.2 | 14 1966 | 2.1 |
| | II | 991.5 | 24.0 | 18.2 | | | | | | | | | 55 | 16.4 | 0.9 | 0.8 | | | | | | | |
| दिसम्बर DEC | I | 996.7 | 12.3 | 10.4 | 22.5 | 8.5 | 26.7 | 5.3 | 32.8 | 2 1948 | 1.2 | 30 1973 | 77 | 11.2 | 1.7 | 1.4 | 11.0 | 0.8 | 87.6 1909 | 0.0 | 56.2 | 28 1977 | 2.7 |
| | II | 993.6 | 19.5 | 15.0 | | | | | | | | | 59 | 13.5 | 1.8 | 1.5 | | | | | | | |
| वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN | I | 987.7 | 22.5 | 18.6 | 31.3 | 18.1 | 44.1 | 3.4 | 47.2 | 28 | 0.6 | 16 | 69 | 19.6 | 2.6 | 2.4 | 751.8 | 40.7 | 1342.9 | 204.5 | 327.2 | 30 | 3.8 |
| | II | 984.7 | 28.5 | 21.2 | | | | | 5 | 1988 | 1 | 1935 | 52 | 20.2 | 2.7 | 2.4 | | | 1933 | 1918 | 6 | 1981 | |
| वर्षों की सं NUMBER OF YEARS | I / II | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 68 | | 68 | | 29 | 29 | 29 | 29 | 28 | 28 | 64 | 64 | 66 | | 15 |

# जलवायवी सारणी
# CLIMATOLOGICAL TABLE

स्टेशन : अलीगढ
STAION : Aligarh

| माह / MONTH | | मौसम परिघटना: के साथ दिनों की संख्या / WEATHER PHENOMENA: No. OF DAYS WITH | | | | | | पवन: पवन की गती के साथ दिनों की संख्या (कि. मी. प्र. घं.) / WIND: No. OF DAYS WITH WIND SPEED (Km. p. h.) | | | | पवन: पवन की दिशा के दिनों की संख्या का प्रतिशत / WIND: PERCENTAGE No. OF DAYS WIND FROM | | | | | | | | | मेघ: मेघ मात्रा (सभी मेघ) सहित दिनों की संख्या - अष्टमांश / CLOUD: No. OF DAYS WITH CLOUD AMOUNT (ALL CLOUDS) OKTAS | | | | | मेघ: निम्न स्तरी मेघ मात्रा सहित दिनों की संख्या - अष्टमांश / CLOUD: No. OF DAYS WITH LOW CLOUD AMOUNT OKTAS | | | | | | दृश्यता: दृश्यता सहित दिनों की संख्या / VISIBILITY: No. OF DAYS WITH VISIBILITY | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | वर्षण 0.3 मि.मि.या अधिक | ओले | गर्जन | कुहरा | धूल भरी आंधी | धंड वात | 62 या अधिक | 20-61 | 1-19 | 0 | उ | उपू | पू | दपू | द | दप | प | उप | शांत | 0 | ले-2 | 3-5 | 6-7 | 8 | 0 | ले-2 | 3-5 | 6-7 | 8 | कुहरा 8 | 1 कि.मी. तक | 1-4 कि.मी. | 4-10 कि.मी. | 10-20 कि.मी. | 20 कि.मी. से अधिक |
| | | PPT 0.3 mm Or more | HAIL | THUN DER | FOG | DUST STORM | SQU ALL | 62 Or more | 20-61 | 1-19 | 0 | N | NE | E | SE | S | SW | W | NW | CALM | 0 | T-2 | 3-5 | 6-7 | 8 | 0 | T-2 | 3-5 | 6-7 | 8 | FOG 8 | UP TO 1 Km | 1-4 Kms | 4-10 Kms | 10-20 Kms | OVER 20 Kms |
| जनवरी | I | 2.1 | 0.1 | 0.2 | 3.0 | 0.0 | 0.0 | 0 | 0 | 25 | 6 | 2 | 14 | 10 | 16 | 2 | 11 | 15 | 9 | 21 | 20 | 1 | 2 | 3 | 5 | 20 | 1 | 2 | 3 | 5 | 0 | 3.3 | 6.2 | 16.9 | 4.6 | 0.0 |
| JAN | II | | | | | | | 0 | 0 | 23 | 8 | 4 | 9 | 6 | 13 | 4 | 5 | 19 | 13 | 27 | 19 | 2 | 2 | 4 | 4 | 20 | 2 | 2 | 3 | 4 | 0 | 1.1 | 11.5 | 6.3 | 12.1 | 0.0 |
| फरवरी | I | 2.4 | 0.1 | 0.5 | 1.2 | 0.0 | 0.0 | 0 | 0 | 23 | 5 | 3 | 14 | 8 | 14 | 2 | 12 | 15 | 14 | 18 | 16 | 2 | 3 | 3 | 4 | 18 | 1 | 2 | 3 | 4 | 0 | 1.9 | 4.8 | 14.5 | 6.8 | 0.0 |
| FEB | II | | | | | | | 0 | 0 | 23 | 5 | 5 | 8 | 5 | 13 | 1 | 9 | 24 | 15 | 20 | 17 | 2 | 3 | 3 | 3 | 18 | 2 | 2 | 3 | 3 | 0 | 0.0 | 8.4 | 4.8 | 14.8 | 0.0 |
| मार्च | I | 2.2 | 0.3 | 0.7 | 0.0 | 0.1 | 0.0 | 0 | 0 | 27 | 4 | 3 | 13 | 8 | 19 | 2 | 12 | 16 | 14 | 14 | 20 | 1 | 3 | 4 | 3 | 22 | 0 | 3 | 3 | 3 | 0 | 0.4 | 4.7 | 13.4 | 12.5 | 0.0 |
| MAR | II | | | | | | | 0 | 0 | 26 | 5 | 6 | 8 | 6 | 11 | 2 | 10 | 20 | 22 | 15 | 17 | 2 | 4 | 5 | 3 | 19 | 2 | 3 | 4 | 3 | 0 | 0.1 | 6.3 | 6.6 | 18.1 | 0.0 |
| अप्रैल | I | 1.9 | 0.1 | 0.9 | 0.0 | 0.8 | 0.0 | 0 | 0 | 26 | 4 | 3 | 15 | 9 | 18 | 2 | 12 | 13 | 15 | 13 | 21 | 1 | 3 | 3 | 2 | 24 | 0 | 2 | 2 | 2 | 0 | 0.0 | 3.6 | 14.0 | 12.4 | 0.0 |
| APR | II | | | | | | | 0 | 0 | 27 | 3 | 8 | 7 | 6 | 12 | 4 | 9 | 13 | 30 | 11 | 19 | 2 | 3 | 4 | 2 | 20 | 2 | 3 | 3 | 2 | 0 | 0.0 | 5.5 | 7.0 | 17.4 | 0.0 |
| मई | I | 3.2 | 0.1 | 0.9 | 0.0 | 2.3 | 0.0 | 0 | 0 | 27 | 4 | 3 | 12 | 11 | 13 | 3 | 12 | 15 | 16 | 15 | 23 | 1 | 2 | 2 | 3 | 25 | 0 | 2 | 1 | 3 | 0 | 0.0 | 5.6 | 15.4 | 9.9 | 0.0 |
| MAY | II | | | | | | | 0 | 0 | 27 | 4 | 7 | 9 | 8 | 12 | 3 | 9 | 16 | 25 | 11 | 22 | 3 | 2 | 2 | 2 | 23 | 2 | 2 | 2 | 2 | 0 | 0.0 | 5.9 | 9.2 | 15.9 | 0.0 |
| जून | I | 5.2 | 0.0 | 0.5 | 0.0 | 1.0 | 0.0 | 0 | 0 | 26 | 4 | 2 | 12 | 13 | 15 | 4 | 14 | 11 | 15 | 14 | 17 | 1 | 3 | 4 | 5 | 17 | 1 | 3 | 4 | 5 | 0 | 0.0 | 5.4 | 13.0 | 11.6 | 0.0 |
| JUN | II | | | | | | | 0 | 0 | 27 | 3 | 5 | 14 | 11 | 15 | 4 | 13 | 11 | 18 | 9 | 15 | 3 | 3 | 4 | 5 | 16 | 3 | 3 | 3 | 5 | 0 | 0.0 | 5.8 | 8.9 | 15.3 | 0.0 |
| जुलाई | I | 13.2 | 0.0 | 0.6 | 0.0 | 0.1 | 0.0 | 0 | 0 | 26 | 5 | 2 | 13 | 11 | 11 | 3 | 18 | 12 | 15 | 15 | 4 | 1 | 2 | 6 | 18 | 5 | 1 | 2 | 6 | 17 | 0 | 0.0 | 4.6 | 12.2 | 14.2 | 0.0 |
| JUL | II | | | | | | | 0 | 0 | 26 | 5 | 5 | 14 | 14 | 12 | 4 | 14 | 10 | 12 | 15 | 2 | 2 | 3 | 8 | 16 | 3 | 2 | 3 | 7 | 16 | 0 | 0.0 | 5.3 | 7.7 | 18.0 | 0.0 |
| अगस्त | I | 14.4 | 0.0 | 0.8 | 0.0 | 0.0 | 0.0 | 0 | 0 | 25 | 6 | 2 | 11 | 12 | 12 | 3 | 15 | 13 | 14 | 18 | 4 | 0 | 3 | 5 | 19 | 5 | 1 | 2 | 4 | 19 | 0 | 0.0 | 3.3 | 11.4 | 16.2 | 0.0 |
| AUG | II | | | | | | | 0 | 0 | 26 | 5 | 5 | 14 | 13 | 10 | 5 | 14 | 13 | 9 | 17 | 2 | 3 | 3 | 6 | 17 | 2 | 3 | 3 | 6 | 17 | 0 | 0.0 | 5.4 | 7.6 | 18.0 | 0.0 |
| सितम्बर | I | 7.4 | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 | 0 | 0 | 24 | 6 | 2 | 11 | 13 | 15 | 3 | 14 | 13 | 11 | 18 | 16 | 1 | 4 | 3 | 6 | 17 | 1 | 3 | 3 | 6 | 0 | 0.0 | 1.4 | 10.2 | 18.4 | 0.0 |
| SEP | II | | | | | | | 0 | 0 | 23 | 7 | 7 | 12 | 10 | 11 | 2 | 11 | 13 | 12 | 22 | 13 | 5 | 3 | 4 | 5 | 15 | 4 | 3 | 3 | 5 | 0 | 0.0 | 4.6 | 6.7 | 18.7 | 0.0 |
| अक्तूबर | I | 1.9 | 0.0 | 0.5 | 0.1 | 0.1 | 0.0 | 0 | 0 | 20 | 11 | 4 | 8 | 10 | 11 | 3 | 5 | 11 | 10 | 38 | 26 | 1 | 1 | 1 | 2 | 27 | 0 | 1 | 1 | 2 | 0 | 0.1 | 1.6 | 11.7 | 17.7 | 0.0 |
| OCT | II | | | | | | | 0 | 0 | 17 | 14 | 8 | 6 | 8 | 9 | 2 | 5 | 8 | 10 | 44 | 25 | 2 | 1 | 1 | 2 | 26 | 1 | 1 | 1 | 2 | 0 | 0.0 | 7.5 | 6.1 | 17.4 | 0.0 |
| नवम्बर | I | 0.7 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0 | 0 | 18 | 12 | 3 | 7 | 7 | 11 | 2 | 8 | 14 | 6 | 42 | 25 | 1 | 2 | 1 | 1 | 27 | 0 | 1 | 1 | 1 | 0 | 0.1 | 3.6 | 16.3 | 10.0 | 0.0 |
| NOV | II | | | | | | | 0 | 0 | 12 | 18 | 6 | 2 | 4 | 5 | 1 | 4 | 11 | 7 | 60 | 25 | 1 | 2 | 1 | 1 | 26 | 1 | 1 | 1 | 1 | 0 | 0.0 | 12.2 | 6.6 | 11.2 | 0.0 |
| दिसम्बर | I | 1.2 | 0.0 | 0.1 | 2.2 | 0.0 | 0.0 | 0 | 0 | 21 | 10 | 1 | 9 | 7 | 15 | 1 | 9 | 14 | 10 | 34 | 22 | 1 | 2 | 3 | 3 | 25 | 0 | 1 | 2 | 3 | 0 | 1.5 | 7.7 | 16.0 | 5.7 | 0.0 |
| DEC | II | | | | | | | 0 | 0 | 17 | 14 | 3 | 4 | 3 | 8 | 1 | 4 | 20 | 10 | 47 | 21 | 2 | 2 | 3 | 3 | 23 | 1 | 2 | 3 | 2 | 0 | 0.1 | 14.6 | 5.9 | 10.4 | 0.0 |
| वार्षिक योग या माध्य | I | 55.8 | 0.8 | 6.1 | 6.7 | 4.3 | 0.0 | 0 | 0 | 287 | 78 | 2 | 12 | 10 | 14 | 2 | 12 | 13 | 12 | 23 | 224 | 11 | 29 | 38 | 63 | 240 | 7 | 24 | 32 | 62 | 0 | 7.3 | 52.6 | 166.8 | 138.4 | 0.0 |
| ANNUAL TOTAL OR MEAN | II | | | | | | | 0 | 0 | 276 | 89 | 6 | 9 | 8 | 11 | 3 | 9 | 15 | 15 | 24 | 202 | 28 | 33 | 46 | 56 | 220 | 24 | 27 | 39 | 55 | 0 | 1.2 | 91.3 | 83.3 | 189.1 | 0.0 |
| वर्षों की सं NUMBER OF YEARS | I / II | 29 | | | | | | 30 | | | | 30 | | | | | | | | | 30 | | | | | 30 | | | | | | 30 | | | | |

ANNEXURE-VII-1

**ANALYSIS OF DM WATER TO BE USED FOR MAKE-UP WATER TO CONDENSER**

Main Plant Condenser

| S.No | Characteristics | Value |
|---|---|---|
| 1. | Silica (Max.) | 0.02 ppm as Sio2 |
| | | |
| 2. | Iron as Fe | Nil |
| | | |
| 3. | Total hardness | Nil |
| | | |
| 4. | pH value | 6.8 -7.2 |
| | | |
| 5. | Conductivity | Not more than 0.1micro mho/cm excluding the effects of free CO2 |

**ANNEXURE-VII-2**

**DESIGN CLARIFIED WATER ANALYSIS**

| S.No | PARAMETER | UNIT | Clarified Water Analysis |
|---|---|---|---|
| | | | Calculated |
| 1 | pH . | - | 6.8-7.3 |
| 2 | Sp. Cond. | µs/cm | 325 |
| 3 | TDS | mg/l | 230 |
| 4 | Turbidity | NTU | 10 |
| 5 | Total hardness | mg/l As CaCO3 | 155 |
| 6 | Calcium | mg/l As CaCO3 | 148.8 |
| 7 | Magnesium | mg/l As CaCO3 | 45 |
| 8 | Sodium | mg/l CaCO3 | 45 |
| 9 | Potassium | | |
| 10 | P Alkalinity | mg/l As CaCO3 | - |
| 11 | M Alkalinity | mg/l As CaCO3 | 125.3 |
| 12 | Chlorides | mg/l As as CaCO3 | 42 |
| 13 | Sulphate | mg/l As CaCO3 | 71.5 |
| 14 | Silica (Total) | mg/l As SiO2 | 21 |
| 15 | Silica (Reactive) | mg/l As SiO2 | 20 |
| 16 | Silica (Collidal) | mg/l As SiO2 | 1 |
| 17 | TOC | mg/l | 6 |
| 18 | COD | mg/l | 45 |
| 19 | BOD | mg/l | 18 |
| 20 | Fe | mg/lt | - |

Note: Cooling water system is expected to operate at a design minimum cycle of concentration (C.O.C) of about 5 to 5.5.

**ANNEXURE- (D)**

**CRITERIA FOR WIND RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT**

All structures shall be designed for wind forces in accordance with IS: 875 (Part-3) and as specified in this document. See Annexure – B for site specific information.

Along wind forces shall generally be computed by the Peak (i.e. 3 second gust) Wind Speed method as defined in the standard.

Along wind forces on slender and wind sensitive structures and structural elements shall also be computed, for dynamic effects, using the Gust Factor or Gust Effectiveness Factor Method as defined in the standard. The structures shall be designed for the higher of the forces obtained from Gust Factor method and the Peak Wind Speed method.

Analysis for dynamic effects of wind must be undertaken for any structure which has a height to minimum lateral dimension ratio greater than “5” and/or if the fundamental frequency of the structure is less than 1 Hz.

Susceptibility of structures to across-wind forces, galloping, flutter, ovalling etc. should be examined and designed/detailed accordingly following the recommendations of IS:875(Part-3) and other relevant Indian standards.

It should be estimated if size and relative position of other structures are likely to enhance the wind loading on the structure under consideration. Enhancement factor, if necessary, shall suitably be estimated and applied to the wind loading to account for the interference effects.

## Damping in Structures

The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:

a) Welded steel structures : 1.0%

b) Bolted steel structures : 2.0%

c) Reinforced concrete structures :1.6%

d) Steel stacks : As per IS: 6533 & CICIND Model Code whichever is more critical.

Appendix-I

SITE SPECIFIC DESIGN PARAMETERS

The various design parameters, as defined in IS: 875 (Part-3), to be adopted for the project site shall be as follows:

a) The basic wind speed “Vb” at ten metre above the mean ground level : 47 metre/second

b) The risk coefficient “K1” : 1.07

c) Category of terrain : Category-2

**Annexure-(E)**

**CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT**

All structures and equipment shall be designed for seismic forces adopting the site specific seismic information provided in this document and using the other provisions in accordance with IS: 1893 (Part 1 to Part 4). Pending finalization of Part 5 of IS: 1893, provisions of part 1 shall be read along with the relevant clauses of IS: 1893:1984, for embankments.

A site specific seismic study has been conducted for the project site. The peak ground horizontal acceleration for the project site, the site specific acceleration spectral coefficients (in units of gravity acceleration 'g') in the horizontal direction for the various damping values and the multiplying factor (to be used over the spectral coefficients) for evaluating the design acceleration spectra are as given at Appendix-I.

Vertical acceleration spectral values shall be taken as 2/3rd of the corresponding horizontal values.

The site specific design acceleration spectra shall be used in place of the response acceleration spectra, given at figure-2 in IS: 1893 (Part 1) and Annex B of IS: 1893 (Part 4). The site specific acceleration spectra along with multiplying factors specified in Appendix-I includes the effect of the seismic environment of the site, the importance factor related to the structures and the response reduction factor. Hence, the design spectra do not require any further consideration of the zone factor (Z), the importance factor (I) and response reduction factor (R) as used in the IS: 1893 (Part 1 to Part 4).

**Damping in Structures**

The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:

| | | | |
|---|---|---|---|
| a) | Steel structures | : | 2% |
| b) | Reinforced Concrete structures | : | 5% |
| c) | Reinforced Concrete Stacks | : | 3% |
| d) | Steel stacks | : | 2% |

**Method of Analysis**

Since most structures in a power plant are irregular in shape and have irregular distribution of mass and stiffness, dynamic analysis for obtaining the design seismic forces shall be carried out using the response spectrum method. The number of vibration modes used in the analysis should be such that the sum total of modal masses of all modes considered is at least 90 percent of the total seismic mass and shall also meet requirements of IS: 1893 (Part 1). Modal combination of the peak response quantities shall be performed as per Complete Quadratic Combination (CQC) method or by an acceptable alternative as per IS: 1893 (Part 1).

In general, seismic analysis shall be performed for the three orthogonal (two principal horizontal and one vertical) components of earthquake motion. The seismic response from the three components shall be combined as specified in IS: 1893 (Part 1).

The spectral acceleration coefficient shall get restricted to the peak spectral value if the fundamental natural period of the structure falls to the left of the peak in the spectral acceleration curve.

For buildings, if the design base shear (VB) obtained from modal combination is less than the base shear ( $\overline{V}$B) computed using the approximate fundamental period (Ta) given in IS: 1893: Part 1 and using site specific acceleration spectra with appropriate multiplying factor, the response quantities (e.g. member forces, displacements, storey forces, storey shears and base reactions) shall be enhanced in the ratio of $\overline{V}$B/ VB. However, no reduction is permitted if $\overline{V}$B is less than VB.

.

**Design/Detailing for Ductility for Structures**

The site specific design acceleration spectra is a reduced spectra and has an in-built allowance for ductility. Structures shall be engineered and detailed in accordance with relevant Indian/International standards to achieve ductility.

**APPENDIX-I**

## SITE SPECIFIC SEISMIC PARAMETERS FOR DESIGN OF STRUCTURES AND EQUIPMENT FOR KHURJA STPP

**The various site specific seismic parameters for the project site shall be as follows:**

1) Peak ground horizontal acceleration (MCE) : 0.32 g

2) Multiplying factor to be applied to the site specific horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') to obtain the design acceleration spectra

   a) for special moment resisting steel frames designed and detailed as per IS:800 : 0.08

   b) for special concentrically braced steel frames designed and detailed as per IS:800 : 0.06

   c) For special moment resisting RC frames designed and detailed as per IS:456 and IS:13920 : 0.048

   d) for RCC chimney, RCC Natural Draft Cooling Tower : 0.16

   e) for Liquid retaining tanks : 0.096

   f) for Steel chimney, Absorber Tower, Vessels : 0.12

   g) for design of structures not covered under 2 (a) to 2 (f) above and under 3 below, in general(excluding special structure/ configuration/ materials) : 0.08

3) Multiplying factor to be applied to the site specific horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') for design of equipment and structures where inelastic action is not relevant or not permitted : 0.16

Note:
g = Acceleration due to gravity

The horizontal seismic acceleration spectral coefficients are furnished in subsequent pages.

**APPENDIX – II**

**HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS**
**(In units of 'g')**

| Time Period (Sec) | Damping Factor (as a percentage of critical damping) | | |
|---|---|---|---|
| | 2% | 3% | 5% |
| 0.000 | 1.000 | 1.000 | 1.000 |
| 0.030 | 1.000 | 1.000 | 1.000 |
| 0.040 | 2.240 | 2.032 | 1.600 |
| 0.050 | 2.450 | 2.222 | 1.750 |
| 0.060 | 2.660 | 2.413 | 1.900 |
| 0.070 | 2.870 | 2.604 | 2.050 |
| 0.080 | 3.080 | 2.794 | 2.200 |
| 0.090 | 3.290 | 2.985 | 2.350 |
| 0.100 | 3.500 | 3.175 | 2.500 |
| 0.105 | 3.500 | 3.175 | 2.500 |
| 0.110 | 3.500 | 3.175 | 2.500 |
| 0.115 | 3.500 | 3.175 | 2.500 |
| 0.120 | 3.500 | 3.175 | 2.500 |
| 0.125 | 3.500 | 3.175 | 2.500 |
| 0.130 | 3.500 | 3.175 | 2.500 |
| 0.135 | 3.500 | 3.175 | 2.500 |
| 0.140 | 3.500 | 3.175 | 2.500 |
| 0.145 | 3.500 | 3.175 | 2.500 |
| 0.150 | 3.500 | 3.175 | 2.500 |
| 0.200 | 3.500 | 3.175 | 2.500 |
| 0.220 | 3.500 | 3.175 | 2.500 |
| 0.230 | 3.500 | 3.175 | 2.500 |
| 0.240 | 3.500 | 3.175 | 2.500 |
| 0.300 | 3.500 | 3.175 | 2.500 |
| 0.350 | 3.500 | 3.175 | 2.500 |
| 0.400 | 3.500 | 3.175 | 2.500 |
| 0.450 | 3.500 | 3.175 | 2.500 |
| 0.500 | 3.500 | 3.175 | 2.500 |
| 0.550 | 3.500 | 3.175 | 2.500 |
| 0.600 | 3.173 | 2.879 | 2.267 |
| 0.650 | 2.929 | 2.657 | 2.092 |
| 0.700 | 2.720 | 2.467 | 1.943 |
| 0.750 | 2.539 | 2.303 | 1.813 |
| 0.800 | 2.380 | 2.159 | 1.700 |
| 0.850 | 2.240 | 2.032 | 1.600 |

| Time Period (Sec) | Damping Factor (as a percentage of critical damping) | | |
|---|---|---|---|
| | 2% | 3% | 5% |
| 0.900 | 2.116 | 1.919 | 1.511 |
| 0.950 | 2.004 | 1.818 | 1.432 |
| 1.000 | 1.904 | 1.727 | 1.360 |
| 1.050 | 1.813 | 1.645 | 1.295 |
| 1.100 | 1.731 | 1.570 | 1.236 |
| 1.150 | 1.656 | 1.502 | 1.183 |
| 1.200 | 1.587 | 1.439 | 1.133 |
| 1.250 | 1.523 | 1.382 | 1.088 |
| 1.300 | 1.465 | 1.329 | 1.046 |
| 1.350 | 1.410 | 1.279 | 1.007 |
| 1.400 | 1.360 | 1.234 | 0.971 |
| 1.450 | 1.313 | 1.191 | 0.938 |
| 1.500 | 1.269 | 1.151 | 0.907 |
| 1.550 | 1.228 | 1.114 | 0.877 |
| 1.600 | 1.190 | 1.080 | 0.850 |
| 1.650 | 1.154 | 1.047 | 0.824 |
| 1.700 | 1.120 | 1.016 | 0.800 |
| 1.750 | 1.088 | 0.987 | 0.777 |
| 1.800 | 1.058 | 0.960 | 0.756 |
| 1.850 | 1.029 | 0.934 | 0.735 |
| 1.900 | 1.002 | 0.909 | 0.716 |
| 1.950 | 0.976 | 0.886 | 0.697 |
| 2.000 | 0.952 | 0.864 | 0.680 |
| 2.050 | 0.929 | 0.843 | 0.663 |
| 2.100 | 0.907 | 0.822 | 0.648 |
| 2.150 | 0.886 | 0.803 | 0.633 |
| 2.200 | 0.865 | 0.785 | 0.618 |
| 2.250 | 0.846 | 0.768 | 0.604 |
| 2.300 | 0.828 | 0.751 | 0.591 |
| 2.350 | 0.810 | 0.735 | 0.579 |
| 2.400 | 0.793 | 0.720 | 0.567 |
| 2.450 | 0.777 | 0.705 | 0.555 |
| 2.500 | 0.762 | 0.691 | 0.544 |
| 2.550 | 0.747 | 0.677 | 0.533 |
| 2.600 | 0.732 | 0.664 | 0.523 |
| 2.650 | 0.718 | 0.652 | 0.513 |
| 2.700 | 0.705 | 0.640 | 0.504 |
| 2.800 | 0.680 | 0.617 | 0.486 |
| 2.850 | 0.668 | 0.606 | 0.477 |
| 2.900 | 0.657 | 0.596 | 0.469 |

| Time Period (Sec) | Damping Factor (as a percentage of critical damping) | | |
|---|---|---|---|
| | 2% | 3% | 5% |
| 2.950 | 0.645 | 0.585 | 0.461 |
| 3.000 | 0.635 | 0.576 | 0.453 |
| 3.050 | 0.624 | 0.566 | 0.446 |
| 3.100 | 0.614 | 0.557 | 0.439 |
| 3.150 | 0.604 | 0.548 | 0.432 |
| 3.200 | 0.595 | 0.540 | 0.425 |
| 3.250 | 0.586 | 0.531 | 0.418 |
| 3.300 | 0.577 | 0.523 | 0.412 |
| 3.350 | 0.568 | 0.516 | 0.406 |
| 3.400 | 0.560 | 0.508 | 0.400 |
| 3.450 | 0.552 | 0.501 | 0.394 |
| 3.500 | 0.544 | 0.493 | 0.389 |
| 3.550 | 0.536 | 0.487 | 0.383 |
| 3.600 | 0.529 | 0.480 | 0.378 |
| 3.650 | 0.522 | 0.473 | 0.373 |
| 3.700 | 0.515 | 0.467 | 0.368 |
| 3.750 | 0.508 | 0.461 | 0.363 |
| 3.800 | 0.501 | 0.455 | 0.358 |
| 3.850 | 0.495 | 0.449 | 0.353 |
| 3.900 | 0.488 | 0.443 | 0.349 |
| 3.950 | 0.482 | 0.437 | 0.344 |
| 4.000 | 0.476 | 0.432 | 0.340 |

# SECTION: I

# SUB-SECTION: C

# TECHNICAL SPECIFICATION

# SECTION: I

# SUB-SECTION: C 1

# SPECIAL TECHNICAL REQUIREMENT

## 1. FUNCTION

The purpose of the system is to provide Ventilation System for different areas of **2 x 660 MW, KHURJA STPP TURBINE GENERATOR AND ASSOCIATED PACKAGES** under the scope of this tender.

## 2. SYSTEM DESCRIPTION

**2.1.** Turbine hall building and associated areas (Non- A/C areas).

a) Ventilation for each unit shall be provided with minimum Ten (10) nos. of Air Washer units (of metallic construction-modular type) each of minimum capacity 100000 $m^3$/hr, with all accessories, 1 no. DIDW centrifugal fans, 1 no. circulating water pumps etc. as detailed out in technical specification shall be provided for each unit.
b) Out of 10 nos. (for each unit) of air washers mentioned in s. no a), five (5) nos. of Air washers shall be placed at A row side and five (5) nos. of Air washers shall be placed at C row side at different elevations in power house.
c) Location of Air washers to be finalized during detail engineering.
d) Ventilation of turbine hall is further assisted by means of roof extractor located suitably at the roof of TG hall building. The number and capacity of these roof extractors shall be selected in such a way that; it extracts approx. 60% of total discharge of air washer units. This will maintain a positive pressure within turbine hall and thus stop ingress of dusty outside air within the building.

**2.2.** Boiler MCC and associated areas (Non-A/C areas).

**a)** Minimum one (1) no. of air washer unit (of metallic construction- modular type) of minimum capacity 50,000 m3/hr, with all accessories, 1 no. DIDW centrifugal fan, 1 no. circulating water pump, etc. as detailed out in technical specification shall be provided for boiler MCC of each unit.

**2.3.** Miscellaneous areas:

All other areas like pump house, MCC rooms and switchgear rooms, Electrical and C&I battery rooms covered under bidder's scope and shall be ventilated by a combination of supply air fans and roof exhauster fans or supply air fans & exhaust fans or supply air fans and back draft dampers or fresh air in-take louvers & exhaust air fans. For ventilation of battery rooms and oil rooms, flame proof motor shall be used. Further, toilets shall be provided with propeller type exhaust air fans.

## 3. DESIGN CRITERIA

The outside design conditions considered are as follows:

| Season | Dry Bulb Temp. (Deg. C) | Wet Bulb Temp. (Deg. C) |
|---|---|---|
| Summer | 45.0 | 23 |
| Monsoon | 35.8 | 28.3 |
| Winter | 2 | 0.0 |

Design criteria shall be as per THDC specification, section-VI, Part-B, Sub section-A-11, clause number 2.00.00 enclosed under-sub section C2A, section -1.

**4. EQUIPMENT AND SERVICES:**

**4.1 Air Washers:**

As per THDC specification, section-VI, Part-B, Sub section-A-11, clause number 3.01.00 enclosed under-sub section C2A, section -1.

**4.2 Centrifugal Fan:**

As per THDC specification, section-VI, Part-B, Sub section-A-11, clause number 3.02.00 enclosed under-sub section C2A, section -1.

**4.3 Centrifugal Pumps:**

As per THDC specification, section-VI, Part-B, Sub section-A-11, clause number 3.03.00 enclosed under-sub section C2A, section -1.

**4.4 Axial Fans:**

As per THDC specification, section-VI, Part-B, Sub section-A-11, clause number 3.04.00 enclosed under-sub section C2A, section -1.

**4.5 Roof Ventilators:**

As per THDC specification, section-VI, Part-B, Sub section-A-11, clause number 3.05.00 enclosed under-sub section C2A, section -1.

| | | | |
|---|---|---|---|
| 1. | Roof extractor units with 15 mmwc static pressure. | | |
| | Capacity | Motor rating | Roof / Slab opening |
| a. | 50,000 CMH | 5.5 KW | 1320mm |
| b. | 40,000 CMH | 5.5 KW | 1320mm |
| c. | 20,000 CMH | 2.2 KW | 1140mm |
| 2 | Axial flow supply fans with 30 mmwc static pressure. | | |
| | Capacity | Motor rating | Wall opening |
| a. | 10,000 CMH | 2.2 KW | 800mmx800mm |
| b. | 7,500 CMH | 1.5 KW | 700mmx700mm |
| c. | 6,000 CMH | 1.1 KW | 600mmx600mm |
| d. | 4,000 CMH | 0.75 KW | 500mmx500mm |
| 3 | Axial flow supply fans with 20 mmwc static pressure. | | |
| | Capacity | Motor rating | Wall opening |
| a. | 15000 CMH | 2.2KW | 900mmx900mm |
| b. | 10,000 CMH | 1.5 KW | 800mmx800mm |
| c. | 7,500 CMH | 1.1 KW | 700mmx700mm |
| d. | 6,000 CMH | 1.1 KW | 600mmx600mm |
| e. | 4,000 CMH | 0.75 KW | 600mmx600mm |
| 4 | Axial flow exhaust fans (Bifurcated type) with 15 mmwc static pressure. | | |
| | Capacity | Motor rating | Wall opening |
| a. | 15,000 CMH | 2.2 KW | 900mmx900mm |
| b. | 10,000 CMH | 1.5 KW | 800mmx800mm |
| c. | 7,500 CMH | 1.1 KW | 700mmx700mm |
| d. | 2,000 CMH | 0.55 KW | 500mmx500mm |

| | | | |
|---|---|---|---|
| 5 | Axial flow exhaust fans with 10 mmwc static pressure. | | |
| | Capacity | Motor rating | Wall opening |
| a. | 15,000 CMH | 1.1 KW | 900mmx900mm |
| b. | 10,000 CMH | 0.75 KW | 800mmx800mm |
| c. | 7,500 CMH | 0.55 KW | 700mmx700mm |
| d. | 6,000 CMH | 0.55 KW | 600mmx600mm |
| e. | 2,000 CMH | 0.37 KW | 500mmx500mm |
| 6 | Exhaust fan (propeller type) with 5 mmwc static pressure. | | |
| | Capacity | Motor rating | Wall opening |
| a. | 1000 CMH | 100 W | 300 mm circular |

**4.6 Piping and Fittings (Material & Standard):**

As per THDC specification, section-VI, Part-B, Sub section-A-11, clause number 3.06.01 enclosed under-sub section C2A, section -1.

**4.7 Valves:**

As per THDC specification, section-VI, Part-B, Sub section-A-11, clause number 3.07.00 enclosed under-sub section C2A, section -1.

**4.8 Air Filters:**

As per THDC specification, section-VI, Part-B, Sub section-A-11, clause number 3.08.00 enclosed under-sub section C2A, section -1.

**4.9 Low Pressure Air Distribution System:**

As per THDC specification, section-VI, Part-B, Sub section-A-11, clause number 3.09.00 enclosed under-sub section C2A, section -1.

**4.10 Duct Fabrication and Supports:**

As per THDC specification, section-VI, Part-B, Sub section-A-11, clause number 3.10.00 enclosed under-sub section C2A, section -1

**4.11 Diffusers, Grills & Dampers:**

As per THDC specification, section-VI, Part-B, Sub section-A-11, clause number 3.13.00 enclosed under-sub section C2A, section -1

**4.12 Thermal and Acoustic Insulation:**

As per THDC specification, section-VI, Part-B, Sub section-A-11, clause number 4.00.00 enclosed under-sub section C2A, section -1

**5. GENERAL**

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

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

**5.3** Vendor to include the Back wash arrangement of pot strainer with gate valve, piping etc for the Air Washer.

**5.4** Vendor to include Level transmitters & gauge for each Air-washer tank for alarm & trip of the pumps. Also include Pressure transmitters for each air washer pump along with pressure gauge.

**5.5** All drawings and documents shall be computer based.

**5.6** All commissioning spares & consumables for trouble free operation shall be provided.

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

**5.8** Indicative list of makes is enclosed as per Annexure-I however these equipments / items shall be subject to Customer & BHEL approval during detail engineering Stage.

**5.9** Minor civil works like making openings to suit/finishing of opening, sealing of duct opening, grouting of foundation/foundation bolts etc. including special type of grouting like GPX2 etc. are in the scope of Ventilation system vendor.

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

**5.11** Fixing frame works for diffusers and grilles in the scope of Vendor.

**5.12** Anchor fastener shall be used by vendor for fixing duct pipes etc. wherever applicable.

**5.13** Necessary beam from main column in TG building along row shall be provided by BHEL. Vendor shall take secondary support (in form of angle/channel/beam/bracket etc.) from

main column/beam provided by BHEL as required for supporting the duct / piping / equipments.
Supporting structure shall be in vendor scope on lump sum basis and no unit rate shall be applicable.

**5.14** Drain piping within room up to the drain point to be provided by the Vendor.

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

**5.16** The tools and machine required for erection of equipment shall be arranged by Vendor.

**5.17** Tools & tackles as required for regular maintenance shall be supplied by Vendor.

**5.18** Instruments required for performance testing of various equipments / system of the package shall be arranged by Vendor at site.

**5.19** Instrument for testing shall be calibrated by Ventilation plant supplier before taking up testing.

**5.20** Temperature transmitter shall be provided with thermo wells and fixing arrangement.

**5.21** Pressure gauges shall have provision for air venting. Three way valves shall be used which shall have air venting provision.

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

**5.23** 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%.

**5.24** Besides the system performance as above, bidder shall guarantee major technical parameters of various equipments as per design basis / details furnished. Motorized fire damper will be installed at supply air duct in electrical areas like MCC / Switchgear room / cable spreader room etc. in power house building. Fire damper will close on receiving fire signal from fire protection system and shall also be possible manually from remote control panel. Also respective Air washers shall trip on receiving fire signal from fire protection system.

**5.25** 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 by BHEL which are categorically listed in the Electrical scope sheet of technical specification.

**5.26** Vendor to furnish drawings / documents as per the drawings/documents submission schedule given in the contract.

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

**5.28** Tender drawings enclosed form the part of specification and the bidder shall check the space requirements.

**5.29** Feeder for a combination of fire dampers / valves etc. shall be derived from respective control panel by bidder. Distribution through junction box / distribution board shall be in bidders' scope and shall have provision for isolation of individual fire damper / valves. Suitable transformer shall be provided by bidder (if required) to derive the power input.

**5.30** 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.

**5.31** Bidder to note that BHEL reserves the right for drawings/documents submission through web based Document Management System. Bidder would be provided access to the DMS for drawings/documents approval and adequate training for the same. Bidder to ensure proper net connectivity at their end.

**5.32** 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 personnel to BHEL / Customer's place any number of time as per the requirement for across the table discussions/ finalizations/ submissions of drawings.

**5.33** All openings required in brick wall for installing the axial supply and exhaust fans, propeller fans, duct opening, louvers and damper openings etc shall be done by BHEL. Grouting of fans along with anchor fasteners shall also be done by vendor. The openings shall be finished properly. In case openings are done once the walls have been painted, repainting, to match with the existing wall paint shall also be done by the vendor. Sealing of duct opening, grouting of foundation / foundation bolts etc. including special type of grouting like GPX2 etc. are in the scope of Ventilation system vendor.

**5.34** Flat, platform type RCC / PCC foundation shall be provided for installing Air washer / pumps etc. Vendor shall fix the equipment using proper anchor fasteners to secure the equipment and obtain parameter related to vibration and noise.

**5.35** 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.

**5.36** All codes and standards shall be as per contract specifications.

**6. EXCLUSIONS**

Items of works listed below are excluded from scope of the Ventilation plant supplier.

6.1 Construction of Air washer plant foundations for Ventilation equipments (air washer, centrifugal fan only).

6.2 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 bidder.

6.3 Provision of drain traps / points, however, vendor to connect the drain to nearest available drain point.

6.4 For Electrical scope, refer Electrical scope matrix sheet.

6.5 Structure (i.e. box girder/ beam between columns) for running the ventilation ducting header; however, required inputs shall be provided by the vendor. Further, any secondary support (i.e. angles/ channels/ beam etc.) to be drawn from column/ interconnecting beam along with tie rods, nuts, bolts etc. for supporting the duct shall be in bidder's scope.

# SECTION: I

# SUB-SECTION: C 2

# CUSTOMER SPECIFICATION

# SECTION: I

# SUB-SECTION: C 2A

# CUSTOMER SPECIFICATIONS
# TECHNICAL REQUIREMENTS

# SUB–SECTION – A-11

# VENTILATION SYSTEM

## VENTILATION SYSTEM

**1.00.00 GENERAL**

1.01.00 This section of specification covers details of system specifications, detailing the areas to be ventilated, basis of design, brief description of the system, equipment and services to be furnished by bidder. The supply, delivery and erection of the entire equipment listed here shall be in bidder's scope of work.

**1.02.00 AREAS TO BE VENTILATED**

1.02.01 The areas to be ventilated by Evaporative Cooling system are as follows:

i) All floors and areas of turbine hall (TG Building) other than the areas which are air conditioned.

ii) Switch gear rooms/MCC and cable gallery areas of turbine (TG) building.

iii) Any other area where equipment heat load is high and requires ventilation by evaporative cooling process.

1.02.02 The areas to be ventilated by mechanical ventilation process shall consist of but not limited to the following:

i) All the pump houses

ii) Electrical and C&I Battery Room, Clean & Dirty Oil room in TG building, non-A/C areas of SWAS room.

iii) Switchgear rooms/MCC/Battery rooms in various auxiliary buildings.

iv) A/C plant room, MCC room, Battery room, etc. in Service Building, etc.

v) All Toilets & Pantries (to be provided with propeller exhaust fans)

vi) Other auxiliary areas not listed above but covered in the scope of Bidder and require ventilation.

**2.00.00 DESIGN PHILOSOPHY**

1. Design ambient conditions for all ventilation system shall be as indicated below:

| Season | Dry Bulb Temp. (Deg. C) | Wet Bulb Temp. (Deg. C) |
|---|---|---|
| Summer | 45.0 | 23 |
| Monsoon | 35.8 | 28.3 |
| Winter | 2 | 0.0 |

2. Minimum air changes per hour (ACPH) in evaporative/ mechanically ventilated areas shall be as follows:

i) For all evaporative cooled areas - 8
ii) General areas - 20
iii) MCC/Switchgear rooms and Battery rooms & other areas where gaseous fumes/ vapors are generated - 30

3. However in areas producing lot of heat, temperature shall be the criteria as follows:-

a) Inside temperature shall be minimum 3 deg.C below the design ambient temperature during summer for evaporative cooled areas.

b) Inside Temperature shall be maximum 3 deg.C above the design ambient temperature during summer for mechanically ventilated areas.

**Note:** Dry bulb temperature during summer season is 45.0 degC. The criteria which gives higher number of air changes/higher quantity of air of either of condition (Cl. 2 or 3) flow shall be selected.

4. All ventilation systems shall operate on 100% fresh air. All mechanically ventilated areas shall be positively ventilated by means of supply air fans fitted with filters and gravity operated back draft dampers or exhaust fans. For ventilation of heat generating areas combination of supply air fans with exhaust air fans shall be provided. MCC / switchgear and cable gallery areas shall be provided with gravity operated back draft dampers in association with supply air fans in order to maintain positive pressure. Battery rooms and other fumes/odor generating areas like central lube oil purification room etc. shall be negatively ventilated by means of exhaust air fans/roof exhausters and intake louvers. All other areas like pump house, etc. shall be positively ventilated by a combination of supply air fan and exhaust air fans. Fan envisaged for MCC & Switchgear rooms shall be provided with pre-filters and fine filters and for other areas shall be provided with pre-filter only.

5. All the equipments of ventilation system shall be designed for continuous duty.

6. The supply air ducts of evaporative type ventilation system shall be provided with automatic (motorized) fire dampers (of 90 minutes fire rating) entry in switchgear room, cable galleries, etc. The operation of these automatic dampers shall be interlocked with the fire alarm system and shall also possible from the control panel remote manually.

7. Circulating water Capacity for Air washer units shall be minimum 1 Cu.M/hr per 1000 Cu.M /hr of air flow. Velocity through piping shall be limited to 2.0 m/sec and for gravity flow the same shall be limited to 1.5 m/sec. Air distribution system shall be sized to have a constant frictional drop along its length and air velocity through ducts shall not exceed 12.5 m/sec.

8. The air washer unit shall be designed for a maximum velocity of 2.7 m/sec and at least 90% saturation efficiency.

9. Type of ventilation for various buildings shall be as follows:

Refer Amendment attached at end of Sub Section C2A

| S. No. | Area | Type of Ventilation system |
|---|---|---|
| (i) | General area like pump house, etc. | Combination of Supply air fan & Exhaust air fans/Roof Extractor Fans |
| (ii) | MCCs, Switchgear room, Cable Vault (other than ESP/FGD Building), etc. | Supply air fans & Back draft dampers |
| (iii) | Battery rooms | Combination of Air Intake Louvers & Exhaust air fans |
| (iv) | Cable Galleries of ESP/FGD Building | UAF systems along with back draft dampers |
| (v) | Toilet/pantry etc. | Exhaust air fans |

10. For pumps, continuous motor rating (at 50$^{o}$C ambient) shall be atleast 10% above the maximum load demand of the pump in the entire operating range. For fans, compressors and blowers continuous motor rating (at 50$^{o}$C ambient) shall be atleast 10% above the maximum load demand at the design duty point. However for V-belt driven fan, continuous motor rating (at 50$^{o}$C ambient) shall be atleast 15% above the maximum load demand at the design duty point.

11. Supply air fans, exhaust air fans & ventilations of each area shall be provided with local starter panels.

**3.00.0 EQUIPMENT DESCRIPTION - VENTILATION SYSTEM**

**3.01.00 Air Washer Unit**

3.01.01 Each double skin Air Washer Units (- Modular Type ,Evaporative System) shall consist of the various Sections such as Air washer chamber / Casing, Tank, Distribution plates, set of metallic/fabric filters at suction, suction louvers, bird screens, water headers, Spray nozzle, piping, pumps, valves, Drift eliminators, Fans, and all other required accessories.

**Housing/Casing of Air Washer Unit**

The housing/casing of the Air Washer Unit shall be double skin construction.

(25±2) mm thick Double Skin Panels shall be made of 0.80 mm pre-painted sheet on outer side and 0.8 mm Galvanized sheet (275 GSM) inside with 40kgs/cub mtr density, fire retardant P.U. insulation injected in between. This panel shall be screwed on to the aluminum frame work with soft rubber Gasket in between to make the joints air tight.

Frame work for each section shall be jointed together with soft rubber gasket in between to make the joints air tight with suitable size air tight access door at various sections for maintenance. The entire fan section housing shall be mounted on rolled formed GSS Channel frame work.

3.01.02 The air washer tank shall be fabricated from MS plate of minimum 6 mm thick and inside and outside surface of the tank shall be spray galvanized **(minimum 60 microns DFT).** 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.

3.01.03 The distribution plate shall be fabricated out of 18G galvanized steel sheets & galvanized steel angle supports with minimum 50% free area.

3.01.04 Air washer shall be two-bank construction (one uni-flow and the other cross flow). All header and stand pipes shall be galvanised. Cat Walks of suitable width shall be provided for maintenance of nozzles.

3.01.05 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 atomized spray and shall be properly spaced to give a uniform coverage of the air washer section. The pressure drop through the nozzle should be in the range of 1.4 to 2.4 Kg/cm2

3.01.06 The eliminator plates shall be of 24G thick GS sheets class 275 or from 100% virgin PVC of minimum finished thickness of 2 mm. The eliminator section made of GSS shall have

minimum six bends. The PVC eliminators shall be UV stabilized 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 galvanised steel or PVC construction and shall be complete with suitable drip tray and drain pipe.

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

3.01.08 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

3.01.09 The specification for centrifugal fans shall generally be as indicated below. Centrifugal fans for air washer units shall be of DIDW type.

3.01.10 Saturation efficiency of Air Washer units shall be minimum 90%.

**3.02.00 Centrifugal Fan**

3.02.01 The casing shall be of welded construction fabricated with heavy gauge galvanised sheet steel or MS sheet with spray galvanization (**minimum** 60 micron DFT). 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.

3.02.02 The impeller shall have die-formed backward-curved blades tie welded to the rim and back plate to have a non overloading characteristic 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.

3.02.03 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.

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

3.02.05 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.

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

3.02.07 The fans shall be provided with V-belts and sheaves. All belts shall be sized for 150% rated HP. All V-belt shall be equipped with removable belt guards that do not impede the air flow to the fan inlet. There shall be a minimum of two belts per drive. Motor rating (at 50 deg.C ambient) shall be atleast fifteen percent (15%) above the maximum load demand of drives at the design duty point.

**3.03.00 Centrifugal Pumps**

a) Type : Horizontal Centrifugal, Axially or radial split type casing pump or end suction, top discharge horizontal centrifugal 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 316 |
| v) Shaft sleeve | : | SS 316 |
| vi) Lantern ring | : | Brass / Bronze |
| vii) Packing | : | Asbestos free |
| viii) Base Plate | : | Carbon steel as per IS:2062 |
| ix) Speed | : | Maximum 1500 rpm |
| x) Other requirements | : | To refer to **Annexure-I** titled "Horizontal Pumps" of this sub section. |

**3.04.00 Axial Fans**

3.04.01 These fans shall have fixed / variable pitch cast aluminum blades of aerofoil design.

3.04.02 The fan casing shall be of heavy gauge sheet steel construction.

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

3.04.04 The speed of the fan shall not exceed 1000 rpm for fan with impeller diameter above 450 mm and 1500 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 1500 rpm for fan with impeller diameter of above 450 mm and 3000 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.

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

3.04.06 Fans of capacity 1000 $m^3$/hr & lower shall be of propeller exhaust type.

3.04.07 Hydrogen generation plant, fuel oil pressurizing pump house, fuel oil unloading pump house, central lube oil purification room, Gas rooms in TG building and battery rooms of TG building, GIS control building, etc. shall be provided with spark proof (with flame proof motor) fans.

**3.05.00 Roof Ventilators**

3.05.01 The roof extractors shall be "COWL" type.

3.05.02 Impeller shall be of axial flow type, cast Aluminum in one piece and dynamically balanced. Casing shall be heavy gauge sheet steel construction of 3 mm thick for impeller upto 750 mm diameter and 5 mm for fans with impeller of diameter 750 and above. In casing, access door with locking arrangement be provided.

3.05.03 The cowl shall be designed for weather protection of the fan also inside of the roof on which the extractor is installed. Galvanised bird screen of 15 mm Square be provided with the cowl. All accessories, steel supports as required will be provided.

3.05.04 The speed of the fan be limited as per limitation given above for axial fans.

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

3.05.06 The vibration level for fans shall be as per ISO: 14694.

**3.06.00 BALANCE EQUIPMENT SPECIFICATION**

**3.06.01 Piping and Fittings (Material & Standard)**

a) Circulating water piping of Ventilation System : Heavy grade-IS: 1239 or Equivalent upto150 NB and Grade 410 of IS: 3589 or Equivalent for pipes beyond 200 NB with thickness as detailed at **Annexure-II.** The piping upto 100 mm diameter shall be of galvanized steel **(galvanization shall be as per IS: 4736)** and those above 100 mm dia. shall be black steel. The piping shall be adequately supported.

b) Drain piping : Same as (a) above & galvanised as per IS: 4736.

c) Fittings :

1) The steel fittings shall conform to ASTM A234 Gr WPB and dimensional standard to ANSI B 16.9/ANSI B16.11 / Equivalent for sizes 65 NB and above.

2) For sizes 50 NB and below, the material shall conform to ASTM A-105.

3) All steel flanges shall be of slip on type and shall conform to ANSI B 16.5

4) For pipe sizes above 350 NB, fabricated fittings from sheets of adequate thickness may be used. The bend radius in case of mitre bends shall be minimum 1.5 times the nominal pipe diameter and angle between two adjacent sections shall not be more than 22.5 deg and shall be as per BS:2633/BS:534.

5) Fittings, flanges and pipe joints of refrigerant piping shall conform to ANSI B31.5

**3.07.00 VALVES**

3.07.01 Technical data sheet of the various types of valves (Gate, Globe, Butterfly and check valve) shall be as per **Annexure-III**.

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

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

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

3.07.05 Valves shall be furnished with back seating arrangement for replacing while working under full working pressure.

3.07.06 Manual gear operators be provided for valves of size 250 NB and above in case of Gate valve & Globe valve.

3.07.07 All valves shall be supplied with companion flanges, nut bolts & washers etc.

**3.08.00 AIR FILTERS**

3.08.01 Pre Filter

1) Type : Flange / Cassette

2) **a) Fabric Filter*:**

Pre-filter shall contain washable non-woven synthetic fiber or high density polyethylene (HDPE) media having 18G GSS / 16G Al alloy frame. The filter media shall be supported with HDPE mesh on air inlet side & Aluminium expanded metal on exit side or G.I. wire mesh on both sides.

**b) Metallic Filter*:**

Filter medium, aluminium alloy shall be supported on galvanized expanded metal casing. Frame shall be fabricated from aluminium alloy of minimum 16G thickness conforming to IS: 737 or 18 gauge.

* For air washer units taking suction from C-row side, only metallic pre-filters shall be provided. However, for other air washer units, Contractor may provide fabric or metallic pre-filters.

3) **Other requirements : (as applicable)**

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.

e) Filter media shall be fire retardant and resistant to moisture, fungi, bacteria & frost.

4) **Efficiency :**

Average arrestance of 65 - 80 % when tested in accordance with BS:6540/ASHRAE – 52 – 76 / EN-779.

5) Minimum thickness : 50 mm

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 : At the Suction of each Air washer and UAF (water repellent nylon type)

**3.08.02** **Fine Filters (Microvee type)**

1) Type : Flange / Cassette

2) Fine filter shall contain washable non-woven synthetic fibre or High density Polyethylene (HDPE) media having 18G GSS / 16G Al alloy frame. The filter media shall be supported with HDPE mesh on air inlet side & Aluminium expanded metal on exit side or G.I. wire mesh on both sides.

3) Other requirements :
   a) A neoprene sponge rubber sealing shall be provided on either face of the filter frame.
   b) Capable of being cleaned by air or water flushing.
   c) Filter media shall be fire retardant and resistant to moisture, fungi, bacteria & frost.

4) Efficiency : Average arrestance > 90% when tested in accordance with BS:6540/ASHRAE–52-76 / EN-779.

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 25 mm WC.

8) Location : i) At the discharge of each Fresh air fan.

ii) At the discharge of each supply air fan having static pressure 30mm wc or more.

**3.09.00** **Low Pressure Air Distribution System.**

3.09.01 Material of air distribution system shall be through galvanised steel sheet (Conforming to Grade 275 of IS: 277) or Aluminium alloy (grade 19000 / SIC or 3100 / NS3 of IS:737)

3.09.02 Thickness of rectangular ducts shall be as follows:

| Larger Dimension of duct (mm) | Thickness of GI sheet(mm) | Thickness of Aluminium sheet (mm) |
|---|---|---|
| up to 750 mm | 0.63 (24 G) | 0.80 |
| 751 to 1500 | 0.80 (22 G) | 1.00 |
| 1501 to 2250 | 1.00 (20 G) | 1.50 |
| 2251 & above | 1.25 (18 G) | 1.80 |

3.09.03 Thickness of round ducts shall be as follows:

| Diameter of Round duct (mm) | Thickness of GI sheet(mm) | Thickness of Aluminium sheet (mm) |
|---|---|---|
| 150 to 500 | 0.63 | 0.80 |
| 501 to 750 | 0.80 | 1.00 |
| 751 to 1000 | 0.80 | 1.00 |
| 1001 to 1250 | 1.00 | 1.50 |
| 1251 & above | 1.25 | 1.80 |

3.10.00 **Duct Fabrication and Supports:**

a) Duct fabrication shall be as per the latest relevant BIS/SMACNA standard.

b) The ducts routed inside the buildings with larger side greater than 2250 mm shall be supported by 16mm MS rods and 50x50x3 mm MS double Angles while those below 2250 mm shall be supported by 10mm MS Rods and 40x40x3 MS angles. The duct supports shall be at a distance of not more than 2000mm for ventilation ducts. The MS rods for these ducts routed inside the building shall be hung from the existing floor beams/wall beams/roof beams/columns as provided by the Employer with provision of necessary auxiliary or special steel members or by hooks or can be provided by contractor by dash fasteners fixed to the ceiling slab. No supports shall be taken from horizontal/vertical bracings of the structures. All items of duct support including MS rods, MS angles and double angles, auxiliary or special steel members, hooks, dash fasteners coach screws and all other supporting material required shall be provided by the bidder.

c) Where the sheet metal duct connects to the intake or discharge of fan units a flexible connection of fire retarding, at least 150 mm width shall be provided of closely woven, rubber impregnated double layer asbestos/canvas or neoprene coated fiber glass.

d) All curves, bends, off-sets and other transformations shall be made for easy and noiseless flow of air. The throat of every branch duct shall be sized to have the same velocity as in the main duct to which the branch duct is connected.

e) Wherever duct passes through a wall, the opening between masonry and duct work shall be neatly caulked or sealed to prevent movement of air from one space to the adjoining space.

f) Wherever pipe hangers or rods pass through the ducts, light and streamline ease-ment around the same shall be provided to maintain smooth flow of air.

g) Access doors shall be provided in the duct work or casing on the both sides of the equipment to be serviced. All access doors shall be of adequate size and shall be lined with substantial felt edging to prevent air leakage. Access doors shall be of built up construction, structurally strong and each shall have at least two hinges. Access doors shall have two rust proof window sash of approved type. All doors shall be set so as to flush with insulation or plaster finish on the duct.

h) Where ever horizontal ducts are running outside the building and or at locations where it is not possible to support the ducts from Employers ceiling/floor due to non-availability of the same, the base steel frame/truss work for supporting the ducts between two columns shall be provided by Employer. However, all other auxiliary steel members, hooks, rods, etc. for supporting the duct work with the base frame/truss work shall be provided by the bidder. For vertical ducts running outside the building, bidder to take support from building columns and beams which is in Employer scope. However, all other auxiliary steel members, hooks, rods, etc. for supporting the duct work with the Employers beam & columns shall be provided by the bidder.

3.11.00 Splitters and dampers shall be provided for equipment/area isolation and for proportional volume control. The same shall be minimum 16 gauge GS sheet of quadrant type with suitable locking device, mounted outside of duct in accessible position.

3.12.00 Gravity operated back draft dampers shall be installed in association with supply air system in order to maintain positive pressure inside MCC/switchgear and cable gallery areas.

**3.13.00 Diffusers, Grills & Dampers**:

3.13.01 Supply air diffusers/grills with volume control dampers be provided for all areas provided with evaporative cooling system.

3.13.02 Inlet/Exhaust air grills/louvers are required for all negatively pressure ventilated areas. Back draft dampers shall be provided for all areas pressurized under ventilation system.

3.13.03 The diffusers/grills shall be of powder coated mild steel construction for Ventilation system.

3.13.04 Supply air grills shall be of double deflection type.

3.13.05 All volume control (VC) damper shall be operated by a key from the front of the grills/diffusers and shall be GI sheet.

3.13.06 The thickness of frames of Diffusers, grills & VC dampers shall be of minimum 20 gauge and thickness of louvers shall be of minimum 26 gauge.

3.13.07 Suitable vanes shall be provided in the duct collar to have uniform and proper air distribution.

3.13.08 Bank of Baffles wherever required shall also be provided.

| | |
|---|---|
| 3.13.09 | Fire dampers shall be motor operated type and shall have fire rating of minimum 90 minutes. |
| 3.13.10 | All plenum chambers of connections to fans, dampers etc shall be constructed in 18 gauge GS sheet and supported on MS angle frames. |
| 3.13.11 | All ducting surfaces, grills, dampers coming in contact with corrosive fumes or gases shall be painted with three coats of epoxy paint over a coat of suitable primer. |
| 4.00.00 | **Thermal and Acoustic Insulation** |
| 4.01.00 | **A)** Application with Glass Wool |
| 4.01.01 | All surfaces to be insulated both thermally and acoustically shall be thoroughly cleaned, dried and an adhesive (CPRX compound of Shalimar Tar Products or Equivalent) be applied @ 1.5 Kg /Sqm on the surface. |
| 4.01.02 | Insulation material (either expanded polystyrene foam or Glass Wool/ Glass fiber or Equivalent) shall be struck to the surface. All the joints shall be sealed with bitumen. |
| 4.01.03 | Insulation mass to be covered with 500 gauge polythene sheet with 50 mm overlaps and sealing all joints on hot side. |
| 4.01.04 | Insulation Finish of types specified under shall be provided thereafter. |
| | **B)** Application with Nitrile Rubber:<br>(a) All surfaces to be insulated shall be properly cleaned.<br>(b) A suitable adhesive such as SR 998 or equivalent shall be applied over the surfaces to be insulated and insulation material surfaces.<br>(c) Insulating material shall than be pasted onto the surfaces in a manner to avoid stretching and any air entrapment within.<br>(d) Two layers of Glass Cloth with a suitable adhesive as SR 998 or equivalent shall be then applied over the insulating material to avoid surface weathering. |
| | **C)** Application with FR Closed Cell Chemically Cross Linked Polyethylene Material (XLPE)<br>(a) All surfaces to be insulated shall be properly cleaned of any dust, grease and moisture.<br>(b) A suitable adhesive, normally, a pressure sensitive acrylic base, such as SR 998/STAR Glue R242 or Neosole AA 900 or equivalent shall be used to paste the insulating material over the cleaned surface.<br>(c) XLPE cut to size for each surface, with overlaps provided for two faces shall be stuck to the surfaces in a manner to avoid air entrapment. The extent of over-lap shall be equivalent to the thickness of the material to be applied. The adhesive is applied on both the surfaces to be insulated and the insulation foam material. |

(d) Application of the insulating material to surfaces should preferably be carried out at ground level, in a clean dust free area.

(e) All joints- lateral & longitudinal, shall be taped with self adhesive aluminium foil tape 75 mm wide. The insulation over the surface shall be then held in position with 12mm wide PVC straps at every 600mm, to provide a neat & clean finish.

**4.02.00 Type of Insulation & Finish**

| Sl. No. | Surface | Insulation Material | Insulation Form | Thick (mm) | Finish (mm) |
|---|---|---|---|---|---|
| 1. | Acoustic insulation of duct | Resin bonded Glass wool | Slab | 25 | As per specifications |
| 2. | Exposed air duct | Resin bonded Glass wool/Rock wool<br>Or<br>Polyisocyanurate Foam | Roll/Slab<br><br>Slab | 50<br><br>50 | F-4<br><br>F-4(a) |

4.03.00 **Specification for insulation shall be as follows: -**

| Insulation Material | Code | Thermal conductivity (w/m/$^{o}$C) | Density Kg/m$^3$ |
|---|---|---|---|
| Resin bonded glass wool / Rock wool | IS:8183 | 0.049 at 50$^{o}$C | i) 24 (For Glass wool)<br>ii) 48 (For Rockwool)<br>iii) 48(For acoustic insulation) |
| Polyurethane Foam<br>Polyisocyanurate Foam | IS12436 | 0.03 at 50 $^{o}$C<br>0.03 at 50 $^{o}$C | 34 $\pm$ 2<br>34 $\pm$ 2 |
| Note : Insulation used for shall be CFC/HCFC free | | | |

4.04.00 The specification for various finishes shall be as follows

| | |
|---|---|
| a) | **Finish F-1**<br><br>Step-1 Wrapping of Poly-Bonded Hessain (PBH – to act as vapour seal) on outer surface of insulation with 50 mm overlap stitching and sealing of overlap with synthetic adhesive like CPRX or Equivalent compound.<br><br>Step-2 The surface then shall be wrapped with 19 mm mesh 24 SWG GI wire netting, butting all the joints and laced down with 22 SWG lacing wire.<br><br>Step-3 Sand cement (4:1) plaster shall be applied in two layers totalling to 12.5 mm thick, the second layer being brought to a smooth finish. A water proofing compound shall be added to the cement before its application. |
| b) | **Finish F-4**<br>Step-1 Same as Step-1 of Finish F-1 above.<br><br>Step-2 Same as Step-2 of Finish F-1 above.<br><br>Step-3 Same as Step-3 of Finish F-1 above.<br><br>Step-4 Application of 3 mm thick coat of suitable water proofing compound and wrapped with fibre glass RP tissue followed by final coat of 3 mm thick water proofing compound over the RP tissue.<br><br>Step-5 After the above treatment, 22G Aluminium sheet cladding, properly stitched at all joints shall be provided over the external surface. |
| c) | **Finish F-4(a) (With FR Closed Cell Chemically Cross Linked Polyethylene Material)** |
| | Application of aluminium sheet 22G cladding to be provided over the XLPE insulating material. Cladding sheet is held in position with SDST screws @ 150 mm C/C over tounge-in-groove joints applied with afelt for sealing joint against water ingress.<br><br>Al sheet joints to be done in a manner to shed water. |

4.05.00 For all inspection covers and hatches on equipment, pump casing, valve bodies and flanges (100 mm and above), insulation shall be applied so as to facilitate removal without minimum damage to the insulation by encasing the insulation in 24 gauge GI box or 22 gauge Aluminium sheet metal boxes which are bolted together around the equipment. However continuity of the vapour seal between the static and removable portions of the insulation is to be maintained

**4.06.00 Acoustic Insulation**

All ducts up to a distance of 5 meters from Air washer unit fan, UAF fan and other centrifugal fan outlet shall be acoustically lined from inside with 25 mm thick resin bonded glass wool of 48 Kg/Cu.M density and 30 gauge perforated aluminium sheet having 5 mm dia perforation at 8 to 10 mm centre-to-centre distance. Insulation shall be fixed on wooden frame of 600 x 600 mm dimension.

Fiber glass tissue sheet shall be applied over the outer surface of insulation before applying perforated aluminium sheet. Application of acoustic insulation shall be inline with the requirements specified above.

**5.00.00 PLANT CONTROL**

**5.01.00 GENERAL**

5.01.01 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 Employer.

5.01.02 **Control Scheme of Ventilation System**

The Ventilation system for main Plant area (excluding roof extraction fans, standalone Air supply and Air Exhaust fans) shall be controlled through microprocessor based Distributed Digital Control Monitoring and Information System (DDCMIS). This DDCMIS system shall perform all functions such as auto/manual operation of valves, pumps, drives, local/remote selection of operation, status indication, annunciation, interlock and protection of pumps/drives, etc.

**5.02.00 Air Washer Units (AWU)**

5.02.01 Air washer units shall be started/stopped by initiation from Main DDCMIS based control system of A/C plant (provided by contractor) for Main plant area. Starting/stopping of pumps shall be automatic upon such initiation.

5.02.02 The operation of the pumps shall be interlocked with the low level of water in the sump. High level of the sump shall be alarmed.

**5.03.00 Miscellaneous control requirements**

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

5.03.02 The status of each pump, centrifugal fans, etc. of centralized ventilation system is available on OWS in control room locally.

5.03.03 All the alarms 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 control system.

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

**6.00.00 CODES & STANDARDS**

6.01.00 The design, manufacture and performance of equipment shall comply with all currently applicable statues, regulations and safety codes in the locality where the equipments are to be installed. Nothing in this specification shall be considered to relieve the bidder of this responsibility.

6.01.02 Unless otherwise specified, equipment shall conform to the latest applicable Indian or IEC standard. Equipment complying with other authoritative standards such as British, USA,

ASHRAE etc. will also be considered if it ensures performance equivalent or superior to Indian Standard.

**7.00.00 PAINTING**

**7.01.00 Painting Details for Vendor's Equipments/Other Items**

a) All the Equipments shall be protected against external corrosion by providing suitable painting.

b) The surfaces of stainless steel, Galvanised steel, Gunmetal, brass, bronze and non-metallic components shall not be applied with any painting. The Contractor shall clean the external surfaces and internal surfaces before Erection by wire brushing and air blowing. The steel surface to be applied with painting shall be thoroughly cleaned before applying painting by brushing, shot blasting etc as per the agreed procedure.

c) For all the steel surfaces (external) exposed to atmosphere (outdoor installation), a coat of red oxide primer of thickness 30 to 35 microns followed up with three coats of synthetic enamel paint, with 25 microns as thickness of each coat, shall be applied. For plant at coastal area, epoxy resin based zinc phosphate primer followed by epoxy resin based paint pigmented with titanium di-oxide shall be used in place of enamel paints.

d) For all the steel surfaces inside the building (indoor installation), a coat of red oxide primer of thickness 30 to 35 microns followed up with two coats of synthetic enamel paint, with 25 microns as thickness of each coat, shall be applied. For plant at coastal area, epoxy resin based zinc phosphate primer followed by epoxy resin based paint pigmented with titanium di-oxide shall be used in place of enamel paints.

e) For centrifugal/axial/Roof extractor fans - Casing shall have hot dip/ spray galvanization (**minimum** 60 micron DFT).

f) However for all parts coming in contact with acid fumes (in Battery rooms), a coat of epoxy resin based zinc phosphate primer of minimum thickness 30 to 35 microns followed up with undercoat of epoxy resin based paint pigmented with Titanium dioxide of minimum thickness of 25 microns shall be applied and a top coat consisting of one coat of epoxy paint of approved shade and colour with glossy finish of minimum thickness of 25 microns.

**7.02.00 Employer's Painting Scheme of Steel Surfaces** (To be followed by the Vendor for affected areas as described in Subsequent clauses)

(a) All steel surfaces shall be provided with self curing Inorganic Zinc Silicate Primer Coat (Solid by Volume Minimum 60%) of Minimum 75 Micron Dry Film Thickness (DFT) applied over blast cleaned surface to near white metal conforming to Sa 2 ½ finish of Swedish standard SIS-05-5900. The Primer shall be applied in Shop immediately after blast cleaning by Airless spray technique.

(b) Primer Coat shall be followed with the application of Intermediate Coat of Polyamide Cured pigmented Titanium Dioxide ($TiO_2$) or Micaceous Iron Oxide (MIO) Epoxy based Paint (Solid by Volume Minimum 60%) of Minimum 75 Micron DFT. This Coat shall be applied in Shop after an interval of Minimum overnight (from the application of Primer Coat) by Airless spray technique.

(c) Intermediate Coat shall be followed with the application of Finish Coat of Polyamide Cured colour pigmented Epoxy based Paint (Solid by Volume Minimum 60%) of Minimum 75 Micron DFT. This Coat shall be applied after an interval of Minimum

overnight and maximum indefinite (from the application of Intermediate Coat) either before Erection by Airless spray technique or after Erection by brush and / or spray. Colour and shade of the Coat shall be as approved by the Employer. The finish Coat thickness of 75 Micron can be built up either in Single application at Shop or in two applications one at Shop and the other at Site.

(d) Finish Coat shall be followed with the application of Final Finish Coat of Polyurethane based colour pigmented Paint (Solid by Volume Minimum 40%) of Minimum 25 Micron DFT. This Coat shall be applied within Seven (7) days (from the completion of Finish Coat), after Erection by brush and / or spray. Colour and shade of the Coat shall be as approved by the Employer.

**7.03.00** **Touch-up Painting on damaged areas**

(a) For Coatings damaged up to metal surface

Surface preparation shall be carried out by Manual Cleaning. Minimum 6 inches adjoining area with existing Coating shall be roughened by Wire brushing, emery paper rubbing etc., for best adhesion of patch Primer.

Primer Coat of self-priming Epoxy Touch-up Primer applied by brush immediately after the surface preparation. (Minimum DFT 100 Microns). Over this Primer Coat, Intermediate Coat, Finish Coat and Final Finish Coat shall be applied as covered above by brush with Intermediate Coat applied within seven (7) days of application of touch up Primer.

(b) For Coatings damaged upto Intermediate Coatings (i.e. where Primer is intact).
Damaged area including Minimum 6 inches adjoining area with existing Coating should be roughened by wire brushing, emery paper rubbing etc., for best adhesion of patch Primer without damaging the Primer Coat.

Touch-up Primer, Intermediate, Finish and Final Finish Coats shall be applied as specified above for Coatings damaged up to metal surface.

7.04.00 Painting to be provided by Vendor over Welded areas / areas exposed after removal of temporary supports / Touch-up Painting on damaged areas of Employer's Structures, where interconnection, Welding / modification etc. has been carried out by the Bidder.

(a) Clean the surface to remove flux spatters and loose rust, loose Coatings in the adjoining areas of Weld seams by wire brush and emery paper.

(b) Painting procedure to be followed as mentioned above for Touch-up Painting on damaged areas.

**Annexure –I**

## GENERAL SPECIFICATION FOR HORIZONTAL PUMPS

1) **SCOPE**

This specification covers the design, material, construction features, manufacture, inspection, testing the performance at the Vendor's/Sub-Vendor's Works and delivery to site of Horizontal Centrifugal Pumps.

2) **CODES AND STANDARDS**

The design, material, construction, manufacture inspection and performance testing of Horizontal Centrifugal Pumps shall comply with all currently applicable statutes, regulations and safety codes in the locality where the Equipment will be installed. Nothing in these specifications shall be construed to relieve the Vendor of this responsibility. The Equipment supplied shall comply with the latest applicable Indian Standards listed below. Other National Standards are acceptable, if they are established to be equal or superior to the Indian Standards.

3) List of Applicable Standards.

IS : 1520 : Horizontal Centrifugal Pumps for clear cold fresh water

IS : 5120 : Technical requirements of rotodynamic special purpose pumps

API : 610 : Centrifugal pumps for general refinery service.

IS : 5639 : Pumps Handling Chemicals & corrosion liquids

IS : 5659 : Pumps for process water

HIS : Hydraulic Institute Standards, USA

ASTM-1-165-65 Standards Methods for Liquid Penetration Inspection.

In case of any contradiction with aforesaid standards and the stipulations as per the technical specifications as specified hereinafter the stipulations of the technical specifications shall prevail.

4) **DESIGN REQUIREMENTS**

a) The Pump shall be capable of developing the required total head at rated capacity for continuous operation. Also the pumps shall be capable of being operated to give satisfactory performance at any point on the HQ characteristics curve. The operating range of the pump shall be 40% to 120% of the duty point unless otherwise mentioned elsewhere. The maximum efficiency of pump shall preferably be within ± 10% of the rated design flow as indicated in data sheets.

b) The total head capacity curve shall be continuously rising from the operating point towards shut-off without any zone of instability and with a minimum shut-off head of about 15% more than the design head.

**Annexure –I**

c) Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division. The head Vs capacity and BHP Vs capacity characteristics should match to ensure even load sharing and trouble free operation throughout the range. Components of identical pumps shall be interchangeable.

d) Pumps shall run smoothly without undue noise and vibration. Peak to peak vibration limits shall be restricted to the following values during operation:

| Speed | Antifriction Bearing | Sleeve Bearing |
|---|---|---|
| 1500 rpm and below | 75.0 micron | 75.0 micron |
| 3000 rpm | 50.0 micron | 65.0 micron |

The noise level shall not exceed 85 dBA overall sound pressure level reference 0.0002 microbar (the standard pressure reference for air sound measurement) at a distance of 1 M from the equipment surface.

e) The pumps shall be capable of starting with discharge valve fully open and close condition. Motors shall be selected to suit to the above requirements. Continuous Motor rating (at 50 deg.C ambient) shall be atleast ten percent (10%) above the maximum load demand of the pump in the entire operating range to take care of the system frequency variation and no case less than the maximum power requirement at any condition of the entire characteristic curve of the pump.

f) The kW rating of the drive unit shall be based on continuously driving the connected equipment for the conditions specified. However, in cases where parallel operation of the pumps are specified, the actual motor rating is to be selected by the Bidder considering overloading of the pumps in the event of tripping of operating pump(s).

g) Pumps shall be so designed that pump impellers and other accessories of the pumps are not damaged due to flow reversal.

h) The Contractor under this specification shall assume full responsibility in the operation of pump and motor as a unit.

5) **DESIGN CONSTRUCTION**

a) Design and construction of various components of the pumps shall conform to the following general specifications. For material of construction of the components, data sheets shall be referred to.

b) **Pump Casing**

Pump casing shall have axially or radially split type construction as specified. The casing shall be designed to withstand the maximum shut-off pressure developed by the pump at the pumping temperature.

Pump casing shall be provided with a vent connection and piping with fittings & valves. Casing drain as required shall be provided complete with drain valves, piping and plugs. It shall be provided with a connection for suction and discharge pressure gauge as standard feature. It shall be structurally sound to provide housing for the pump assembly and shall be designed hydraulically to minimum radial load at part load operation.

**Annexure –I**

c) **Impeller**

Impeller shall be closed, semi-closed or open type as specified elsewhere and designed in conformance with the detailed analysis of the liquid being handled.

The impeller shall be secured to the shaft, and shall be retained against circumferential movement by keying, pinning or lock rings. On pumps with overhung shaft, impellers shall be secured to the shaft by a lockout or cap screw which tightness in the direction of normal rotation.

d) **Impeller/Casing Wearing Rings**

Replaceable type wearing rings shall be provided at suitable locations of pumps. Suitable method of locking the wearing ring shall be used. Wearing rings shall be provided in pump casing and/or impeller as per manufacturer's standard practice.

e) **Shaft**

The critical speed shall be well away from the operating speed and in no case less than 130% of the rated speed.

The shaft shall be ground and polished to final dimensions and shall be adequately sized to withstand all stresses from rotor weight, hydraulic loads, vibration and torques coming in during operation.

f) **Shaft Sleeves**

Renewable type fine finished shaft sleeves shall be provided at the stuffing boxes/mechanical seals. Length of the shaft sleeves must extend beyond the outer faces of gland packing of seal end plates so as to distinguish between the leakage between shaft and shaft sleeve and that past the seals/gland.

Shaft sleeves shall be fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation.

**Annexure –I**

g) **Bearings**

Heavy duty bearings, adequately designed for the type of service specified in the enclosed pump data sheet and for long, trouble free operation shall be furnished.

The bearings offered shall be capable of taking both the radial and axial thrust coming into play during operation. In case, sleeve bearings are offered additional thrust bearings shall be provided. Antifriction bearings of standard type, if provided, shall be selected for a minimum life 20,000 hrs. of continuous operation at maximum axial and radial loads and rated speed.

Proper lubricating arrangement for the bearings shall be provided. The design shall be such that the bearing lubricating element does not contaminate the liquid pumped. Where there is a possibility of liquid entering the bearings suitable arrangement in the form of deflectors or any other suitable arrangement must be provided ahead of bearings assembly.

Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearings housing.

h) **Stuffing Boxes**

Stuffing box design should permit replacement of packing without removing any part other than the gland.

Stuffing boxes of packed ring construction type shall be provided wherever specified. Packed ring stuffing boxes shall be properly lubricated and sealed as per service requirements and manufacturer's standards. If external gland sealing is required, it shall be done from the pump discharge. The Bidder shall provide the necessary piping valves, fittings etc. for the gland sealing connection.

i) **Mechanical Seals**

Wherever specified in pump data sheet, mechanical seals shall be provided. Unless otherwise recommended by the tenderer, mechanical seals shall be of single type with either sliding gasket or bellows between the axially moving face and shaft sleeves or any other suitable type. The sealing faces should be highly lapped surfaces of materials known for their low frictional coefficient and resistance to corrosion against the liquid being pumped.

j) The pump supplier shall coordinate with the seal maker in establishing the seal chamber of circulation rate for maintaining a stable film at the seal face. The seal piping system shall form an integral part of the pump assembly. For the seals under vacuum service, the seal design must ensure sealing against atmospheric pressure even when the pumps are not operating. Necessary provision for seal water supply along with complete piping fittings and valves as required shall form integral part of pump supply.

k) **Pump Shaft Motor Shaft Coupling**

The pump and motor shafts shall be connected with an adequately sized flexible coupling of proven design with a spacer to facilitate dismantling of the pump without disturbing the motor. Necessary coupling guards shall also be provided.

**Annexure –I**

l) **Base Plate**

A common base plate mounting both for the pump and motor shall be furnished. The base plate shall be fabricated steel and of rigid construction, suitably ribbed and reinforced. Base plate and pump supports shall be so constructed and the piping unit so mounted as to minimise misalignment caused by mechanical forces such as normal piping strain, internal differential thermal expansion and hydraulic piping thrust. Suitable drain troughs and drip lip shall be provided.

m) **Assembly and Dismantling**

Assembly and dismantling of each pump with drive motor shall be possible without disturbing the grouting base plate or alignment.

n) **Drive Motor (Prime Mover)**

The kW rating of the drive shall be based on continuously driving the connected equipment for the conditions specified. However, in cases where parallel operation of the pumps are specified, the actual motor rating is to be selected by the Bidder considering overloading of the pumps in the event of tripping of operating pump(s).

**ANNEXURE-II**

**PIPING THICKNESS:** Pipes for sizes 200 NB & above shall confirm to IS: 3589 Grade 410. The thickness as mentioned below are the minimum specified nominal thickness as per IS: 3589. Tolerance as code shall be applicable.

| Nominal pipe Size (mm) | Outside Diameter (mm) | Wall Thickness (mm) |
|---|---|---|
| 200 NB | 219.1 | 4.5 |
| 250 NB | 273 | 5 |
| 300 NB | 323.9 | 5.6 |
| 350 NB | 355.6 | 5.6 |
| 400 NB | 406.4 | 6.3 |
| 450 NB | 457 | 6.3 |
| 500 NB | 508 | 6.3 |
| 600 NB | 610 | 6.3 |

**Annexure-III**

**I. DATA SHEET FOR WATER LINE GATE VALVES**

| | | |
|---|---|---|
| 1.0 | Size Range | 50 MM & above |
| 2.0 | Design Code | IS: 14846 or BS : 5150 |
| 3.0 | Pressure Rating | a) PN 1.0 (as per IS:14846)<br>b) PN 10 (as per BS:5150) |
| 4.0 | **Construction features** | |
| 4.1 | Stem | Outside screw and yoke type, rising stem |
| 4.2 | Ends | Flanged, ANSI B16.5 Cl 150 (minimum) |
| 4.3 | Bonnet | Bolted |
| 4.4 | Wedge | Solid Wedge |
| 5.0 | Operation | by handwheel<br>(Gear reduction unit for valve size 200 NB and above wherever applicable ) |
| 6.0 | Seat | |
| | a) Body | Renewable |
| | b) Disc. | Renewable |
| 7.0 | **Material of construction** | |
| 7.1 | Body/Bonnet/Handwheel | Cast Iron to IS:210 FG-200 |
| 7.2 | Wedge Gland | Cast Iron to IS:210 FG-200 |
| 7.3 | Stem | S.S. 410 |
| 7.4 | Body Seat | GM to IS:318 Gr.-2 |
| 7.5 | Wedge Seat | GM to IS:318 Gr.-2 |
| 7.6 | Packing | Graphited Asbestos. |
| 7.7 | Back Seat Bushing | GM to IS:318 Gr.-2 |
| 7.8 | Bolts, Nuts, & Studs | Carbon Steel to IS:1367, Cl- 4.6/4.0 |
| 8.0 | **Accessories required** | |
| | a) Position indicator | |
| | b) Draining arrangement for valve seat | |
| | c) Locking facility with lock | |

| | | |
|---|---|---|
| | d) Gear reduction unit for valve size 200 NB and above. | |

**II. DATA SHEET FOR GLOBE VALVES (AS APPLICABLE)**

| | | |
|---|---|---|
| 1.0 | Size Range | 50 MM & Above |
| 2.0 | Design Code | BS : 5152 / Equiv. |
| 3.0 | Pressure Rating | PN 10 (as per BS:5152) |
| 4.0 | **Construction features** | |
| 4.1 | Stem | Outside screwed & rising spindle |
| 4.2 | Ends | Flanged, ANSI B16.5 Cl 125 / Cl. 150 |
| 4.3 | Bonnet | Bolted |
| 4.4 | Wedge | Solid wedge |
| 5.0 | Operation | by handwheel<br>(Gear reduction unit for valve size 200 NB and above wherever applicable ) |
| 6.0 | Seat | |
| | a) Body | Renewable |
| | b) Disc. | Renewable |
| 7.0 | **Material of construction** | |
| 7.1 | Body/Bonnet/Handwheel | Cast Iron to IS:210 FG-200 |
| 7.2 | Wedge Gland | Cast Iron to IS:210 FG-200 |
| 7.3 | Stem | S.S. 410 |
| 7.4 | Body Seat | GM to IS:318 Gr.-2 |
| 7.5 | Wedge Seat | GM to IS:318 Gr.-2 |
| 7.6 | Packing | Graphited Asbestos. |
| 7.7 | Back Seat Bushing | GM to IS:318 Gr.-2 |
| 7.8 | Bolts, Nuts, & Studs | Carbon steel to IS:1367, CL – 4.6/4.0 |
| 8.0 | **Accessories required** | |
| | a) Position indicator | |
| | b) Draining arrangement for valve seat | |
| | c) Locking facility with lock | |
| | d) Gear reduction unit for valve size 200 NB and above. | |

**III.** **DATA SHEET FOR CHECK VALVES**

| | | | |
|---|---|---|---|
| 1.0 | Size range | Below 50 NB | 50 NB and above |
| 2.0 | Design Code/rating | IS : 778 | IS : 5312/ BS:5153 |
| 3.0 | Type | Swing check type | |
| 4.0 | Pressure Rating | a) PN 1.0 (as per IS:5312)<br>b) PN 10 (as per BS:5153) | |
| 5.0 | End connection | Screwed ends ANSI B16.5 | Flanged to Class 150 min |
| 6.0 | Material Specifications | | |
| | a) Body, cover, flap, hinges | GM to IS:318 Gr.2 | Cast Iron IS:210 Gr. FG.200 |
| | b) Hinge pin, door pin | HT Brass | SS |
| | c) Body seat ring, disc. facing ring | ------- | GM to IS:318, LTB 2 |
| | d) Gaskets | ------- | Compressed asbestos Fiber. |

**IV.** **DATA SHEET FOR BUTTERFLY VALVE**

| | | |
|---|---|---|
| 1.0 | Size Range | 50 MM & Above |
| 2.0 | Design Code & Rating | Double flanged or lugged wafer type of low leakage rate confirming to AWWA C-504/BS:EN:593/API 609/equivalent |
| 3.0 | Pressure Rating | PN 10 |
| 4.0 | End Connection | Flanged as per ANSI B.16.5 Class 125 / BS-EN 1092 |
| 5.0 | **Material of construction** | |
| 5.1 | Body & Disc | Cast Iron |
| 5.2 | Shaft | SS 410 / SS 420 |
| 5.3 | Seat Rings | EPDM |
| 6.0 | **Accessories required** | |
| 6.1 | Position indicator | |
| 6.2 | Draining arrangement for valve seat | |
| 6.3 | Locking facility with lock | |
| 6.4 | Gear reduction unit for valve size 200 NB and above. | |

# SUB–SECTION – A-10

# PLANT UTILITIES

**2.00.00 VENTILATION SYSTEM**

a) **General**

Complete Ventilation system consisting of modular type air washer units, supply air fans, roof extractor fans, exhaust air fans, louvers, filters, ducting, diffusers, piping, instrumentation etc., for all the buildings which are in the scope of the Bidder, as detailed out in Part-B of Section-VI.

b) **Turbine hall building and associated areas**

i) Minimum ten (10) nos. of air washer units (of metallic construction-modular type) each of minimum capacity 1,00,000 $m^3$/hr, with all accessories, 1 no. DIDW centrifugal fan, 1 no. circulating water pump, etc. as detailed out in technical specification shall be provided for each unit.

ii) Minimum one (1) no. of air washer unit (of metallic construction- modular type) of minimum capacity 50,000 $m^3$/hr, with all accessories, 1 no. DIDW centrifugal fan, 1 no. circulating water pump, etc. as detailed out in technical specification shall be provided for boiler MCC of each unit.

iii) Ventilation of turbine hall is further assisted by means of roof extractor located suitably at the roof of TG hall building. The number and capacity of these roof extractor shall be selected in such a way that, it extracts approx. 60% of total discharge of air washer units. This will maintain a positive pressure within turbine hall and thus stop ingress of dusty outside air within the building.

c) **Miscellaneous areas:** All other areas like pump houses, MCC rooms and switchgear rooms, Electrical and C&I battery rooms, etc. covered under Bidder's scope and shall be ventilated by a combination of supply air fans & roof exhauster fans or supply air fans & exhaust fans or supply air fans & back draft dampers or fresh air in-take louvers & exhaust air fans. For

ventilation of battery rooms and oil rooms, flame proof motor shall be used. Further, toilets shall be provided with propeller type exhaust air fans.

d) Apart from the above, any area/building which are in the scope of the bidder and require ventilation, those areas/buildings shall be provided with ventilation system, as detailed out in Part-B of Technical Specification.

e) Supply of Mandatory spares as specified.

f) Any additional items which may not be specifically stated in the specifications but are required for completeness of the system shall be supplied by the Contractor.

g) For ventilation system, the Bidder shall provide all Instrumentation systems, accessories and associated equipment, which are included in Bidder's scope, in a fully operational condition acceptable to the Employer. The Contractor shall also provide all material, equipment and services which may not be specifically stated in the specifications but are required for completeness of the equipment/systems furnished by the Contractor and for meeting the intent and requirements of these specifications.

h) Control system of ventilation system is indicated in Sub-section IIC, Control & Instrumentation, Scope of Supply & Services, Part-A of Technical Specifications.

# THDC INDIA LIMITED

**(A Joint Venture of Govt. of India & Govt of U.P.)**

## 2X660 MW KHURJA SUPER THERMAL POWER PROJECT

(TURBINE GENERATOR AND ASSOCIATES PACKAGE)

## TECHNICAL SPECIFICATION
## FOR
## MATERIAL HANDLING EQUIPMENTS

## BHARAT HEAVY ELECTRICALS LIMITED
## (A Govt. of India Undertaking)

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

# Material Handling Equipments

## 1.0 ELECTRIC HOIST AND MANUAL HOIST (CHAIN PULLEY BLOCK)

Required number of electric hoist / manual hoist of adequate capacity, to meet the erection and maintenance requirements are to be provided for the various areas.

Manual hoists (hand operated) shall be designed to duty class 2 as per IS 3832 and electric wire rope hoist shall be designed to duty class 2 as per IS: 3938 (latest).

The stipulations of all statutory codes like Indian Electricity Act, Indian Electricity Rules, Factory Acts, Local Municipality act etc. shall however prevail over the specification requirements, in case any conflict arises between this specification and the statutory codes.

Maintenance tools and tackles shall be as per data sheet attached.

### DESIGN CRITERIA

1.0.0 Electrically operated wire rope hoists of suitable capacity, lift, and travel length shall be provided for handling of items weighing 2T and / or having lifting height more than 10m. Other hoist blocks shall be of hand operated type for both travel and lift. The hoist capacity shall be selected considering 25% margin over the weight of heaviest component /equipment to be handled. The hoist parameters (i.e. lift & travel) are subject to change/s, to suit the final layout of the area in which it is intended to be installed.

**Electric hoist** shall be provided for capacity >2T. Electric hoists shall be provided for lifts >10m irrespective of the capacity.
**Chain pulley block (Manual hoist)** - 300kg to <2T, wherever feasible, considering layout constraints.

Capacity of electric and manual (Chain pulley block) hoists shall be decided keeping 25% margin over equipment to be handled.

For hand operated hoists, the hoists shall be suitable for operation from floor level. Hand chain shall be provided for long travel of trolley and the Hoisting mechanism. The operator shall be able to control the movement of the electrical/ manual hoist with the help of floor operated pendant

### MINIMUM LIFTING REQUIREMENT

| S.N. | AREA DESCRIPTION | QTY (nos) | CAPACITY (T) | TYPE |
|---|---|---|---|---|
| 1 | LIST TO BE MENTIONED AS APPLICABLE | | | |
| 2 | | | | |
| 3 | | | | |

Note:
1. Area, type, capacity mentioned are minimum requirement and shall be finalised during detail engineering without any commercial implication
2. Travel and Lift are layout dependent and shall be finalised during detail engineering without any commercial implication
3. Additional electric/manual hoist required during detail engineering shall be provided as per design criteria given above without any commercial implication.

## 2.0 SCOPE OF SUPPLIES

Equipment and services to be furnished by the bidder for the ELECTRIC HOIST/ MANUAL HOIST with accessories as per the details given in the technical specification and data sheet A. Any equipment / accessories not specified in the specification but required to make the ELECTRIC HOIST/ MANUAL HOIST complete and efficient operation shall also be under the

bidder's scope of work.
Compliance with this specification shall not relieve the bidder of the responsibility of furnishing material and workmanship to meet the specified working/duty conditions.

2.1.0 Electric hoist shall include but not be limited to the following: -

a) Equipment offered shall be suitable for indoor duty conforming to Class II of IS: 3938.
b) Equipment shall be designed to operate in non- hazardous area.
c) Electric hoists shall be pendent operated.
d) Both hoisting and trolley movement shall be motor driven.
e) Hoisting motion shall be thru' VVVF drives to achieve creep speed of 10% of main speed.
f) Wheels shall be single flanged type.
g) Hook shall be swiveling type and fitted with a safety latch.
h) Control panel shall be hoist mounted.
i) Power feeding to the electric hoists shall be thru' PVC shrouded DSL.
j) Brakes shall be fail to safety.
k) Load/overload testing of the hoists shall be carried out as per IS: 3938.
l) All material, castings and forgings will be of tested quality & certificates shall be made available for review as per approved QAP

2.2.0 Erection and Commissioning spares (ELECTRIC HOIST)
The Bidder shall also supply erection & commissioning spares along with his main equipment as per his experience, for replacement of damaged or unserviceable parts during the execution of the project at site, to avoid delay in the project schedule. This shall form part of the main equipment supply. The Purchaser shall retain the unutilized commissioning spares. The initial fill of lubricants, oil etc. shall also be supplied by the bidder.

2.3.0 Services to be provided by the bidder
Packing, forwarding and transportation to site, storage and handling at site.

2.4.0 Erection and Commissioning

2.5.0 Functional test (Overload testing, load testing at rated speed, travel and hoisting motion checks as per relevant Indian standards)

2.6.0 Obtaining clearance and acceptance certificate from the concerned competent authority after site test as applicable. Necessary fees/expenditure as required shall be borne by the supplier.

## 3.0 Inspection and Testing

As per enclosed reference quality plan and as per IS 3938 (latest revision). Prime inspection agency shall be Consultant/ End Customer. Equipment supplied shall be strictly in accordance with nomenclature & technical specification. Any additional testing requirement/CHP (Customer Hold Point) at any stage of inspection deemed necessary by Consultant/ End Customer during detailed engineering shall be carried out without any commercial or technical implication.

## 4.0 Works Excluded

Supply of ISMB monorail.

## 5.0 PAINTING SPECIFICATION

As per painting details specified elsewhere in specification.

## 6.0 PACKING

In general packing shall be wooden box packing.

## 7.0 TESTING AT VENDOR'S WORKS

Hoist along with its drives, controls and other accessories shall be demonstrated for the rated capacity against the rated speed of motions and for the service conditions specified as specified in QAP and as per IS 3938 for electric hoist and IS 3832 for manual hoist.

The bidder shall have the full responsibility for the safe and efficient operation of the hoist with associated accessories as a single unit.

If the shop performance tests indicate the failure of any of the components to achieve the guaranteed performance, the deficiency shall be made good at bidder's cost.

Demonstration tests shall be carried out each time after the rectification /modification is carried out.

## 8.0 MAKE OF SUB - VENDOR ITEMS

Makes of bought out items will be as per list specified in the specification. No other make will be acceptable, until and unless specifically got it approved by the purchaser/ end client. (Refer Annexure-I)

## 9.0 TESTING AT SITE

**A) ELECTRIC HOIST:**

As required for statutory clearance for operating at site i.e., overload test, load test and other tests as per IS 3938.

Test for Operation -After the supply has been connected, tests shall be carried out to prove the following:

a) The satisfactory operation of each controller, switch, contactor, relay and other control devices and in particular the correct operation of all limit switches under the most unfavorable conditions;
b) The correctness of all circuits and interlocks and sequence of operation; and
c) The satisfactory operation of all protective devices.

Overload Test -After test but before the hoist is put into service, it shall be tested with overload relays appropriately set, to lift and sustain a test load of 125 percent of the working load. During the overload test, the hoist shall sustain the load under full control. The specified speeds need not be attained but the hoist shall show itself capable of dealing with the overload without difficulty.

**B) MANUAL HOIST:**

As required for statutory clearance for operating at site with following minimum test i.e. overload and load test.

## 10.0 TECHNICAL DATA SHEET:

A) Technical data sheet-A for ELECTRIC HOIST:

| Sl.no | DESCRIPTION | TECHNICAL PARTICULARS |
|---|---|---|
| 1.0 | Type | Steel wire electric hoist with electrically operated trolley |
| 2.0 | Scope (Qty., Capacity, Lift, Travel Length) | As mentioned in specification |
| 3.0 | Type of service | Indoor |
| 4.0 | Overload test | 125% of SWL |
| 5.0 | Design Ambient temperature | 50° C |
| 6.0 | General Design | As per IS: 3938 / 1983 or latest, Class-II duty |
| 7.0 | Operating speed | |

| | | |
|---|---|---|
| 7.1 | Hoisting speed/ Creep speed ( thru' VVVF drive) | 3 MPM with creep speed 10% of main speed. |
| 7.2 | Trolley speed | 10 MPM |
| 8.0 | Type of transmission | Through Electric motor and gear box. |
| 9.0 | Wire Rope | |
| 9.1 | Construction / core | 6 x 36 or 6 x 37 construction, steel/ Fibre core |
| 9.2 | Code | IS:2266 |
| 9.3 | Tensile designation | 1770/1960 N/mm2 |
| 9.4 | Number of falls | Min. 4 |
| 9.5 | Factor of safety | Not less than 5 |
| 10.0 | Load Hook and block | Normalized hook only |
| 10.1 | Type of load hook | Plain shank trapezoidal section with safety latch. |
| 10.2 | Load hook Code | IS: 15560 |
| 10.3 | Load hook Material | Alloy steel/carbon steel as per IS:15560 |
| 10.4 | Hook suspension | Thrust bearing |
| 10.5 | Material of block suspension | Fabricated from steel plate, Material: IS: 2062 |
| 10.6 | Hook can swivel freely under full load | Yes |
| 10.7 | Safety latch on hook provided | Yes |
| 10.8 | Locking device on swivelling hook | Provided |
| 10.9 | Bearing type | Antifriction Ball / Roller |
| 10.10 | Bearing life | 10,000 working hours. |
| 11.0 | Gearing | |
| 11.1 | Type | Spur / Helical, hardened and tempered with machine cut teeth |
| 11.2 | Gear material | Forged steel as per IS 3938 |
| 11.3 | Lubrication | Oil splash/ grease lubricated |
| 11.4 | Bearing type | Antifriction Ball / Roller |
| 11.5 | Bearing life | 10,000 working hours. |
| 12.0 | Trolley drive | |
| 12.1 | Wheel | Single flange taper thread |
| 12.2 | Wheel conform to (Std. / code) | IS: 3938 |
| 12.3 | Wheel material | Heat treated carbon steel/ low alloy steel, graded cast iron. |

| | | |
|---|---|---|
| 12.4 | Bearing type | Antifriction Ball / Roller |
| 12.5 | Bearing life | 10,000 working hours. |
| 12.6 | Trolley type | Rolled structural steel with side plates extended beyond wheel flanges to protect wheels. |
| 12.7 | Hardness | Max hardness 200 BHN |
| 13.0 | SHEAVE | |
| 13.1 | Material | Cast steel or mild steel. |
| 13.2 | Bearing type | Antifriction Ball / Roller. |
| 13.3 | Bearing life | 10,000 working hours. |
| 14.0 | BRAKE (HOIST) | |
| 14.1 | Type | DC EM brakes disc type (fail to safety). |
| 14.2 | Capacity | As per IS 3938. |
| 14.3 | Number | One number for each motor. |
| 15.0 | BRAKE (TROLLEY) | |
| 15.1 | Type | DC EM brakes disc type (fail to safety). |
| 15.2 | Capacity | As per IS 3938. |
| 15.3 | Number | One number for each motor |
| 16.0 | ROPE DRUM | |
| 16.1 | Material | Cast iron, cast steel or mild steel. |
| 16.2 | Flange / Flangeless | Flanged |
| 16.3 | Type of groove | As per manufacturers standard to suit the layout requirement.(Shall be decided during detail engineering) |
| 17.0 | TYPE OF DSL | |
| 17.1 | CT travel | PVC shrouded GI conductor bus bar<br>-DSL shall be sized with a margin of 10% over load requirement. |
| 18.0 | MOTORS | |
| 18.1 | Type | Sq. Cage induction, TEFC, S4 duty, 40% CDF. |
| 18.2 | Number of start | 150 starts / hr, Motors shall be suitable for direct on-line (DOL) starting |
| 18.3 | Voltage , Phase and Frequency | Suitable for rated frequency of 50 Hz with a voltage variation of +/-10% and frequency variation of +3 to -5% occurring separately or combined voltage and frequency variation of 10%. 3 phase, 4 wire |

| | | | |
|---|---|---|---|
| 18.4 | Class of insulation | Class “F” and temperature rise limited to class B. | |
| 18.5 | Type of enclosure | TEFC | |
| 18.6 | Degree of protection provided for enclosure | IP-55 | |
| 18.7 | Margin | Motor nameplate rating at 50 deg C shall have Motor rating will be calculated keeping margin of at least 10% over the maximum power requirement. | |
| 19.0 | LIMIT SWITCHES | Hoisting | Trolley |
| 19.1 | Type | One (1) no. Snap action, self-actuating type | One (1) no. two way limit switch |
| 20.0 | Control panel | * Fabricated from CRCA sheet steel not less than 1.6 mm thick<br>* Degree of protection shall be IP 52<br>* Power on indicating lamps shall be provided<br>* Panel illumination lamps operated by door switch.<br>* 2 nos earthling terminals on panel.<br>* Gland plate thickness shall be minimum 3mm.<br>* Gland plate shall be double brass compression type. | |
| 20.1 | Qty | 1 No. | |
| 21.0 | Pendent Push buttons | Up /down / forward / Reverse push buttons. Indicative marking for easy operation shall be provided. | |
| 22.0 | Fixed type Power cables | Copper/Aluminum material, minimum size : Min. 2.5 mm2 for Cu/ min 6 mm2 for Aluminum. Extruded PVC insulated, armoured and FRLS PVC sheathed heavy duty 1100 V | |
| 23.0 | Fixed type Control cable | Copper material, min. 1.5 mm2 Control cables shall have stranded copper conductor, Extruded PVC insulated, armoured and FRLS PVC sheathed heavy duty 1100 V | |
| 24.0 | Trailing cable (Power/ Control) | EPR insulated, copper conductor trailing cables, as per IS:9968. | |
| 25.0 | Control Voltage | 110 V | |
| 26.0 | End stopper for CT | 2 nos., MOC shall be as per IS 2062 | |
| 27.0 | Buffer for CT | 2 nos. Spring/rubber type shall be provided on trolley | |
| 28.0 | Bearing (Type/life) | Antifriction Ball / Roller, 10,000 working hours life | |

B) MANUAL HOIST (CHAIN PULLEY BLOCK):

**DATA SHEET-A**

| | | |
|---|---|---|
| **1.0** | **Type** | Chain pulley block with/without trolley |
| **2.0** | **General Design** | IS: 3832 |
| **3.0** | **Duty Class as per IS:3832** | Class –II |

| | | |
|---|---|---|
| **4.0** | **Hoisting Mechanism** | |
| a) | Type | Hand operated gear transmission |
| b) | Type of gear | Spur / Helical |
| c)<br><br>i)<br>ii)<br>iii) | Load Chain<br><br>Type<br>Material<br>Conforms to (Std./Code) | <br><br>Link type<br>As per relevant standard<br>IS: 6216 / IS 3077/IS 3019 |
| d)<br><br>i)<br>ii)<br>iii) : | Hand Chain<br><br>Type<br>Material<br>Conform to Std. | <br><br>Link type<br>Mild steel Grade 30<br>IS:2429 (Part II) |
| e) | Load Hook & Hook Block | |
| i) | Type of load hook | Plain shank- Trapezoidal section/ 'C' type |
| ii) | Load hooks conforms to | IS: 15560 |
| iii) | Type of hook suspension | Swivelling type with safety latch |
| iv) | Type of make of bearing | Thrust ball bearing of hook suspension |
| v) | Type & Material of hook | As per IS 15560 |
| f) | Gears/ Pinions | |
| i)<br>ii) | Type<br>Material<br>Type of Bearing | Spur<br>Alloy steel / carbon steel/ High graded cast iron<br>Antifriction ball bearing / Roller |
| g) | Sprockets:<br>Type of bearings used | <br>Antifriction ball bearing / Roller |
| i) | Method of lubrication<br><br>Bearings<br>Gearing & Pinions<br>Sprocket | <br><br>Grease<br>Grease<br>Grease |
| h) | Brakes<br>Type | <br>Screw and friction disc type |
| **5.0** | **Trolley and Bridge drive** | |
| a)<br>i)<br>ii) | Trolley<br>Type<br>Material of frame | Geared (Manually operated)<br>Mild steel (IS:2062 Grade A or B) |
| b)<br>i)<br>ii)<br>iii) | Drive Chain<br>Type<br>Material<br>Design of drive chain | Link type<br>Steel Gr.30<br>IS : 2429 part 1 :1870 |
| c)<br>i)<br>ii)<br>iii)<br>iv) | Wheel<br>Number of pairs of wheel<br>Flange<br>Type of bearings need<br>Wheel material | Two in each trolley/bridge<br>Single flanged<br>Antifriction<br>As per IS 3832 |
| d)<br>i)<br>ii)<br>iii) | Gears<br>Type<br>Material<br>Type of bearings used | <br>Spur / helical<br>Cast iron/EN8<br>Antifriction |
| e)<br>i)<br>ii)<br>iii) | Method of lubrication for<br>Bearings<br>General<br>Sprockets | <br>Grease<br>Grease<br>Grease |

| | | |
|---|---|---|
| **6.0** | **Painting** | As per manufacturer's standard |

## 11.0 Maintenance Tools and Tackles

One (1) complete unused new set of special purpose tools, tackles and accessories along with detailed instructions and maintenance manual shall be supplied. Tools shall be of suitable sizes for maintenance of electric hoist of each type and capacity. Each tool and wrench shall be stamped so as to be identified easy for its use. The tools shall be supplied in steel toolbox and with a copy of instruction manual. The items supplied shall be of the best quality, specially protected against rusting. The following shall be provided as minimum requirement:

| S. No. | Description | Qty. |
|---|---|---|
| 1 | Complete set of ring spanners | 1 Set |
| 2 | Complete set of screwdrivers (Min. 6 nos of suitable sizes) | 1 Set |
| 3 | Adjustable Spanner | 1 No. |
| 4 | Insulated pliers | 1 No. |
| 5 | Wrench spanner | 1 No. |
| 6 | Grease Gun | 1 No. |
| 7 | Oil Gun | 1 No. |
| 8 | Hand Lamp | 1 No. |
| 9 | Line tester | 1 No. |

Note: -The tools shall be supplied in one tool box. Bidder shall ensure that the tools & tackles mentioned in above list are sufficient to handle all sizes/capacities of hoists & in case any other /additional tool is required for handling/maintenance any size/capacity of hoist the same shall be included in this list.

## 12.0 DRAWING/DOCUMENT SUBMISSION

The successful bidder shall submit the following drawings / documents during detail engineering for customer's approval /information:

A) ELECTRIC HOIST

| Sl. No. | BHEL DRG.NO | DRAWING TITLE |
|---|---|---|
| 1 | PE-V0-475-553-A100 | Manufacturing Quality Plan with Sub vendor list |
| 2 | PE-V0-475-553-A101 | GA Drawing for Electric Hoist, DSL arrangement and painting details |
| 3 | PE-V0-475-553-A102 | Schematic Circuit Diagram |
| 4 | PE-V0-475-553-A103 | Mechanism Sizing Calculation |
| 5 | PE-V0-475-553-A105 | O & M Manual |

B) MANUAL HOIST (CHAIN PULLEY BLOCK):

| Sl. No. | BHEL DRG.NO | DRAWING TITLE |
|---|---|---|
| 1 | PE-V0-475-553-A200 | Manufacturing Quality Plan |

| | | |
|---|---|---|
| 2 | PE-V0-475-553-A201 | GA Drawing for Chain Pulley Block with detail BOM with painting details |
| 3 | PE-V0-475-553-A202 | O & M Manual |

Notes:

1. The above drawing list is tentative and shall be finalized with the successful bidder after placement of order.

2. Drawings shall be prepared in Auto-Cad latest edition. Required no. of hard and soft copies (editable) of the drawings shall be furnished as per requirement specified elsewhere in the specification.

3. All the drawings and documents including general arrangement drawing, data sheet, calculation etc. to be furnished to the customer during detailed engineering stage shall include / indicate the following details for clarity w.r.t. Inspection, construction, erection and maintenance etc.:-

   a) All drawings and documents shall indicate the list of all reference drawings including general arrangement.

   b) All drawings shall include / show plan, elevation, side view, cross - section, skin section, blow - up view; all major self-manufactured and bought out items shall be labeled and included in BOQ / BOM in tabular form.

   c) Painting schedule shall also be made as a part of general arrangement drawing of each equipment / items indicating at least 3 trade names.

   d) All the drawings required to be furnished to customer during detailed engineering stage shall include technical parameters, details of paints and lubrication, hardness and BOQ / BOM in tabular form indicating all major components including bought out items and their quantity, material of construction indicating its applicable code / standard, weight, make etc.

   e) Drawings/ documents to be submitted for purchaser's review/ approval shall be under Revision A, B, C… etc. while drawings /documents to be submitted thereafter for customer's approval after purchaser's approval shall be under R-0, 1, 2, 3 etc.

## ANNEXURE I: MAKES AND SUB VENDOR LIST

| Package Name | Vendor Name |
|---|---|
| ELECTRIC HOIST | Alpha Services |
| | CONSOLIDATED HOISTS PVT LTD |
| | CENTURY CRANE ENGINEERS PVT. LTD. |
| | TECHNO INDUSTRIES |
| | EDDY CRANES PVT. LTD. |
| | Grip Engineers Pvt. Ltd., |
| | TRACTEL TIRFOR INDIA PVT. LTD. |
| | Mangla Hoists Pvt Ltd |
| | BRADY & MORRIS ENGINEERING CO. LTD. |
| | REVA INDUSTRIES LTD. |
| | UNIVERSAL HOIST-O-FABRIK |
| CHAIN PULLEY BLOCK | UNIVERSAL HOIST-O-FABRIK |
| | CENTURY CRANE ENGINEERS PVT. LTD. |
| | BAKELITE ELECTRICAL MFG. CO. PVT. LTD. |
| | TRACTEL TIRFOR INDIA PVT. LTD. |
| | BRADY & MORRIS ENGINEERING CO. LTD. |
| | TUOBRO FURGUSON (INDIA) PVT LTD |
| | TECHNO INDUSTRIES |

**Note:** No other make will be acceptable, until and unless specifically got approved by BHEL/Customer / Customer's consultant during detail engineering only. Acceptance/non acceptance of same shall not have any impact on manufacturing, delivery schedule and on cost of the Electric hoists/CPB.

**MAKES OF SUB VENDORS ITEMS AS APPLICABLE TO ELECTRIC HOIST:**

| S. No. | ITEM | MAKES |
|---|---|---|
| 1.0 | STEEL | SAIL/IISCO/TATA STEEL / JINDAL |
| 2.0 | HOOKS | MOOZUMDAR / SIMRITI FORGING / HARMAN MOHTA / STEEL FORGING & ENGG. CO., KOLKATA / |
| 3.0 | GEAR COUPLINGS | ALLIANCE / HICLIFF / OEM |
| 4.0 | WIRE ROPE | USHA MARTIN Black / BOMBAY WIRE ROPES / FORT WILLIAMS / UNITED WIRE ROPE/BHARAT WIRE ROPES. |
| 5.0 | BEARINGS | SKF/ FAG |
| 6.0 | MOTORS | SIEMEN/ ABB /NGEF/ CROMPTON /KIRLOSKAR /GECA / BHARAT BIJLI / MARATHON / LHP. |
| 7.0 | BRAKES | STROM CRAFT/ ELECTROMAG /SPEED-O- CONTROL / EMCO LENZE |
| 8.0 | CONTACTOR | SIEMENS / L&T /TELE MECHANIQUE / BCH |
| 9.0 | OVER LOAD RELAYS | SIEMENS / L&T / TELE MACHANIQUE / ABB |
| 10.0 | HRC FUSES | SIEMENS / L&T/ ENGLISH ELECTRIC/GE Power |
| 11.0 | ISOLATING SWITCH | SIEMENS/ L&T / CONTROL & SWITCH GEAR |
| 12.0 | SWITCH FUSE UNITS | SIEMENS/ L&T/ CONTROL/ & SWITCH GEAR/ GEC A |
| 13.0 | TIME DELAY RELAYS | SIEMENS/ L&T/ ABB/ BCH/ GEC A |
| 14.0 | TRANSFORMERS | INDCOIL/AE / LOGICSTAT/ PRAGATI / KAPPA / SOUTHERN ELECTRIC |
| 15.0 | BULB & FLOURESCENT TUBES/FITTINGS | PHILIPS/ BAJAJ/ CROMPTON |
| 16.0 | CABLE LUGS (HEAVY DUTY) | DOWELLS |
| 17.0 | CABLES | |
| a) | POWER CABLES | NICCO / UNIVERSAL / INCAB / FORT GLOSTER TORRENT / CCI / ICL / RADIANT / FINOLEX/ POLYCAB/KEI/HAVELL |
| b) | CONTROL CABLES | NICCO / UNIVERSAL / INCAB / FORT GLOSTER / DELTON / FINOLEX / TORRENT / CCI / ICL / RADIANT POLYCAB / KEI/ HAVELL. |

| | | |
|---|---|---|
| c) | TRAILING CABLE | UNIVERSAL/ FGL/CCL/HVP/KEI/RADIANT. |
| 18.0 | CABLE GLAND | COMMET / SIEMEN / SUNIL&CO. |
| 19.0 | PUSH BUTTONS | SIEMENS / L&T / BCH /TEKNIC/VAISHNO |
| 20.0 | LIMIT SWITCHES | SPEED-O-CONTROL / ELECTROMAG / JAI BALA JI / KAYCEE / BCH |
| 21 | SELECTOR SWITCHES | KAYCEE/ SULZER |
| 22 | PENDENT PUSH BUTTON STATION | OEM |
| 23 | INDICATING LAMPS | TECKNIC / BCH / SIEMENS / STANDARD/ VAISHNO |
| 24 | MCB | MDS / INDO COPP / STANDARD |
| 25 | PANELS | OEM/BCH |
| 26 | DSL | SUSHEEL/STROMAG |
| 27 | TERMINAL BLOCKS | ELMEX/CONNECTWELL/WAGO ( FOR CONTROL ONLY) |
| 28 | VVVF | YASAKAWA(L&T)/ABB/SIEMENS/SCHNIDER |
| 29 | CASTING | KOLHAPUR STEEL / GNAT FOUNDARY / KIRTI ALLOYS |
| 30 | Tools & tackles | Reputed make |

**MAKES OF SUB VENDORS ITEMS AS APPLICABLE TO MANUAL HOIST:**

| S. No. | ITEM | MAKES |
|---|---|---|
| 1.0 | STEEL | SAIL/IISCO/TATA STEEL / JINDAL |
| 2.0 | HOOKS | STEEL FORGINGS/ KARACHIWALA/SMRITI/NASIK FORGE. |
| 3.0 | STEEL FORGINGS | CHOWDHARY/WESTERN INDIA FORGINGS/ HINDUSTAN STEEL FORGINGS/ RUBY FORGINGS OR AS APPROVED BY BHEL. |
| 4.0 | BRAKES | OEM |

**NOTE:**

1) THE SUB VENDOR LIST ABOVE IS INDICATIVE ONLY AND IS SUBJECT TO BHEL AND CUSTOMER APPROVAL DURING DETAILED ENGINEERING STAGE WITHOUT ANY COMMERCIAL & DELIVERY IMPLICATION TO BHEL.

## PAINTING SPECIFICATION

1) Painting specification for steel structures: -

| | |
|---|---|
| Surface preparation | De greasing and Mechanical cleaning with wire brush or blasting according to SIS 055900, Grade 2 ½ . |
| Primer | HB Zn Phosphate - 2 coat, Minimum DFT 80 µ per coat |
| Finish Coat | HB MIO epoxy - 1 coat, Minimum DFT 120 µ per coat |
| Total DFT | 260 µm |

2) Painting specification for Indoor components such as motors, electrical parts etc:-

| | |
|---|---|
| Surface preparation | Blasting according to SIS 055900, Grade 2 ½. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 25 µm may be used. |
| Primer | Zinc phosphate epoxy - 2 coat, Total DFT 80 µm. |
| Finish Coat | Chlorinated rubber paint- 2 coats, Total DFT 80 µm for indoor and 100 µm for outdoor. |
| Total DFT | 160 µm for indoor and 180 µm for outdoor |

3) Color Shade:

| SL. No | Item Description | Color Shade |
|---|---|---|
| 1 | Crane Structure | Golden Yellow shade 356 as per IS-5 |
| 2 | Trolley and hook | Crimson shade 540 as per IS-5 |
| 3 | Motors | Light grey, shade 631 as per IS-5 |
| 4 | Control Panels | Paint shade shall be RAL 9002 for front & rear and RAL 5012 for side covers. |
| 5 | Bottom Block assembly. | Golden Yellow shade 356 as per IS-5 |
| 6 | End Carriage sweep. | Golden Yellow shade 356 as per IS-5 |

| | MANUFACTURERS NAME & ADDRESS | MANUFACTURING QUALITY PLAN | | | | PROJECT | 2X660 MW THDC KHURJA TPS- TG & ASSOCIATE PKG. |
|---|---|---|---|---|---|---|---|
| | AS PER APPROVED VENDOR LIST | ITEM: | ELECTRIC WIRE ROPE | QP NO | | PACKAGE | ELECTRIC WIRE ROPE HOIST |
| | | | | REV | 0 | CONTRACT No | |
| | | | | DATE | JUNE, 2020 | CONTRACTOR | BHEL-PEM |
| | | | | PAGE | 1 of 4 | | |

| Sl.No | COMPONENT & OPERATIONS | CHARACTERISTICS | CATEGORY | TYPE OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORMS | FORMAT OF RECORD | D* | AGENCY M | AGENCY C | AGENCY N | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | ** | 10 | | 11 |
| 1.0 | **RAW-MATERIALS** | | | | | | | | | | | | |
| 1.1 | a) STRUCTURAL MATERIAL b) RAW MATERIAL FOR HOIST AND GEAR BOX HOUSING, TROLLEY PLATE, ROPE DRUM IF FABRICATED ETC | CHEM & MECH PROPS | MA | Lab analysis | 1 SAMPLE PER LOT% | IS 2062 /APPD. DRG./ DATA SHEET | | MTC/IR | √ | P/V | V | V | Test shall be carried out in absence of mill TC or non-correlation of TC with material.BHEL to identify Samples for testing. Test to be carried out at NABL accredited Lab. Reports to be submitted for verification during inspection. |
| | | NDT | MA | UT | 100% | ASTM A388-2004 | NOTE 1 | IR | √ | P | V | V | For dia / plate thickness above 25 mm |
| 1.1 A | SEAMLESS PIPE FOR ROPE DRUM | CHEMICAL , MECHANICAL | MA | Lab analysis | 1 SAMPLE /pipe | Approved drg/ASTM A 106 Grade A or B | | MTC/IR | √ | P/V | V | V | Test shall be carried out in absence of mill TC or non-correlation of TC with material.BHEL to identify Samples for testing. Test to be carried out at NABL accredited Lab. Reports to be submitted for verification during inspection |
| | | Flattening & Acid Etching test | MA | PHYSICAL & METALLOGRAPHY | 1 SAMPLE /pipe | No cracks, pitting, rusting , damage etc | | IR | √ | P | V | V | |
| | | SURFACE DEFECTS | MA | Visual | 100% | | | | | | | | |
| 1.2 | FORGINGS FOR GEARS BLANKS ,PINIONS, SHAFT/AXLES, WHEELS , STEEL CASTINGS | MECH , CHEM. PROPS | MA | Lab analysis | 100% | APPD. DRG./ DATA SHEET | APPD. DRG./ DATA SHEET / IS:3938 | LAB. REPORT / MANUFACTURER'S TEST CERTIFICATE | √ | P | V | V | |
| | | NDT | CR | UT | 100% | ASTM A 388 | NOTE 1 | INSPN. REPORT | √ | P | **V** | V | IF DIA or THK > 50mm |
| | | Hardeness , surface defects after hardfacing and machining/grinding | MA | DPT/MPI | 100% | ASTM E -165 /E-709, No linear indication | | MTC | √ | P | **V** | V | |
| 1.3 | WIRE ROPE | Dimensional, type, constrcution , | MI | measurement | 100% | APPD. DRG./ DATA SHEET | APPD. DRG./ DATA SHEET | MFRS' TEST CERT. | √ | P | V | V | |
| | | EXAMINATION OF REPORT OF BREAKING LOAD CAPACITY | CR | Review of TC | 100% | IS: 2266 | | MFRS' TEST CERT. | √ | P | V | V | |
| 1.4 | HOOKS | MECH. , CHEM. PROPS. | MA | LAb analysis | 100% | APPROVED DRG/DATA SHEET IS:15560 | | MFRS' TEST CERT. | √ | P | V | V | |
| | | U.T IF SHANK DIA > 50mm | CR | NDT | 100% | ASTM A 388 | NOTE 1 | INSPN. REPORT | √ | P | V/W | V | SHANK PORTION ONLY |
| | | Dimension & PROOF LOAD TESTING | CR | Measurment , PROOF LOAD TEST | 100% | APPROVED DRG/DATA SHEET / IS:3938 / IS:15560 | | QCR | √ | P | V/W | V | IF REQUIRED BY END CUSTOMER. |
| | | DPT AFTER PROOF LOAD | CR | NDT | 100% | ASTM E-165 | NO CRACKS | INSPN. REPORT | √ | P | V/W | V | |
| 1.5 | SHEAVES | MECH | MA | Tensile & hardness | 1/lot | Approved drgs | | MTC/IR | √ | P | V | V | |

| | MANUFACTURERS NAME & ADDRESS | MANUFACTURING QUALITY PLAN | | | PROJECT | 2X660 MW THDC KHURJA TPS- TG & ASSOCIATE PKG. |
|---|---|---|---|---|---|---|
| | AS PER APPROVED VENDOR LIST | ITEM: | ELECTRIC WIRE ROPE | QP NO | PACKAGE | ELECTRIC WIRE ROPE HOIST |
| | | | | REV 0 | CONTRACT No | |
| | | | | DATE JUNE, 2020 | CONTRACTOR | BHEL-PEM |
| | | | | PAGE 1 of 4 | | |

| Sl.No | COMPONENT & OPERATIONS | CHARACTERISTICS | CATEGORY | TYPE OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORMS | FORMAT OF RECORD | D* | AGENCY M | C | N | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | ** | 10 | | 11 |
| 1.6 | CASTING FOR BEARING PLATED, ROPE GUIDES, PULLEYS ETC | CHEMICAL & MECHANICAL | MAJOR | LAB ANALYSIS | 1/LOT | APPROVED DRG/MFG STANDARD | APPROVED DRG/MFG STANDARD | LAB REPORT | √ | P | V | V | |
| 2.0 | **IN-PROCESS** | | | | | | | | | | | | |
| 2.1 | Welding process capability and welder skill | WPS,PQR & WPQ | MA | Welding procedure approval and Welder performance qualification in accordance with ASME Section IX | 100% | ASME Section IX | | WPS,PQR & WPQ | | P | V | V | In case approved WPS/PQR/WPQ from BHEL/NTPC/EIL/LLOYDS/TPL available, then documents/records to be submitted for verification during inspection, else, Vendor shall get the approval of Welding Procedure / Welder from the identified agency prior to carrying out welding at the job. |
| 2.2 | Welding of trolley, rope drum etc | Fillet weld | MA | DPT | 10% | ASTM E165 or Eq/ No cracks or linear indication | | INSPN. REPORT | √ | P | V | V | |
| | | Butt welds | MA | RT, DPT | 100% | ASME SEC VIII, DIV 1, UW 51/52 | | RT FILM & REPORT | √ | P | V | V | 100% RT for butt weld in tension and 10 % in compression. 100% RT on butt weld of rope drum |
| | | DPT AFTER STRESS RELIEVING OF ROPE DRUM | MA | NDT | 100% | ASTM E-165 | NO CRACKS | INSPN. REPORT | √ | P | V | V | |
| 2.3 | NDT OF LOAD BEARING BUTT WELDS (**IF ANY)** | WELD QUALITY OF BUTT WELDS IN TENSION | CR | PT & RT | 100% | ASME SEC. VIII DIV. I | ASME SEC. VIII DIV. 4 . CLUW-51 FOR RT APPENDIX -8 FOR PT | INSPN. REPORT ND FILM | √ | P | W | V/W | FILMS TO BE REVIEWED BY BHEL & END CUSTOMER/THIRD PARTY. DPT SHALL BE CHP . |
| 2.4 | **GEAR BOXES** | | | | | | | | | | | | |
| | COMPLETE ASSEMBLY | OVERALL DIMENSIONS. LEAK TEST, REDUCTION RATIO, BACK LASH AND CONTACT PATTERN, | MA | MEAS./VISUAL | 100% | MFG. DRG./KERSON E TEST | MFG. DRG./NO LEAKAGE WHEN FILLED | INSPN. REPORT | √ | P | V | | |
| | NO LOAD RUN TEST FOR 4 HRS | CHECK FOR OIL LEAKAGE, VIBRATION, NOISE ,TEMP. RISE. REDUCTION RATIO, BACKLASH , CONTACT PATTERN | MA | PERFORMANCE | 100% | APPROVED DRGS /No leakage,Noise 85dbA maxat 1 mtrs, vibration 75 microns max, oil temp rise 20 deg above ambient max | | - DO - | √ | P | V | V | |
| 3.0 | **ELECTRICALS** | | | | | | | | | | | | |
| 1 | MOTORS & CABLES | Make, type , rating | MA | Visual /measurment | 100% | Apprvd drg | IS 325 / IS:3938 | IR, MTC | √ | P | V | V | For motor refer Note: 2 |
| | | ROUTINE TESTS | | | | | | | | | | | |
| 3 | LIMIT SWITCHES,SFU, ISOLATOR/ O/L RELAY, MCB, FUSES,PUSH BUTTONS,CONTACTOR, INDICATING LAMPS etc | Make , type , rating, functional, Continuity | MA | Review of TC | 100% | Approved drgs | | IR | √ | P | V | V | |
| 4 | BRAKES | Make , type , rating, HV/IR, Functional test | MA | Review of TC | 100% | Approved drgs | | IR, MTC | √ | P | V | V | |
| 5 | DSL | Make , type , rating, dimension | MA | Review of TC | 100% | Approved drgs | | IR | √ | P | V | V | |
| 6 | Control transformer | Make , type , rating, input/output | MA | Review of TC | 100% | Approved drgs | | IR | √ | P | V | V | |

| | MANUFACTURERS NAME & ADDRESS | MANUFACTURING QUALITY PLAN | | | | PROJECT | 2X660 MW THDC KHURJA TPS- TG & ASSOCIATE PKG. |
|---|---|---|---|---|---|---|---|
| | AS PER APPROVED VENDOR LIST | ITEM: | ELECTRIC WIRE ROPE | QP NO | | PACKAGE | ELECTRIC WIRE ROPE HOIST |
| | | | | REV | 0 | CONTRACT No | |
| | | | | DATE | JUNE, 2020 | CONTRACTOR | BHEL-PEM |
| | | | | PAGE | 1 of 4 | | |

| Sl.No | COMPONENT & OPERATIONS | CHARACTERISTICS | CATEGORY | TYPE OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORMS | FORMAT OF RECORD | D* | AGENCY M | C | N | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | ** | 10 | | 11 |
| ` | CONTROL PANEL, PENDANT SWITCH | * FIXING OF COMPONENTS WIRING MARKING CONTINUITY<br>* FUNCTIONAL TEST<br>* IR & H.V. TEST<br>* IP - PROTECTION TEST<br>* PAINT SHADE, THICKNESS, SHEET THICHKNESS, ADHESION TEST<br>* DIMENSION | MA | VISUAL/MEASUR | 100% | APPD.DRG. WIRING DIAGRAM, | APPD. DRG. WIRING DIAGRAM, | IR | √ | P | V | V | |
| 8 | VVVF DRIVES ( IF APPLICABLE) | MAKE , TYPE , RATING , ROUTINE TESTS | MA | VISUAL/ VERIFY | 100% | APPROVED DRAWINGS | APPROVED DRAWINGS | MTC | √ | P | V | V | |
| 4.0 | FINAL INSPECTION | | | | | | | | | | | | |

| | MANUFACTURERS NAME & ADDRESS | MANUFACTURING QUALITY PLAN | | | | PROJECT | 2X660 MW THDC KHURJA TPS- TG & ASSOCIATE PKG. |
|---|---|---|---|---|---|---|---|
| | AS PER APPROVED VENDOR LIST | ITEM: | ELECTRIC WIRE ROPE | QP NO | | PACKAGE | ELECTRIC WIRE ROPE HOIST |
| | | | | REV | 0 | CONTRACT No | |
| | | | | DATE | JUNE, 2020 | CONTRACTOR | BHEL-PEM |
| | | | | PAGE | 1 of 4 | | |

| Sl.No | COMPONENT & OPERATIONS | CHARACTERISTICS | CATEGORY | TYPE OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORMS | FORMAT OF RECORD | D* | AGENCY M | C | N | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | ** 10 | | | 11 |
| 4.1 | COMPLETELY ASSEMBLED HOIST | 1. COMPLETENESS, CORRECTNESS, WELD QUALITY, OVERALL DIMENSIONS. | MA | VISUAL, MEAS | 100% | APPD. DRG. | APPD. DRG. | MNFRS' TEST CERT. | √ | P | W | V | CHP |
| 4.2 | ASSEMBLED HOIST PERFORMANCE WITH ACTUAL CONTROL PANEL, AND PENDENT PUSH BUTTON | 1. LOAD TEST | CR | LOAD TEST at SWL | 100% | IS:6547 / IS:39 | IS:6547 / IS:3938 | MNFRS' TEST CERT. | √ | P | W | V | CHP |
| | | 2. HOISTING & LOWERING SPEED, PERFORMANCE OF CONTROLLERS SWITCHES CONTACTORS, RELAYS AND OTHER CONTROL DEVICES CORRELATIONS OF CIRCUITS AND INTERLOCKS AND SEQUENCES OF OPERATION , CURRENT MEASUREMENT,LIMIT SWITCH OPERATION. | CR | MEAS & VISUAL | 100% | IS:3938, TECH SPEC. | TECH SPEC. | MNFRS' TEST CERT. | √ | P | W | V | CHP |
| | | 3. OPERATION OF ALL PROTECTIVE DEVICES | CR | VISUAL | 100% | TECH SPEC | TECH SPEC. | MNFRS' TEST CERT. | √ | P | W | V | CHP |
| 4.3 | OVER LOAD TEST | OVER LOAD TEST INCLUDING HOLDING CAPACITY OF BRAKES, LIFTING LOAD FROM MID AIR, SOUNDNESS OF WELD AFTER OVERLOAD TEST. | CR | TEST AT 125 % OF-SWL | 100% | IS:3938 | IS:3938 | INSPN. REPORT | √ | P | W | V | CHP |
| 5 | PAINTING | | | | | | | | | | | | |
| 5.1 | PRIMER & FINISHING AND SHADE | Examination - Shade , DOP by paper insertion method | MI | visual | 100% | DRG. & DATA SHEET & RELV. IS SPEC. | | MNFRS' TEST CERT. | | P | V | | |
| | | DFT | MA | measurement | Sample | | | | | P | V | | |
| 6 | PACKING | STURDINESS, PROTECTION MARKING | MA | VISUAL | 100% | MFG STD | MFG STD | | | P | | | |
| | NOTE: | | | | | | | | | | | | |
| 1 | When back wall echo is set to 100% in sound area then a) defect echo shall not exceed 20% b) Back echo shall be minimum 80% in any area. | | | | | | | | | | | | |
| 2 | Less than 30 KW. Acceptance of motor less than 30 KW is based on COC of the manufacturer & the contractor confirming as follows : It is hereby confirmed that the above mentioned motor/motors was/were manufactured taking care of specific requirement regarding ambient temp, voltage & frequency variation, hot start, pull out torque, starting KVA/KW, temp rise, distance between centerof stud and gland plate and tested in accordance with approved drawing/data sheet. | | | | | | | | | | | | |

| | | | |
|---|---|---|---|
| | LEGNDS | | |
| | * RECORDS INDENTIFIED WITH 'TICK' SHALL BE ESSENTIALLY INCLUDED BY MANUFACTURER IN QA DOCUMENTATION. | | |
| | ** M: MANUFACTURER/SUBCONTRACTOR | | |
| | C: BHEL/BHEL NOMINATED THIRD PARTY INSPECTION AGENCY | | |
| MANUFACTURER/ SUB CONTRACTOR | N: CUSTOMER/CUSTOMER'S CONSULTANT/CUSTOMER'S APPOINTED THIRD PARTY | | |
| | 'P'- PERFORM", W"- WITNESS AND "V"- VERIFICATION | | |
| SIGNATURE | " CHP" CUSTOMER HOLD POINT | REVIEWED BY | NAME & SIGN OF APPROVING AUTHORITY &SEAL |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **RAW MATERIAL & B/OUT ITEMS:** | | | | | | | | | | | | |
| 1.1 | HOOKS | CHEMICAL & MECH | MA | LAB ANALYSIS | ONE SAMPLE PER HEAT | MATERIAL SPECIFICATION AS PER APPROVED DRAWINGS. | | MTC. | ✓ | P | V | V | |
| | | MARK & IDENTIFICATION | MA | VISUAL | 100% | HOOK TC FROM COMPETENT AUTHORITY | | TC | ✓ | P | V | V | |
| | | INTERNAL DEFECTS | MA | UT | 100% | ASTM A-388 | ( REFER NOTE I) | IR | ✓ | P | V | V | ON SHANK PORTION |
| | | PROOF LOAD TEST | MA | REVIEW | 100% | IS 15560 | | TC | ✓ | P | V | V | |
| | | NDT AFTER PROOF LOAD TEST | MA | DPT | 100% | ASTM E-165 | NO RELEVANT INDICATTION | TC | ✓ | P | V | V | |
| 1.2 | LOAD CHAIN | - DIMENSIONS | MA | MEASUREMENT | 100% | APPD. DRGS | APPD. DRGS. | IR | ✓ | P | V | V | |
| | | - BREAKING STR & % ELONGATION | MA | -TENSILE TEST | 1/LOT | -DO- | -DO- | MTC | ✓ | P | V | V | |
| | | - PROOF LOAD -HEAT TREATMENT | MA | -TENSILE TEST | 100% | -DO- | -DO- | MTC | ✓ | P | V | V | |
| | | | MA | REVIEW | 100% | -DO- | -DO- | HT CHRT | ✓ | P | V | V | |
| | | -GRADE | MA | REVIEW | 1/BATCH | -DO- | -DO- | MTC | ✓ | P | V | V | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.3 | RAW MATL. ( BAR /FORGING) FOR GEAR BLANKS/SHAFTS/ PINIONS/AXLE/ RATCHET PAWL / RATCHET WHEEL & PLATES FOR FABRICATION ETC | CHEMICAL COMPOSITION<br>MECHANICAL<br>INTERNAL DEFECTS<br>NDT AFTER MACHINING | MA<br>MA<br>MA<br>MA | Review<br>Review<br>UT<br>DPT | ONE SAMPLE PER HEAT<br>100%<br>100% | Material specification as per approved drawings.<br>ASTM A-388 REFER NOTE 1<br>ASTM E-165 NO RELEVANT INDICATION | | MFR'S TC<br>IR<br>TC | ✓<br>✓<br>✓<br>✓ | P<br>P<br>P<br>P | V<br>V<br>V<br>V | V<br>V<br>V<br>V | TC or inspection report for components shall be given. For rounds ≥50mm and plates ≥25 mm. |
| 1.4. | LOAD CHAIN WHEELS | - CHEMICAL & MECHANICAL PROPERTIES | MA | CHEMICAL MECHANICAL PROPERTIES | ONE SAMPLE PER LOT | APPD. DRG. | APPD. DRG. | MTC | ✓ | P | V | V | |
| 1.5 | BEARINGS | MAKE, TYPE, CATALOUGE NO. | MA | VISUAL | RANDOM | APP DRG / MFR"S CATALOGUE | APP DRG / MFR"S CATALOGUE | IR | ✓ | P | V | V | |
| 1.6 | HAND CHAIN WHEEL | CHEMICAL MECHANICAL PROPERTIES | MA | CHEMICAL MECHANICAL PROPERTIES | ONE SAMPLE PER LOT | AS PER DRAWING | AS PER DRAWING | MTC | ✓ | P | V | V | |
| 1.7 | HAND CHAIN | GRADE/ DIMENSION | MA | GRADE DIMENSION | 100% | AS PER DRAWING | AS PER DRAWING | MTC | ✓ | P | V | V | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.8 | TROLLEY GEARS, PINION,WHEELS, AXLE | CHEMICAL & MECHANICAL | MA | LAB ANALYSIS, | 100% | APPVD DRGS | APPVD DRGS | IR/TC | ✓ | P | V | V | |
| 2 | **IN PROCESS** | | | | | | | | | | | | |
| 2.1 | RATCHET PAWL / RATCHET WHEEL | -HARDNESS<br>-SURFACE CRACK | MA<br>MA | HARDNESS<br>DPT | 100%<br>100 % | IS:3832/ APPD DRG.<br>ASTM E165 | IS:3832/ APPD. DRG.<br>NO DEFECT | IR<br>IR | ✓<br>✓ | P<br>P | V<br>V | V<br>V | |
| 2.2 | COMPONENTS AFTER HARDFACING & MACHINING | HEAT TREATMENT<br>SURFACE HARDNESS<br>SURFACE CRACK<br>DIMENSION | MA<br>MA<br>MA<br>MA | HT CHART<br>HARDNESS<br>DPT FOR SURFACE CRACK<br>MEASURE | 100%<br>10%<br>100%<br>10% | IS 1875/IS 4367/IS 3832<br>--DO--<br>ASTM E 165<br>IS 3832 | NO DEFECT | IR<br>IR<br>IR<br>IR | ✓<br>✓<br>✓<br>✓ | P<br>P<br>P<br>P | V<br>V<br>V<br>V | V<br>V<br>V<br>V | |
| 3.0 | **FINAL INSPECTION** | | | | | | | | | | | | |
| 3.1 | COMPLETE ASSEMBLY | OVERALL DIMENSION<br>ENDURANCE TYPE TEST<br>OPERATIONAL PROOF LOAD & LIGHT LOAD TEST, EFFORT. | CR<br>MA<br>CR | MEASUREMENT<br>TYPE TEST<br>LOAD TEST | 100 %<br>1 PER SIZE<br>100% | IS:3832 /APPD DRG<br>IS 3832<br>-DO- | IS:3832 /APPD DRG<br>IS 3832<br>-DO- | IR<br>TC<br>IR | ✓<br>✓<br>✓ | P<br>P<br>P<br>P | W<br>V<br>W<br>W | V<br>V<br>V<br>V | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | HEIGHT OF LIFT<br>SWIVELING OF HOOK<br><br>EFFORT | MA<br>MA<br><br>MA | VISUAL<br>VISUAL<br><br>PULL ON CHAIN | 100 %<br>100%<br><br>100% | -DO-<br>APPROVED DRG<br>-DO- | -DO-<br>APPROVED DRG<br>-DO- | IR<br>IR<br><br>IR | ✓<br>✓<br>✓ | P<br><br>P | W<br><br>W | V<br><br>V | |
| 3.2 | PAINTING | -CLEANING<br>- SHADE & DFT OF PAINT | MA<br>MI | VISUAL<br>VISUAL | AT RANDOM<br>AT RANDOM | APPROVED DRAWING/ **SPECIFICATION** | APPROVED DRAWING/ **SPECIFICATION** | IR<br>IR | | P<br>-<br>p | ---<br><br>W | --<br><br>--- | |
| 3.3 | NAME PLATE | VERIFICATION | MA | VISUAL | 100% | | | IR | | P | V | --- | |
| 3.4 | PACKING | -VERIFICATION | MI | VISUAL | 100% | SPECS. | SPECS. | IR | | P | --- | --- | |
| 3.5 | REVIEW OF QA DOCUMENTATION | VERIFICATION | MA | VISUAL | 100% | APPD. QP | APPD. QP | | ✓ | V | V | V | |

CR – CRITICAL, MA – MAJOR , MI – MINOR

NOTE 1: WHEN BACK WALL ECHO (BWE) IS SET AT 100% OF FULL SCREEN HEIGHT (FSH) IN DEFECT FREE AREA THEN
(A) DEFECT ECHO SHALL NOT EXCEED 20% OF FSH &
(B) BWE SHOULD BE MINIMUM 80% OF FSH IN ANY AREA.
NOTE 2: RECORDS IDENTIFIED WITH TICK SHALL BE ESSENTIALLY INLCUDED IN QA DOCUMENTATION.

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

| | | | | | | |
|---|---|---|---|---|---|---|
| 63. | VI/B | A11 | 2 of 25 | 2.00.00 | 9. Type of ventilation for various buildings shall be as follows:<br><br>**S. No.** / **Area** / **Type of Ventilation system**<br>(i) General area like pump house, etc. — Combination of Supply air fan & Exhaust air fans/Roof Extractor Fans<br>(ii) MCCs, Switchgear room, Cable Vault (other than ESP/FGD Building), etc. — Supply air fans & Back draft dampers<br>(iii) Battery rooms — Combination of Air Intake Louvers & Exhaust air fans<br>(iv) Cable Galleries of ESP/FGD Building — UAF systems along with back draft dampers<br>(v) Toilet/pantry etc. — Exhaust air fans | 9. Type of ventilation for various buildings shall be as follows:<br><br>**S. No.** / **Area** / **Type of Ventilation system**<br>(i) General area like pump house, etc. — Combination of Supply air fan & Exhaust air fans/Roof Extractor Fans<br>(ii) MCCs, Switchgear room, Cable Vault (other than TG Building), etc. — Supply air fans & Back draft dampers<br>(iii) Battery rooms — Combination of Air Intake Louvers & Exhaust air fans<br>(iv) MCCs, Switchgear room, Cable Vault in TG Building — Air washer systems along with back draft dampers<br>(v) Toilet/pantry etc. — Exhaust air fans |

# SECTION: I

# SUB-SECTION: C 2B

# CUSTOMER SPECIFICATIONS
# PROJECT SPECIFIC GENERAL REQUIREMENTS

# PART – C

# GENERAL TECHNICAL REQUIREMENT (GTR)

## PART - C

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# 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 Section-VI, the Technical Specification 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 Employer 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 Contractor 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 will 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 Employer. Sufficient amount of information for justifying such proposals shall be furnished to Employer along with the bid to enable the Employer 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 equipments furnished by the Contractor 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 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 same standard components/ parts of same equipment provided, shall be interchangeable with one another.

4.03.00 For the C&I systems, the Contractor shall be required to provide regular information about future upgrades and migration paths to the Employer.

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.) Indian electricity act

(b.) Indian electricity rules

(c.) Indian Explosives Act

(d.) Indian Factories Act and State Factories Act

(e) Indian Boiler Regulations (IBR)

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

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

(h) Pollution Control Regulations of Department of Environment, Government of India

(i.) State Pollution Control Board.

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

(k.) Building and other construction workers (Regulation of Employment and Conditions of services) Act, 1996

(l.) Building and other construction workers (Regulation of Employment and Conditions of services) Central Rules, 1998

(m.) Explosive Rules, 1983

(n.) Petroleum Act, 1984

(o.) Petroleum Rules, 1976,

(p.) Gas Cylinder Rules, 1981

(q.) Static and Mobile Pressure Vessels (Unified) Rules, 1981

(r.) Workmen's Compensation Act, 1923

(s.) Workmen's Compensation Rules, 1924

(t.) NTPC Safety Rules for Construction and Erection

(u.) NTPC Safety Policy

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

5.02.00 Unless covered otherwise 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) Bureau of Indian Standards (BIS)

(b.) Japanese Industrial Standards (JIS)

(c.) American National Standards Institute (ANSI)

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

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

(f.) American Petroleum Institute (API)

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

(h.) International Organisation for Standardization (ISO)

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

(j.) American Welding Society (AWS)

(k.) National Electrical Manufacturers Association (NEMA)

(l.) National Fire Protection Association (NFPA)

(m.) International Electro-Technical Commission (IEC)/European Norm (EN)
(n.) Expansion Joint Manufacturers Association (EJMA)

(o.) Heat Exchange Institute (HEI)

p) IEEE standard

q) JEC standard

5.03.00 Other International/ National standards such as DIN, VDI, BS, GOST etc. shall also be accepted for only material codes and manufacturing standards, subject to the Employer's approval, for which the Bidder shall furnish, 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 equipments 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. 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, and structural works shall be provided by the Contractor to the Employer 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 Employer shall

have the option to incorporate the changed requirements or to retain the original standard. It shall be the responsibility of the Contractor to bring to the notice of the Employer such changes and advise Employer of the resulting effect.

6.00.00 **EQUIPMENT FUNCTIONAL GUARANTEE**

6.01.00 The functional guarantees of the equipment under the scope of the Contract is given in Section-VI Part - A & B of technical specification .These guarantees shall supplement the general functional guarantee provisions covered under General Conditions of Contract.

6.02.00 Liquidated damages for shortfall in meeting functional guarantee(s) during the performance and guarantee tests shall be assessed and recovered from the Contractor 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 Contractor shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinated 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/works 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 turbine and equipments, inspection of the

steam path and the minor and major overhauls shall be specified in terms of running hours, clearly defining the spare parts and manhour requirement for each stage.

Lifting devices i.e. hoists and chain pulley jacks, etc. shall be provided by the contractor 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 contractor for lifting the equipment and accessories covered under the specification.

8.00.00 **DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY CONTRACTOR**

8.01.00 Bidders may note that this is a contract inclusive of the scope as indicated elsewhere in the specification. Each of the plant and equipment shall be fully integrated, engineered and designed to perform in accordance with the technical specification. All engineering and technical services required to ensure a completely engineered plant shall be provided in respect of mechanical, electrical, control & instrumentation, civil & structural works as per the scope.

Each main and auxiliary equipment/item of the plant including instruments shall be assigned a unique tag number. The assignment of tag numbers shall be in accordance with KKS system. In all drawings/documents/data sheet etc. KKS tag number of the equipment/item/instrument etc. shall be indicated.

The Contractor shall furnish engineering data/drawings. in accordance with the schedule of information as specified in Technical Specification and Technical data sheet.

8.02.00 The number of copies/prints/CD-ROMs/manuals to be furnished for various types of documents is given in Annexure-I to this Part-C, Section-VI of the Technical Specification.

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

8.03.01 (a.) **BASIC ENGINEERING DOCUMENTATION**

Prior to commencement of the detailed engineering work, the Contractor shall furnish a Plant Definition Manual within 12 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/ equipments/ structures/ equipment foundations alongwith 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 equipments / system covered under the scope.

viii. General Layout plan of the power station incorporating all facilities in Contractor's as well as those in the Employer's scope. This drawing shall also be furnished in the form of CD-ROMs to the Employer for engineering of areas not included in bidder's scope.

ix. Basic layouts and cross sections of the TG building (various floor elevations), and other areas included in the scope of thebidder.

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

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 Employer.

(b) **DETAILED ENGINEERING DOCUMENTS**

i. General layout plan.

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

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

iv. Start-up curves for turbine, for various start-ups, viz. cold, warm and hot start-up.

v. Piping isometric, composite layout and fabrication drawings.

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

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

viii. Detailed design calculations for components, system/sub-system, piping etc., wherever applicable including sizing calculations for all auxiliaries like BFPs, CEPs, Heaters/ Deaerators, Condensers, vacuum pumps etc.

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, 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 Employer'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 / Sequence of Event (SOE) 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.

xxii. Detailed DDCMIS system manuals

xxiii. Detailed flow chart for digital control system.

xxiv. Mimic diagram layout, Assignment for other application engg.

xxv. Civil & Structural works drawings and documents for all structures, facilities, foundations, underground and overground works and super-structural works as included 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.

The Contractor 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.

8.03.02 **INSTRUCTION MANUALS**

The Contractor shall submit to the Employer, draft instruction manuals for all the equipments 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 Employer 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 Employer. The Instruction Manuals shall comprise of the following.

(a.) **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 equipments 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

(b.) **Operation & Maintenance Manuals**

a) The manual shall be a two rim PVC bound stiff sided binder able to withstand constant usage or where a thicker type is required it shall have locking steel pins, the size of the manual shall not be larger than international size A3. The cover shall be printed with the Project Name, Services covered and Volume / Book number Each section of the manual shall be divided by a stiff divider of the same size as the holder. The dividers shall clearly state the section number and title. All written instructions within the manual not provided by the manufacturers shall be typewritten with a margin on the left hand side.

b) The arrangement and contents of O & M manuals shall be as follows :

1) Chapter 1 - Plant Description : To contain the following sections specific to the equipment/system supplied

(a) Description of operating principle of equipment / system with schematic drawing / layouts.

(b) Functional description of associated accessories / controls. Control interlock protection write up.

(c) Integrated operation of the equipment alongwith the intended system. (The is to be given by the supplier of the Main equipment by taking into account the operating instruction given by the associated suppliers).

(d) Exploded view of the main equipment, associated accessories and auxiliaries with description. Schematic drawing of the equipment alongwith its accessories and auxiliaries.

(e) Design data against which the plant performance will be compared.

(f) Master list of equipments, Technical specification of the equipment/ system and approved data sheets.

(g) Identification system adopted for the various components, (it will be of a simple process linked tagging system).

(h) Master list of drawings (as built drawing - Drawings to be enclosed in a separate volume).

2) Chapter 2.0 - Plant Operation: To contain the following sections specific to the equipment supplied

(a) Protection logics provided for the equipment alongwith brief philosophy behind the logic, Drawings etc.

(b) Limiting values of all protection settings.

(c) Various settings of annunciation/interlocks provided.

(d) Startup and shut down procedure for equipment alongwith the associated systems in step mode.

(e) Do's and Don'ts related to operation of the equipment.

(f) Safety precautions to be take during normal operation. Emergency instruction on total power failure condition/lubrication failure/any other conditions.

(g) Parameters to be monitored with normal value and limiting values.

(h) Equipment isolating procedures.

(i) Trouble shooting with causes and remedial measures.

(j) Routine testing procedure to ascertain healthiness of the safety devices alongwith schedule of testing.

(k) Routine Operational Checks, Recommended Logs and Records

(l) Change over schedule if more than one auxiliary for the same purpose is given.

(m) Preservation procedure on long shut down.

(n) System/plant commissioning procedure.

3) Chapter 3.0 - Plant Maintenance- To contain the following sections specific to the equipment supplied.

(a) Exploded view of each of the equipments. Drawings alongwith bill of materials including name, code no. & population.

(b) Exploded view of the spare parts and critical components with dimensional drawings (In case of Electronic cards, the circuit diagram to be given) and spare parts catalogue for each equipment.

(c) List of Special T/ P required for Overhauling /Trouble shooting including special testing equipment required for calibration etc.

(d) Stepwise dismantling and assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained etc. Clearance to be maintained etc.

(e) Preventive Maintenance schedules linked with running hours/calendar period alongwith checks to be carried out.

(f) Overhauling schedules linked with running hours/calendar period alongwith checks to be done.

(g) Long term maintenance schedules

(h) Consumables list alongwith the estimated quantity required during normal running and during maintenance like Preventive Maintenance and Overhauling.

(i) List of lubricants with their Indian equivalent, 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 and quantity required for complete replacement..

(j) Tolerance for fitment of various components.

(k) Details of sub vendors with their part no. in case of bought out items.

(l) List of spare parts with their Part No, total population, life expediency & their interchangeability with already supplied spares to NTPC.

(m) List of mandatory and recommended spare list along with manufacturing drawings, material specification & quality plan for fast moving consumable spares.

(n) Lead time required for ordering of spares from the equipment supplier, instructions for storage and preservation of spares.

(o) General information on the equipment such as modification carried out in the equipment from its inception, equipment population in the country / foreign country and list of utilities where similar equipments have been supplied.

8.03.03 After finalization and approval of the Employer, the O & M Manuals shall be submitted as indicated in Annexure-VI. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals (both erection and O & M manuals have been supplied to the Employer.

If after the commissioning and initial operation of the plant, the instruction manuals (Erection and /or O &M manuals) require modifications/additions/ changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the Contractor to the Employer for records and number of copies shall be as mentioned in Annexure-VI.

8.03.03 **PLANT HANDBOOK AND PROJECT COMPLETION REPORT**

**(a.) PLANT HANDBOOK**

The Contractor shall submit to the Employer a preliminary plant hand book preferably in A-4 size sheets which shall contain the design and performance data of various plants, equipments 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 Employer's comments, the final plant handbook complete in all respects shall be submitted three (3) months before start-up and commissioning activities.

(b.) **Project Completion Report**

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

8.03.04 **DRAWINGS**

(a.) All documents submitted by the Contractor for Employer's review shall be in electronic form (soft copies) along with the desired number of hard copies as per Annexure-I of Part-C. The soft copies shall be uploaded by the vendors in c-folder, a web based system of NTPC ERP, for which a username and password will be alloted to the new vendor by NTPC.

Similarly, the vendor can download the drawings / documents, approved / commented by NTPC , through above site.
The soft copies of identified drawings / documents shall be in pdf format, whereas the attachements / reply to the submitted document(s) can be in .doc, .xls, .pdf, .dwg or .std formats.

(b.) Final copies of the approved drawings alongwith requisite number of hard copies shall be submitted as per Annexure-I of Part-C.

(c.) Contractor shall prepare the model of all the facilities located in TG building (including all facilities), and any other facility located in TG building area in an integrated & intelligent 3D software solution using rule-based, data centric 3D Design software with equipment drawings, data sheets, intelligent P&ID correlated with intelligent 3D Model, BOQ, schematics and logic diagrams

etc. attached to the respective equipment / systems in the aforesaid 3D model.

All piping layouts, equipment layouts, floor plans, ducting layout (A/C, Ventilation etc.), General Arrangement drawings of major buildings, structural arrangement drawings and RCC layout drawings shall necessarily be extracted from the aforesaid 3D model and submitted for employer's review along with the 3D review model to enable NTPC to review and approve these drawings.

Contractor shall prepare and provide 3D design review model (network ready, which shall include visual interference check, walk-through animation, video simulation for major equipment placement and removal, visual effect, photo realism etc.), which is extracted from intelligent 3D model and shall make a presentation of the same every 3 months from LOA to enable NTPC to review the progress of engineering or as and when required by employer.. After the completion of engineering of facilities covered under this package, the corresponding complete 3D review model shall be handed over to the employer for its reference.

(d.) All documents/text information shall be in latest version of MS Office/ MS Excel/ PDF Format as applicable.

(e.) All drawings submitted by the Contractor 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 equipments 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 Contractor (including those of subvendors) shall bear a title block at the right hand bottom corner with clear mention of the name of the Employer, the system designation, the specifications title, the specification number, the name of the Project, drawing 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 drawings submitted by the Contractor (or their subvendors) shall bear Employer's drawing number in addition to contractor's (their sub-vendor's) own drawing number. Employer's drawing numbering system shall be made available to the successful bidder so as to enable him to assign Employer's drawing numbers to the drawings to be submitted by him during the course of execution of the Contract.

Similarly, all the drawings/ documents submitted by the Contractor during detailed engineering stage shall be marked "FOR APPROVAL" or "FOR INFORMATION" prior to submission.

Further, space shall be identified on each drawing for approval stamp and electronic signature.

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

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

(l.) All manufacturing, fabrication and execution of work in connection with the equipment / system, prior to the approval of the drawings, shall be at the Contractor's risk. The Contractor is expected not to make any changes in the design of the equipment /system, once they are approved by the Employer. However, if some changes are necessitated in the design of the equipment/system at a later date, the Contractor may do so, but such changes shall promptly be brought to the notice of the Employer indicating the reasons for the change and get the revised drawing approved again in strict conformance to the provisions of the Technical Specification.

(m.) 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 Employer prior to erection. Small diameter pipes shall however be routed as per site conditions in consultation with site authority / representative of Employer 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.

(n.) Assessing & anticipating the requirement and supply of all piping and equipment shall be done by the contractor 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.

(o.) As Built Drawings

After final acceptance of individual equipment / system by the Employer, the Contractor will update all original drawings and documents for the equipment / system to "as built" conditions and submit number of coppies as per **Annexure-I**.

(p.) Drawings must be checked by the Contractor in terms of its completeness, data adequacy and relevance with respect to Engineering schedule prior to submission to the Employer. In case drawings are found to be submitted without proper checking by the Contractor, the same shall not be reviewed and returned to the Contractor for re-submission. The contractor 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 contractor 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 Employer's scope and submit all necessary drawings/ documents for the same.

(q.) The Contractor shall submit adequate prints of drawing / data / document for Employer's review and approval. The Employer shall review the drawings and return soft copy to the Contractor 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 Contractor to submit/rectify and resubmit in time shall not be accepted as a reason for delay in the contract schedule.

(r.) All engineering data submitted by the Contractor after final process including review and approval by the Project Manager/ Employer 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 Project Manager in writing.

8.03.05 **e-Learning Package:**

e-learning packages shall be supplied for the equipment / system for the following Steam Turbine Generator & auxiliaries along with associated electrical and C&I system.

8.03.05.01 **Steam Turbine Generator & Auxiliaries**

Steam Turbine including stop valves, control valves, overload valves and cross over piping. Steam Turbine Auxiliary Systems including Quick Closing and Ordinary NRVs, Turbine gland sealing system, Lubricating oil system and its purification system, Centralised oil storage and its purification system, Control fluid and its purification system, governing and protection system, exhaust hood spray cooling system, drainage and vent system, turbine preservation system, HP/LP Bypass system.

Generator and Auxiliary System including Generator, complete hydrogen cooling, carbon dioxide and nitrogen gas systems as applicable, complete seal oil system, complete water cooling system where applicable and complete excitation system.

Condensing Plant including Condenser, Condenser air evacuation system and Condenser on load tube cleaning system as applicable.

Drip Pump along with all accessories as applicable, Condensate Extraction Pumps along with all accessories, Deaerator level Control Station, Feed Water Heating Plant including Drain Cooler, low pressure heaters, deaerator and feed storage tank, high pressure heaters and associated accessories, Boiler Feed Pumps along with all accessories, Drive Turbine for Boiler Feed Pump along with all accessories, Feed regulating station, Make up system to Condenser, Gland Steam Condenser Recirculation System, Turbine Hall EOT Cranes and EOT Crane for Boiler Feed Pump as applicable.

8.03.05.02 These packages shall be installed on the Learning Management Server (LMS) of Power Management Institute (PMI) , NTPC located at Noida . The Engineer- In-Charge (EIC) for the e-learning modules shall be from PMI.

1. The objective of the e-Learning package consisting of courses for erection, commissioning, operation and maintenance of equipment / system as specified above is to facilitate the employees to have first hand information /requirement with respect to above activities for the supplied equipment /system.

2. The bidder shall submit e-learning courses each for erection, commissioning, operation and maintenance of each of the equipment / system supplied as above.
   a. The erection course(s) should include instructions on pre-checks, prerequisites, erection strategy, erection procedure etc.
   b. The commissioning course(s) should include instructions on recommissioning,commissioning, initial operation etc.
   c. The operation course(s) should include instructions on the permissive, interlocks, physical check ups, start up , shutdown and protections etc.
   d. The maintenance course(s) should include instructions on predictive, preventive, breakdown and overhauling.

   Depth of coverage of above courses shall be as specified for “Instruction Manuals” in above clauses. A literature on caution / safety while handling equipment / system for the above modules shall follow the description of the said equipment /system.

3. The e-Learning packages on equipment / system shall be installed by the vendor and shall be successfully test run in the presence of EIC or representative before acceptance by NTPC. The vendor will also give the master copy in form of Flash Drive/CD/DVD. The respective module for erection & commissioning shall be delivered and successfully test run at least three months before the scheduled start of the corresponding activity at site.

   The respective module for operation & maintenance shall be delivered and successfully test run at least three months before scheduled first synchronization of first unit.

4. **e-Learning course broad requirements:**

   a. The courses shall be web based and mobile based Application type.

      It shall run on all possible versions of web browser like Internet Explorer, Google Chrome, Firefox etc. on Laptop/Desktop and shall be Smartphone/Tablet/Mobile responsive. The Mobile responsive courses shall run on Android, Windows Mobile, Blackberry, iOS etc.

   b. The courses shall support liquid/fluid page layout so that the entire screen gets adjusted to PC, Laptop, Smartphone/Mobile, Tablet and any other display devices.

   c. Course content text shall be in English language and be associated with a voiceover in English language with Indian accent.

   d. Courses shall be SCORM (Sharable Content Object Reference Model) compliant, version 1.2 which is compatible with LMS at PMI.

   e. Each course shall have every physical and functional detail of the equipment / system supplied.

   f. Each of the e-Learning course shall be based on multiple web pages and mobile pages with multiple modules.

   g. There shall be option for self-assessment test after every course. In case the user doesn't opt for self assessment test the user shall be able to go to the next course. There shall be no restriction in no. of times for repeating the assessments. All correct answers along with the answers marked by the users shall be displayed at the end of test/quiz.

   h. If Java and Flash, as applicable are not available in the system to run the package, then there shall be a prompt message for updation of the same.

   i. Each course shall have a self-running interactive content with navigation buttons containing forward, backward, pause, bookmark and menu options in the course window.

j. The course shall contain chapter titled 'Introduction/overview' that explains the purpose of the course.

k. The course content shall contain descriptive text shall be factual, specific, terse, clearly worded, and simply illustrative, so that the user can understand it.

l. The system shall provide the user with the ability to select the information with a Cursor.

m. The course menu should contain table of content linked to concerned pages. The user shall be given the capability to access all of the functions available on the system through a menu system. This shall consist of active buttons, which shall control a hierarchy of pull down/pop up menus. Menu shall appear quickly and exist only while a selection is being made. The user shall be given the capability to position the cursor or pointer on the menu item and use pointer device such as mouse to activate the function.

n. Every course shall contain the 3D design/drawing/exploded view/360$_0$ turn around view of the equipment/system, textual description of the equipment/system and its functionality with video (as applicable), animation and audio.

o. The users shall be able to control audio sound level associated with the courses.

p. Drawings / text in the courses shall be scalable (Zoom In/ Out).'

q. The user shall have the capability to record a **bookmark** to mark displayed information for later recall, whenever he accesses the same course next time.

Notes:

1. e-learning Package of an equipment / system shall include e-learning courses for each of erection, commissioning, operation and maintenance of that equipment / system.

2. e-learning courses on erection, commissioning, operation and maintenance of an equipment / system shall include e-learning lessons/chapters/modules (as required) for erection, commissioning, operation and maintenance respectively of that equipment / system.

3. The vendor shall get the approval of one sample course from EIC before proceeding for further courses.

**8.04.00 Engineering Co-ordination Procedure**

8.04.01 The following principal coordinators will be identified by respective organizations at time of award of contract:

NTPC Engineering Coordinator (NTPC EC) :

Name :

Designation :

Address :

a) Postal :

b) Telegraphic / e-Mail :

c) FAX : TELEPHONE :

Contractor's/ Vendor's Engineering Coordinator (VENDOR EC):

Name :

Designation :

Address :

a) Postal :

b) Telegraphic / e-Mail :

c) FAX : TELEPHONE :

8.04.02 All engineering correspondence shall be in the name of above coordinators on behalf of the respective organizations.

8.04.03 Contractor's/Vendor's Drawing Submission and Approval Procedure:

a) All data/information furnished by Vendor in the form of drawings/ documents/catalogues or in any other form for NTPC's information/ interface and or review and approval are referred by the general term "drawings".

b) Not used

c) All drawings (including those of subvendor's) shall bear at the right hand bottom corner the 'title plate' with all relevant information duly filled in. The Contractor shall furnish this format to his subvendor along with his purchase order for subvendor's compliance.

d) Not used

e) The contractor 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 contractor 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 Employer's scope and submit all necessary drawings/ documents for the same.

f) **Drawings must be checked by the Contractor in terms of its completeness, data adequacy and relevance with respect to engineering schedule prior to submission to the Employer. In case drawings are found to be submitted without proper endorsement for checking by the Contractor, the same shall not be reviewed and returned to the Contractor for re-submission.**

g) The Contractor shall submit adequate prints of drawing / data / document for Employer's review and approval. The drawings submitted by the Contractor/vendor shall be reviewed by NTPC and their comments shall be forwarded within three (3) weeks of receipt of drawings. Upon review of each drawing, depending on the correctness and completeness of the drawing, the same will be categorized and approval accorded in one of the following categories :

| | |
|---|---|
| CATEGORY- I: | Approved |
| CATEGORY- II | Approved, subject to incorporation of comments/ modification as noted. Resubmit revised drawing incorporating the comments. |
| CATEGORY –III | Not approved. Resubmit revised drawings for approval after incorporating comments/ modification as noted. |
| CATEGORY -IV | For information and records. |

h) Contractor shall resubmit the drawings approved under Category II, III & IVR within three (3) weeks of receipt of comments on the drawings, incorporating all comments. Every revision of the drawing shall bear a revision index wherein such revisions shall be highlighted in the form of description or marked up in the drawing identifying the same with relevant revision Number enclosed in a triangle (eg. 1, 2, 3 etc). Contractor shall not make any changes in the portions of the drawing other than those commented. If changes are required to be made in the portions already approved, the Contractor shall resubmit the drawing identifying the changes for Employer's review and approval. **Drawings resubmitted shall show clearly the portions where the same are revised marking the relevant revision numbers and Employer shall review only such revised portion of documents.**

i) In case, the Contractor/ Vendor does not agree with any specific comment, he shall furnish the explanation for the same to NTPC for consideration. In all such cases the Contractor shall necessarily enclose explanations along with the revised drawing (taking care of balance comments) to avoid any delay and/or duplication in review work.

j) It is responsibility of the Contractor/ Vendor to get all the drawings approved in the Category I & IV (as the case may be) and complete engineering activities within the agreed schedule. Any delay arising out of submission and modification of drawings shall not alter the contract completion schedule.

k) If Contractor/ Vendor fails to resubmit the drawings as per the schedule, construction work at site will not be held up and work will be carried out on the basis of comments furnished on previous issues of the drawing.

l) These comments will be taken care by the contractor while submitting the revised drawing.

The contractor shall use a single transmittal for drawings. Submission. This shall include transmittal numbers and date, number of copies being sent, names of the agencies to whom copies being sent, drawing number and titles, remarks or special notes if any etc.

8.05.00 **ENGINEERING PROGRESS AND EXCEPTION REPORT**

8.05.01 The Contractor shall submit every month an Engineering progress and Exception 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 Employer within four (4) weeks of the award of the contract, which shall then be discussed and finalised with the Employer.

8.06.00 **TECHNICAL CO-ORDINATION MEETING**

8.06.01 The Contractor shall be called upon to organise and attend monthly Design/ Technical Co-ordination Meetings (TCMs) with the Employer/Employer's representatives and other Contractors of the Employer during the period of contract. The Contractor shall attend such meetings at his own cost at NEW DELHI / NOIDA or 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 Contractor should note that Time is the essence of the contract. In order to expedite the early completion of engineering activities, the Contractor shall submit all drawings as per the agreed Engineering Information Submission Schedule.The drawings submitted by the Contractor will be reviewed by the Employer as far as practicable within three (3) weeks from the date of receipt of the drawing .The comments of the Employer shall then be discussed across the table during the above Technical Co-ordination Meeting (s) wherein best efforts shall be made by both sides to ensure the approval of the drawing.

8.06.03 The Contractor shall ensure availability of the concerned experts / consultants/ personnel who are empowered to take necessary decisions during these meetings. The Contractor 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 Contractor to incorporate Employer's comments and resubmit the same during the TCM shall be considered as a default and in no case shall entitle the Contractor to alter the Contract completion date.

8.07.00 **DESIGN IMPROVEMENTS**

The Employer or the Contractor 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 Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

8.07.01 **Testing of major design features:**

The major design features of the system shall be conducted by the Contractor at the Contractor's works or any other place mutually agreed within six months from the date of LOA. These are the system function tests, which have a major impact on the detailed system design & finalization of important engineering documents like configuration, functional grouping, BOM etc., but do not require a fully engineered system for conductance. Bidder shall identify these features & include detailed test procedures in the bid, which shall be finalized during discussions with the bidder before award. The developments and any augmentation of standard features undertaken by the Bidder to fulfill the various specification requirements, shall be also be tested during these major design tests. This shall include but not be limited to the following.

a) System accuracy tests of DDCMIS for the various type of inputs identified in Part-B.

b) Loop reaction time for sample loops/ logics.

c) N/A.

d) Server changeover.

e) Various response times, having serious implication on operation & maintenance philosophy.

f) Duty cycle of controller/ HMIPIS with simulated load, representative of the final engineered load.

g) Unified HMI for DDCMIS as indicated in IIC-01, Scope of supply & services chapter of Part-A, Section-VI.

The results of the above tests, after its acceptance by the Employer, shall be properly documented and submitted to Employer. If any of the envisaged tests have

been carried out by Bidder in a previous NTPC project, then the same need not be specifically conducted by the Bidder for this project, provided it is clearly established by the Bidder & accepted by the Employer that there is no difference between the system offered for this project & the previous NTPC project w.r.t. the test. However, even in such a case, test report of the previous project shall be submitted by the Bidder as a part of MDFT (Major Design Feature Test) report.

8.07.02 **Demonstration of Application Engineering**

A) The Contractor shall prepare and submit typical implemented scheme in their system (Control system & HMI) on sample basis. The typical cases to be covered shall include but not be limited to the following.

(i) Logics/Loops:

a) Drive logics implementation for each type of binary drive along with its display in HMI.

b) Sequence implementation along with its display in HMI.

c) Single non-cascade controller implementation.

d) Cascade loop implementation.

e) Master slave implementation with different slave combination.

f) Temperature & pressure compensation for flow signals & pressure compensation for level signals as applicable.

(ii) HMI Functions:

a) LVS Annunciation.

b) Graphics.

c) HSR

d) Logs/Reports.

e) N/A.

B) The above typical cases shall be finalized with the Employer through Technical Co-ordination meetings.

After review and finalization of the typical cases, the implementation of each logic & control loop shall be carried out by the Contractor. After implementation of these

logics & loops, the Contractor shall test each logic/loop and record the observations in a format to be provided by the Employer and demonstrate to Employer at Employer premises during engineering finalization. Any modifications as a result of the demonstration shall be done and documented as part of the test report along with the final scheme. Similarly, HMI functions shall also be demonstrated by the Contractor at Employer premises & the results shall be documented as part of test report.

C) During the integrated testing at the Contractor's works, only sample checks shall be done by the Employer for the items covered in above application engineering demonstration.

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 Employer. 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 All the first fill and one year's topping requirements of consumables such asgreases, oil, lubricants, servo fluids / control fluids, gases (excluding H2, CO2 and N2 for Generator) and essential chemicals etc. which will be required to put the equipment covered under the scope of specifications, into successful commissioning / initial operation and to establish completion of facilities shall be supplied by the Contractor. Suitable standard lubricants as available in India are desired. Efforts should be made to limit the variety of lubricants to minimum.

Bidder scope shall also include supply of H2 , CO 2 and N2 as applicable for the Generator till successful commisioning of the Generator.

Bidder shall also supply a quantity not less than 10% of the full charge of each variety of lubricants, servo fluids, gases, chemicals etc ( as detailed above) 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 Employer alongwith 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 utilised 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 Employer.

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 Employer or as detailed in appropriate section of the technical specifications.

8.13.03 Such nameplates or labels shall be of white nonhygroscopic 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 enamel.

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 Employer'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 Contractor 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 Contractor shall also ensure that these tools and tackles are not used by him during erection, commissioning and initial operation. For this period the Contractor should bring his own tools and tackles. All the tools and tackles shall be of reputed make acceptable to the Employer.

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 equipments to be performed by others the requirements shall be submitted to the Employer in advance of commencement of erection work.

8.16.00 **COLOUR CODE FOR ALL EQUIPMENTS/ PIPINGS/ PIPE SERVICES**

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

8.17.00 **PROTECTION AND PRESERVATIVE SHOP COATING**

8.18.00 **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 pipings 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. The requirements for painting specification shall be complied with as detailed out in Part-A & B of the Technical Specification.

8.19.00 **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 as per the requirement covered in the relevant part of the Technical Specification.

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

8.19.01 Shop primer for all steel surfaces which will be exposed to operating temperature below 95 degrees Celsius shall be selected by the Contractor after obtaining specific approval of the Employer 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 Employer.

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

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

8.19.04 Painting for Civil structures shall be done as specified under technical requirements on civil works in relevant part of this specifications.

9.00.00 **QUALITY ASSURANCE PROGRAMME**

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

(a.) His organisation 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-contractor'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 Employer.

(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 contractor for some of the major items is given in the respective technical specification which shall be finalised giving due consideration to the manufacturer's standard and proven practices being followed. This is, however, not intended to form a comprehensive programme as it is the contractor's responsibility to draw up and implement such programme duly approved by the Employer. The detailed Quality Plans for manufacturing and field activities

shall be drawn up by the Bidder and will be submitted to Employer 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 on enclosed format No. QS-01-QAI-P-02/F1.

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 Contractor's/ Sub-contractor'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 through c-folders, a web based system of NTPC ERP 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 Contractor'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 Employer's approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved Quality Plans, Employer shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Employer's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Employer in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Employer 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 Employer'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 contractor shall submit to the Employer Field Welding Schedule for field welding activities in the enclosed format No.: QS-01-QAI-P-02/F2. The field welding schedule shall be submitted to the Employer 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 Employer.
All welding/brazing procedures shall be submitted to the Employer 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 Contractor's/sub-contractor'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 Employer.

9.02.10 Welding procedure qualification & Welder qualification test results shall be furnished to the Employer for approval. However, where required by the Employer, tests shall be conducted in presence of Employer/authorised representative.

9.02.11 For all IBR pressure parts and high pressure piping welding, the latest applicable requirements of the IBR (Indian Boiler Regulations) shall also be essentially complied with. However, for other piping system ASME B31.1 or other relevant code as applicable shall be followed. 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 Employer, 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) / EN /

Equivalent. 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 Contractor shall list out all major items/ equipment/ components to be manufactured in house as well as procured from sub-contractors (BOI). All the sub-contractor proposed by the Contractor 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 Contractor and finalised with the Employer, shall be subject to Employer's approval. The contractor'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 Employer for approval within the period agreed at the time of pre-awards discussion and identified in "DR" category prior to any procurement. Monthly progress reports on sub-contractor detail submission / approval shall be furnished on enclosed on format no. QS-01-QAI-P-02/F1. Such vendor approval shall not relieve the contractor 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 Employer, the contractor's purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the sub-contractor 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 Employer and such approved Quality Plans shall form a part of the purchase order/contract between the Contractor and sub-contractor. 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 Employer on the monthly basis by the Contractor along with a report of the Purchase Order placed so far for the contract.

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

9.02.19 The contractor shall carry out an inspection and testing programme during manufacture in his work and that of his sub-contractor'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. Contractor 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 Employer 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 Contractor 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 Employer/ authorised representative.

9.02.23 Environmental Stress Screening

All solid state electronic system / equipment / sub assembly shall be free from infant mortile components. For establishing the compliance to this requirement, the contractor / sub - contractor should meet the following.

1) The Contractor / Sub - contractor shall furnish the established procedure being followed for eliminating infant mortile components. The procedure followed by the Contractor / Sub - contractor should be substantiated along with the statistical figures to validate the procedure being followed. The necessary details as required under this clause shall be furnished at the stage of QP finalization.

OR

In case the Contractor / Sub - contractor do not have any established procedure to eliminate infant mortile components then two or 10% which ever is less, most densely populated Panels shall be tested for Elevated Temperature Cycle Test as per the following procedure.

Elevated Temperature Test Cycle

During the elevated temperature test which shall be for 48 hours, the ambient temperature shall be maintained at 50° C. The equipment shall be interconnected with devices and kept under energized conditions so as 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° C above the ambient temperature at 50° C.

In case of any failure during the test cycle, the further course of action should be mutually discussed for demonstrating the intent of the above requirement.

2) Burn in Test Cycle

The test shall be conducted on all the panels fully assembled and wired including the panels having undergone the above mentioned elevated temperature test.

The period of Burn in Test Cycle shall be 120 hrs and process shall be similar to the elevated temperature 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.

During the Burn in 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° C above the ambient temperature.

The Contractor / Sub-contractor shall carry out routine test on 100% item at contractor / sub-contractor's works. The quantum of check / test for routine & acceptance test by employer 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 Contractor 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 Employer and Contractor for the agreed Customer Hold Points.

(h.) Certificate of Conformance (COC) wherever applicable.

(i.) MDCC

9.03.03 NOT USED.

9.03.04 NOT USED.

9.03.05 Similarly, the contractor 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.

9.03.06 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 for 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.

9.03.07 **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 Employer.

For the particular case of phased/part derivatives of equipment, the complete quality document of that particular equipment to the Employer 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 GCC of Vol.I, the Contractor 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 Contractor'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 authorised representative and/or an outside inspection agency acting on behalf of the Employer

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 authorised representative and/or an outside inspection agency acting on behalf of the Employer 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 Contractor shall obtain for the Project Manager and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works.

9.05.03 The Contractor shall give the Project Manager/Inspector ten (10) working days written notice of any material being ready for testing. Such tests shall be to the Contractor'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 ten (10) working days of the date on which the equipment is noticed as being ready for test/inspection failing which the contractor 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 ten (10) working days from the date of inspection as defined herein give notice in writing to the Contractor, 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 Contractor 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 Contractor's or sub-contractor's works, the Project Manager /Inspector shall issue a certificate to this effect ten (10) working days after completion of tests but if the tests are not witnessed by the Project Manager /Inspectors, the certificate shall be issued within ten (10) working days of the receipt of the Contractor's test certificate by the Project Manager /Inspector. Project Manager /Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificates shall not bind the Employer 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 Contractor or any sub-contractor, the Contractor, 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 authorised representatives to carry out effectively such tests on the equipment in accordance with the Contractor and shall give facilities to the Project Manager/Inspector or to his authorised 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 Contractor 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 Contractor 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 contractor shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Contractor shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by NTPC. Wherever asked specifically, the contractor 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 & Sub-supplier approval.
Format No. QS-01-QAI-P-01/F3-R0

9.06.02 Status of Quality Plan and Sub-supplier approval
Format No. QS-01-QAI-P-02/F1-R0

9.06.03 Field Welding Schedule Format No.: QS-01-QAI-P-02/F2-R0

9.06.04 Manufacturing Quality Plan Format No.: QS-01-QAI-P-09/F1-R0

9.06.05 Field Quality Plan Format No.: QS-01-QAI-P-09/F2-R0
The above formats are enclosed as Annexure-III to 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 Employer and the Contractor 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 Contractor's quality assurance programme as well as those included in Part-D, Section-VI and elsewhere in the Technical Specifications.

(b.) The Contractor'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, equipments shall be operated integral with sub-systems and supporting equipment as a complete plant.

(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 Employer six months prior to the respective implementations. The Employer 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 Employer's commissioning (start-up) Engineer(s), should be checked out and cleaned. The checking and inspection of individual systems should then follow a prescribed schedule to be agreed by the Employer.

(f.) The Contractor 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.) Contractor shall furnish the commissioning organization chart for review & acceptance of employer 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.

The Initial Operation shall be considered successful, provided that each item/ part of the facility can operate continuously at the specified operating characteristics, for the period of Initial Operation with all operating parameters within the specified limits and at or near the predicted performance of the equipment/ facility.

The Contractor shall intimate the Employer about the commencement of initial operation and shall furnish adequate notice to the Employer in this respect.

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

In the event of test interruptions as a result of Force Majeure or Employer-Caused-Delay during Initial Operation test, where.

(i) The total cumulative interrupted time during the test is more than twenty-four (24) hours.

(ii) The total number of interruptions during the test is more than four (4).

The test shall not be deemed a successful Initial Operation Test.

The interrupted test resulting from Force Majeure or Employer-Caused-Delay shall be extended by an amount of time equal to the cumulative length of the interruptions, including time to return to steady-state operation; the test data for the period of interruptions shall be excluded from analysis; and the test data that were collected both before and after the interruptions shall be included in the analysis.

d) 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 Contractor. 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 Contractor to the full satisfaction of the Employer 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.

(g) **Grid Restriction**

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

11.00.00 **GUARANTEE TESTS**

a) The final test as to prove the Functional Guarantees shall be conducted at Site by the Contractor in presence of the Employer. The contractor's Commissioning, Start-up Engineer shall make the unit ready to conduct such test before start of initial operation. Such test shall be conducted along with Initial Operations.

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, accuracy class shall be as per specified test codes. 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 Employer'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 Contractor, free of cost.

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

12.00.00 **TAKING OVER**

Upon successful completion of Initial Operations and all the tests conducted to the Employer's satisfaction, the Employer shall issue to the Contractor 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 Employer 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 Contractor of any of his obligations which otherwise survive, by the terms and conditions of the Contract after issuance of such certificate.

13.00.00 **TRAINING OF EMPLOYER'S PERSONNEL**

13.01.00 The scope of service under training of Employer's engineers 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 Employer:

(a.) Training for TG and related equipments.

(b.) TG related C&I system like turbine supervisory system (TSS) etc.

(c.) DDCMIS as detailed in Part-B

(d.) Training for Electric Power Supply systems

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

13.02.00 The scope of services under training shall also necessarily include training of Employer's Engineering personnel covering entire scope for the package This shall

cover all disciplines viz, Mechanical, Electrical, C&I, & QA etcand 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.

13.03.00 Contractor shall also arrange for training of Employer's personnel in respect of fire detection and protection systems and other Balance of Plant equipments.

13.04.00 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.

13.05.00 In all the above cases, the lodging and boarding of the Employer's personnel shall be at the cost of Bidder. The Bidder shall make all necessary arrangements towards the same.

13.06.00 Take off prices (product wise) should be indicated by the Bidder in the Bid Proposal Sheets. Employer reserves the right to include or exclude these item(s) during placement of Award.

**Note**:

1. For training purposes, one (1) man month implies 30 working days (excluding all intervening holidays) per person.
2. The total man months in each area shall be divided into suitable number of modules which shall be discussed and finalized during post award stage.
3. Duration of each module shall not be less than 10 (ten) working days out of which 20 % shall be for plant/manufacturers' works visits and 80% shall be class room training.
4. A) Location of class room training for engineering shall be at Design/Engineering office.

   B) Class room training for erection/O&M shall be at location of Manufacturers' works.

**TRAINING REQUIRED IN MAN MONTH**

| Area | Engineering (Man months) | Erection (Man months) | O&M (Man months) |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Steam Turbine Generator and its Auxiliaries including electricals | 6.5 | 9.0 | 23 |
| Station C&I (Control and Instrumentation) | 3.5 | 5.5 | 10 |
| **Total** | | | |

| Area | Topics | MANDAYS |
|---|---|---|
| **Condensate Polishing Plant (CPU)** | **System/Product Design**<br>- Basic design features including Pre-filters<br>- Theory & principle of operation<br>- Latest technological trends in CPU & Pre-filters and design aspects & Selection criteria.<br><br>**Plant Visit**<br>- Operational feedback<br>- O&M history / problems related to CPU plant<br><br>**Visit to Manufacturer's Work**<br>-Manufacturing process of pre-filters and major equipment<br>-Testing facilities<br><br>**Operation & Maintenance of Plant**<br>-Trouble shooting and fault analysis<br>-Familiarization of special maintenance techniques<br>-Special tool and tackles familiarization | **3** |

14.00.00 **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 Employer's safety rules for construction and erection shall be used. Rungs shall not be welded on columns. All the stairs shall be provided with handrails immediately after its erection.

15.00.00 **NOISE LEVEL**

The equivalent 'A' weighted sound pressure level measured at a height of 1.5 m above floor level in elevation and at a distance of one (1) metre horizontally from the nearest surface of any equipment / machine, furnished 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-115 dBA.

(b.) Regulating drain valves in which case it shall be limited to 90 dBA-115dBA.

(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 90 dBA.

(e) For BFP motor, the noise level shall be within the limit of 90 dBA

16.00.00 **PACKAGING AND TRANSPORTATION**

All the equipments 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. 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 Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The Contractor shall ascertain the availability of Railway wagon sizes from the Indian Railways or any other agency concerned in India well before effecting despatch of equipment. Before despatch 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 & preassembly to bare minimum. The Employer's Inspector shall have right to insist for completion of works in shops before despatch of materials for transportation.

17.00.00 **ELECTRICAL ENCLOSURE**

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

18.00.00 **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.

18.01.00 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 centimetre (Kg/cm2). 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 | - | Millimetres 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 centimetre. |

18.02.00 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.

18.03.00 **NOT USED**.

19.00.00 **ELECTRICAL NOISE CONTROL**

The equipment furnished by the Contractor shall incorporate necessary techniques to eliminate measurement and control problems caused by electrical noise. Areas in Contractor'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.

20.00.00 **INSTRUMENT AIR SYSTEM**

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

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

21.00.00 **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 Contractor will be intimated about thread standard to be adopted.

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

(a.) Temperature test pockets with stub and thermowell

(b.) Pressure test pockets

**22.00.00 SYSTEM DOCUMENTATION**

The Bidder shall provide drawings, system overview & description, hardware/ software details, technical literature, functional & hardware schemes, bill of material, parts list, interconnection diagrams, data sheets, erection/ installation/

commissioning procedures, instruction/ operating manuals, etc. for each of the C& I system / sub-systems/ equipment supplied under this package. The documentation shall include complete details of the C&I systems/ sub-systems/ equipment to enable review by Employer during detailed engineering stage and to provide information to plant personnel for operation & Maintenance (including quick diagnostics & trouble shooting) of these C&I systems/ sub-systems/ equipment at site. The minimum documentation requirements for C&I systems shall be as stipulated under C&I "Techncial Data Sheets" Part of specifications. In addition to this, system documentation for DDCMIS shall include as a minimum to that specified elsewhere in the Technical Specification.

The exact format, submission schedule and contents of various documents shall be as finalised during detailed engineering stage.

22.01.00 Bill of material (instrument list) for all C&I equipment/ devices shall be furnished by the bidder in standard formats as approved by the Employer.

23.00.00 **MAINTENANCE MANUALS OF ELECTRONIC MODULES**

The Contractor shall have to furnish two (2) sets of all maintenance manual of each and every electronic card/module as employed on the various systems and equipment including peripherals etc., offered by him. The Contractor will also have to furnish the data regarding the expected failure rate of various modules and other system components. Further, the contractor shall furnish a set of operating manuals which should include block diagrams, make, model/type, details wiring and external connection drawings etc as required to do the testing and maintenance of the electronic modules.

**ANNEXURE-I**

| S.NO. | DESCRIPTION OF DOCUMENTS | NO OF PRINTS | NO. OF CD-ROMs |
|---|---|---|---|
| 1. | PLANT DEFINITION MANUAL- | 2 sets | 4 CD-ROMs |
| 2. | Drawings "FOR APPROVAL" | | |
| | i) Layout drawings / P&IDs | 6 | 2 CD - ROMs |
| | ii) Other drawings | 2 | 2 CD - ROMs |
| 3. | Drawings "FOR INFORMATION" | 2 | 2 CD - ROMs |
| 4. | Drawings "FINAL DRAWING" | 15 | 4 CD-ROMs |
| 5. | Drawings "AS BUILT " | 15 | 4 CD-ROMs |
| 6 | DATASHEETS, DESIGN CALCULATIONS, PURCHASE SPECIFICATIONS, etc. and Other type of documents | | |
| | i) For Approval | 2 | 2 CD - ROMs |
| | ii) FINAL | 15 | 4 CD-ROMs - |
| | iii) Analysis reports of equip-ments/ piping/ structures components/ systems employing software packages as detailed in the specifications | 2 | 2 CD - ROMs |
| 7. | Erection manual "1st Submission" | 4 Sets | 2 CD - ROMs |
| 8 | Erection manual "FINAL" | 4 Sets | 4 CD ROMs |
| 9 | Operation & Maintenance manual "1st submission" | 4 | 2 CD - ROMs |

| S.NO. | DESCRIPTION OF DOCUMENTS | NO OF PRINTS | NO. OF CD-ROMs |
|---|---|---|---|
| 10 | Operation & Maintenance manual "FINAL" | 4 Sets | 4 CD-ROMs |
| 11 | Plant Hand Book "1st Submission" | 4 Sets | 2 CD ROMs |
| 12 | Plant Hand Book "FINAL" | 4 Sets | 4 CD ROMs |
| 13 | Commissioning and Performance Procedure manual "1st Submission" | 4 Sets | 2 CD-ROMs |
| 14 | Commissioning and Performance Procedure manual "FINAL" | 4 Sets | 4 CD ROMs |
| 15 | Performance and Functional GURANTEES TEST REPORT | 4 Sets | 4 CD ROMs |
| 16 | Project completion report | 15 | 4 CD ROMs |
| 17 | QA programme including Organi-sation for implement-ation and QA systemmanual (with revision-servicing) | 1 | 1 CD ROM |
| 18 | Vendor details in respect of pro-posed vendors including contractor's evaluation report. | 1 | 1 CD ROM |
| 19 | Manufacturing QPs, Field QPs, Field welding schedules and their reference documents like test procedures, WPS, PQR etc. | | |
| | (i) For review/comment | 2 | 2 CD-ROMs |
| | (ii) For final approval | 2 | 2 CD ROMs |

| S.NO. | DESCRIPTION OF DOCUMENTS | NO OF PRINTS | NO. OF CD-ROMs |
|---|---|---|---|
| 20 | Welding Manual, HeatTreatment Manuals, Storage & preservation manuals | | |
| | 1st Submission | 4 Sets | 2 CD ROMs sets |
| | Final | 4 sets | 4 CD ROMs |
| 21 | QA Documentation Packagefor items / equipmentmanufactured and and despatched to site | 2 sets | 4 CD ROMs |
| 22 | QA Documentation Package for field activities on equipment / systems at site | 2 sets | 4 CD ROMS |

ANNEXURE-II

## LIST OF CODES AND STANDARDS

| Indian Standards | Title | International and Internationally recognised standards |
|---|---|---|
| IS:277 | Galvanised steel sheets (plain or corrugated) | |
| IS:655 | Specification for metal air duct | |
| IS:800 | Code of practice for use of structural steel in general building construction | BS 449:1969<br>BS 5950<br>ASA A57, 1-1952 |
| IS:807 | Code of practice for design, manufacture, erection and testing (Structural portion) of cranes and hoists<br>6588 (Issued by Standards Associa-tion of Australia).<br>DIN 120:1936 (Sheet 1)<br>DIN 120:1936 (Sheet 2)<br>327 part-I, 1951<br>BS 466 part-II, 1960<br>BS 644:1960<br>BS 1757:1951<br>BS 2573:part-I:1960 | Draft Revision of A.S. NO. CS.2 SAA Crane and Hoist code Doc:No. BU/4 Rev |
| IS:875 | Code of practice for design loads (other than earthquake) for buildings and structures<br>Leading standards (issued by Canadian Standard)<br>DIN-1055-1955 (Issued by ASA) | National Building code of Canada (1953)-Part-IV<br><br>Design section 4.1 |

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|---|---|---|
| IS:1239 Part-I | Mild steel tubes | (ISO/R 65-1957)<br>(ISO/R-64-1958)<br>(ISO/R-65-1958)<br>(BS 1387 : 1957) |
| IS:1239 Part-II | Mild steel tubulars and other wrought steel pipe fittings | BS 1387 : 1967<br>BS 1387 :1967<br>BS 1740 :1965 |
| IS:2825 | Code for unfired vessels | |
| IS:1520 | Horizontal centrifugal pumps for clear cold and fresh water | |
| IS:1600 | Code for practice for performance of constant speed IC Engines for general purpose | |
| IS:1601 | Specification for perform-ance of constant speed IC Engines for general Purpose | |
| IS:1893 | Criteria for earthquake resistant design of structures | |
| IS1978-1971 | Line Pipe April 1969. | API Standards 5L |
| IS:2254-1970 | Dimensions of vertical shaft motor for pumps | IEC Pub 72-1 part I<br>NEMA Pub MG 1 1954 |
| IS:2266 | Steel wire ropes for general engineering purposes | BS :302 : 1968 |
| IS:2312 | Propellant type Ventilation fans | |

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|---|---|---|
| IS:2365 | Steel wire suspension ropes for lifts and hoists | BS : 1957 |
| IS:3346 | Method for the determin-ation of thermal conductivity of thermal insulation materials (two slab guarded hot plate method) | DIN 52612 (Deutscher Normenausschuss)<br>ASTM C 163-1964 (American Society of Testing and materials)<br>ASTM C 167-1974<br>ASTM C 177-1963 |
| IS:3354 | Outline dimensions for electric lifts. | |
| IS:3401 | Silica gel | |
| IS:3588 | Specification for electrical axial flow fans | |
| IS:3589 | Electrically welded steel pipes for water, gas and sewage (200mm to 2000 mm Nominal Diametre) | |
| IS:3677 | Unbonded rock and slag wool for thermal insulation | |
| IS:3815 | Point hook with shank for general engineering purposes | BS 482 - 1968<br>Doc.:67/3 1284 (Revision of BS 2903) (Issued BS) |
| IS:3895 | Specification for monocry-stallines semiconductor rectifier cells and stacks | |
| IS:3963 | Roof extractor unit | |
| IS:3975 | Mild steel wires, strips and tapes for armouring cables | |

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|---|---|---|
| IS:4503 | Shell and tube type heat Exchanger | |
| IS:4540 | Specification for monory-stallines rectifire assembly equipment | |
| IS:4671 | Expanded polystyrene for thermal insulation purpose | |
| IS:4736 | Hot dip zinc coating on steel tubes | |
| IS:4894 | Centrifugal fans | |
| IS:5456 | Code of practice for testing of positive displacement type air compressors and exhauster (For Test Tolerance Only) | |
| IS:5749 | Forged ramshorn hooks | Entwurf DIN 15402 Blett 1<br>Entwurf DIN 15402<br>BS 3017-1958 |
| IS:6392 | Steel pipe flanges | BS 4504 : 1969 |
| IS:6524 Part-I | Code of practice for design of tower cranes Static and rail mounted | BS 2799 : 1956 |
| IS:7098 | Cross linked Polyethylene insulated PVC sheathed cables | Standard No. 1 to IPCEA (USA) Pub. No. 5-66-524 |
| IS:7373 | Specification for wrought aluminium and aluminium sheet and strips | |
| IS:7938 | Air receivers for compressed air installation | |

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| ISO:1217 | Displacement compressor-Acceplance test |
| ASHRAE-33 | Methods of testing for rating of forced circulation air cooling and air heating coils. |
| ASHRAE-52-76 | Air cleaning device used in general ventilation for removing particle matter. |
| ASHRAE-22-72 | Method of testing for rating of water cooled refrigerant condensers. |
| ASHRAE 23-67 | Methods of testing for rating of positive displacement refrigerant compressors. |
| ARI-450-6 | Standard for water cooled refrigerant condensers. |
| ARI-550 | Standard for centrifugal water chilling packages. |
| ARI-410 | Standard for forced circulation air cooling and air heating coils |
| ARI-430/435 | Central station AHU/Application of Central Station AHU |
| BS:848 (Part-1,2) | Fans |
| BS:400 | Low carbon steel cylinders for the storage & transport of permanent gases. |
| BS:401 | Low carbon steel cylinders for the storage & transport of liquified gases. |
| CTI Code ACT-105 | Acceptance test code for Water Cooling Tower. |
| ANSI-31.5 | Refrigerant piping |
| ASME-PTC-23-1958 | Atmospheric Water Cooling Equipment |
| AMCA A-21C | Test Code for air moving devices |
| API:618 | Reciprocating Compressor for general refinary services. |

HYDRAULIC INSTITUTE STANDARDS.

HYDRANT SYSTEM MANUALS OF TAC.

TAC MANUALS OF SPRAY SYSTEM

NFPA USA/ NSC UK/ UL USA/ FM USA STANDARDS.

INDIAN EXPLOSIVES ACT.

INDIAN FACTORIES ACT.

STANDARD OF TUBULAR EXCHANGER MANUFACTURER'S ASSOCIATION.

**CODE AND STANDARD FOR CIVIL WORKS**

Some of the applicable Standards, Codes and references are as follows:

**Excavation & Filling**

IS: 2720 (Part-II, IV TO VIII, XIV, XXI, XXIII, XXIV, XXVII TO XXIX, XL) Methods of test for soils-determination for water content etc.

IS: 4701 Code of practice for earth work on canals.

IS: 9758 Guide lines for Dewatering during construction.

IS: 10379 Code of practice for field control of moisture and compaction of soils for embankment and sub-grade.

**Properties, Storage and Handling of Common Building Materials**

IS: 269 Specification for ordinary Portland cement, 33 grade.

IS: 383 Specification for coarse and fine aggregates from natural sources for concrete.

IS: 432 Specification for mild steel and (Parts 1&2) medium tensile steel bars and hard-drawn steel wires for concrete reinforcement.

IS: 455 Specification for Portland slag cement.

IS: 702 Specification for Industrial bitumen.

IS: 712 Specification for building limes.

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| IS: 808 | Rolled steel Beam channel and angle sections. |
| IS: 1077 | Specification for common burnt clay building bricks. |
| IS: 1161 | Specification of steel tubes for structural purposes. |
| IS: 1363 | Hexagon head Bolts, Screws and nuts of production grade C. |
| IS: 1364 | Hexagon head Bolts, Screws and Nuts of Production grade A & B. |
| IS: 1367 | Technical supply conditions for Threaded fasteners. |
| IS: 1489 | Specification for Portland-pozzolana cement: |
| (Part-I) | Fly ash based. |
| (Part-II) | Calcined clay based. |
| IS: 1542 | Specification for sand for plaster. |
| IS: 1566 | Specification for hard-drawn steel wire fabric for concrete reinforcement. |
| IS: 1786 | Specification for high strength deformed bars for concrete reinforcement. |
| IS: 2062 | Specification for steel for general structural purposes. |
| IS: 2116 | Specification for sand for masonry mortars. |
| IS: 2386 (Parts-I to VIII) | Testing of aggregates for concrete. |
| IS: 3150 | Hexagonal wire netting for general purpose. |
| IS: 3495 (Parts-I to IV) | Methods of tests of burnt clay building bricks. |
| IS: 3812 | Specification for fly ash, for use as pozzolana and admixture. |
| IS: 4031 | Methods of physical tests for hydraulic cement. |
| IS: 4032 | Methods of chemical analysis of hydraulic cement. |

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| IS: 4082 | Recommendations on stacking and storage of construction materials at site. |
| IS: 8112 | Specification for 43 grade ordinary portland cement. |
| IS: 8500 | Medium and high strength structural steel. |
| IS: 12269 | 53 grade ordinary portland cement. |
| IS: 12894 | Specification for Fly ash lime bricks. |

**Cast-In-Situ Concrete and Allied Works**

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| IS: 280 | Specification for mild steel wire for general engineering purposes. |
| IS: 456 | Code of practice for plain and reinforced concrete. |
| IS: 457 | Code of practice for general construction of plain & reinforced concrete for dams & other massive structures. |
| IS: 516 | Method of test for strength of concrete. |
| IS: 650 | Specification for standard sand for testing of cement. |
| IS: 1199 | Methods of sampling and analysis of concrete. |
| IS: 1791 | General requirements for batch type concrete mixers. |
| IS: 1838 (Part-I) | Specification for preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type). |
| IS: 2204 | Code of practice for construction of reinforced concrete shell roof. |
| IS: 2210 | Criteria for the design of reinforced concrete shell structures and folded plates. |
| IS: 2438 | Specification for roller pan mixer. |
| IS: 2502 | Code of practice for bending and fixing of bars for concrete reinforcement. |
| IS: 2505 | General requirements for concrete vibrators, immersion type. |

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| IS: 2506 | General requirements for concrete vibrators, screed board type. |
| IS: 2514 | Specification for concrete vibrating tables. |
| IS: 2645 | Specification for Integral cement water proofing compounds. |
| IS: 2722 | Specification for portable swing weigh batches for concrete. (single and double bucket type) |
| IS: 2750 | Specification for Steel scaffolding. |
| IS: 2751 | Code of practice for welding of mild steel plain and deformed bars for reinforced concrete construction. |
| IS: 3025 | Methods of sampling and test waste water. |
| IS: 3366 | Specification for Pan vibrators. |
| IS: 3370 (Part I to IV) | Code of practice for concrete structures for the storage of liquids. |
| IS: 3414 | Code of practice for design and installation of joints in buildings. |
| IS: 3550 | Methods of test for routine control for water used in industry. |
| IS: 3558 | Code of practice for use of immersion vibrators for consolidating concrete. |
| IS: 4014 (Parts I & II) | Code of practice for steel tubular scaffolding. |
| IS: 4326 | Code of practice for earthquake resistant design and construction of buildings. |
| IS: 4461 | Code of practice for joints in surface hydro-electric power stations. |
| IS: 4656 | Specification for form vibrators for concrete. |
| IS: 4925 | Specification for batching and mixing plant. |
| IS: 4990 | Specification for plywood for concrete shuttering work. |

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| IS: 4995 (Parts I & II) | Criteria for design of reinforced concrete bins for the storage of granular and powdery materials. |
| IS: 5256 | Code or practice for sealing joints in concrete lining on canals. |
| IS: 5525 | Recommendations for detailing of reinforcement in reinforced concrete work. |
| IS: 5624 | Specification for foundation bolts. |
| IS: 6461 | Glossary of terms relating to cement concrete. |
| IS: 6494 | Code of practice for water proofing of underground water reservoirs and swimming pools. |
| IS: 6509 | Code of practice for installation of joints in concrete pavements. |
| IS: 7861 | Code of practice for extreme weather concreting. (Parts I & II) |
| IS: 9012 | Recommended practice for shot concreting. |
| IS: 9103 | Specification for admixtures for concrete. |
| IS: 9417 | Recommendations for welding cold worked steel bars for reinforced concrete construction. |
| IS: 10262 | Recommended guidelines for concrete mix design. |
| IS: 11384 | Code of practice for composite construction in structural steel and concrete. |
| IS: 11504 | Criteria for structural design of reinforced concrete natural draught cooling towers. |
| IS: 12118 | Specification for two-parts poly sulphide. |
| IS: 12200 | Code of practice for provision of water stops at transverse contraction joints in masonry and concrete dams. |
| IS: 13311 | Method of non-destructive testing of concrete. |
| Part-1 | Ultrasonic pulse velocity. |

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| Part-2 | Rebound hammer. |
| SP:23 | Handbook of concrete mixes |
| SP: 24 | Explanatory Handbook on IS: 456-1978 |
| SP: 34 | Handbook on concrete reinforcement and detailing. |

**Precast Concrete Works**

| | |
|---|---|
| SP: 7(PartVI/ | National Building Code- Structural design of prefabrication and Sec.7) systems building. |
| IS: 10297 | Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units. |
| IS: 10505 | Code of practice for construction of floors and roofs using pre-cast reinforced concrete units. |

**Masonary and Allied Works**

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|---|---|
| IS: 1905 | Code of Practice for Structural Safety of Buildings-Masonry walls. |
| IS: 2212 | Code of Practice for Brickwork. |
| IS: 2250 | Code of Practice for Preparation and use of Masonry Mortar. |
| SP: 20 | Explanatory hand book on masonry code. |

**Sheeting Works**

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|---|---|
| IS:277 | Galvanised steel sheets (plain or corrugated). |
| IS: 459 | Unreinforced corrugated and semi-corrugated asbestos cement sheets. |
| IS: 513 | Cold-rolled carbon steel sheets. |
| IS: 730 | Specification for fixing accessories for corrugated sheet roofing. |

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|---|---|
| IS: 1626 | Specification for Asbestos cement building pipes and pipe fittings, gutters and gutter fittings and roofing fittings. |
| IS: 2527 | Code of practice for fixing rain water gutters and down pipe for roof drainage. |
| IS: 3007 | Code of practice for laying of asbestos cement sheets. |
| IS: 5913 | Methods of test for asbestos cement products. |
| IS: 7178 | Technical supply conditions for tapping screw. |
| IS: 8183 | Bonded mineral wool. |
| IS: 8869 | Washers for corrugated sheet roofing. |
| IS: 12093 | Code of practice for laying and fixing of sloped roof covering using plain and corrugated galvanised steel sheets. |
| IS: 12866 | Plastic translucent sheets made from thermosetting polyster resin (glass fibre reinforced). |
| IS: 14246 | Specification for continuously pre-painted galvanised steel sheets and coils. |

**Fabrication and Erection of Structural Steel Work**

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|---|---|
| IS: 2016 | Specification for plain washers. |
| IS: 814 | Specification for covered Electrodes for Metal Arc Welding for weld steel. |
| IS: 1852 | Specification for Rolling and Cutting Tolerances for Hot rolled steel products. |
| IS: 3502 | Specifications for chequered plate. |
| IS: 6911 | Specification for stainless steel plate, sheet and strip. |
| IS: 3757 | Specification for high strength structural bolts |
| IS: 6623 | Specification for high strength structural nuts. |

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|---|---|
| IS: 6649 | High Tensile friction grip washers. |
| IS: 800 | Code of practice for use of structural steel in general building construction. |
| IS: 816 | Code of practice for use of Metal Arc Welding for General Construction. |
| IS: 4000 | Code of practice for assembly of structural joints using high tensile friction grip fasteners. |
| IS: 9595 | Code of procedure of Manual Metal Arc Welding of Mild Steel. |
| IS: 817 | Code of practice for Training and Testing of Metal Arc Welders. |
| IS: 1811 | Qualifying tests for Metal Arc Welders (engaged in welding structures other than pipes). |
| IS: 9178 | Criteria for Design of steel bins for storage of Bulk Materials. |
| IS: 9006 | Recommended Practice for Welding of Clad Steel. |
| IS: 7215 | Tolerances for fabrication steel structures. |
| IS: 12843 | Tolerance for erection of structural steel. |
| IS: 4353 | Recommendations for submerged arc welding of mild steel and low alloy steels. |
| SP: 6 (Part 1 to 7) | ISI Hand book for structural Engineers. |
| IS: 1608 | Method of Tensile Testing of Steel products other than sheets, strip, wire and tube. |
| IS: 1599 | Method of Bend Tests for Steel products other than sheet, strip, wire and tube |
| IS : 228 | Methods of chemical Analysis of pig iron, cast iron and plain carbon and low alloy steel. |
| IS : 2595 | Code of Practice for Radio graphic testing. |

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|---|---|
| IS : 1182 | Recommended practice for Radiographic Examination of fusion welded butt joints in steel plates. |
| IS : 3664 | Code of practice for Ultra sonic Testing by pulse echo method. |
| IS : 3613 | Acceptance tests for wire flux combination for submerged Arc Welding. |
| IS : 3658 | Code of practice for Liquid penetrant Flaw Detection. |
| IS : 5334 | Code of practice for Magnetic Particle Flaw Detection of Welds. |

**Plastering and Allied Works**

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|---|---|
| IS : 1635 | Code of practice for field slaking of Building lime and preparation of putty. |
| IS : 1661 | Application of cement and cement lime plaster finishes. |
| IS : 2333 | Plaster-of-paris. |
| IS : 2402 | Code of practice for external rendered finishes. |
| IS : 2547 | Gypsum building plaster. |
| IS : 3150 | Hexagonal wire netting for general purpose. |

**Acid and Alkali Resistant Lining**

| | |
|---|---|
| IS : 158 | Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali & heat resisting. |
| IS : 412 | Specification for expanded metal steel sheets for general purpose. |
| IS : 4441 | Code of practice for use of silicate type chemical resistant mortars. |
| IS : 4443 | Code of practice for use of resin type chemical resistant mortars. |
| IS : 4456 | Method of test for chemical resistant tiles. (Part I & II) |

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|---|---|
| IS : 4457 | Specification for ceramic unglazed vitreous acid resistant tiles. |
| IS : 4832 | Specification for chemical resistant mortars. |
| | Part I Silicate type |
| | Part II Resin type |
| | Part III Sulphur type |
| IS : 4860 | Specification for acid resistant bricks. |
| IS : 9510 | Specification for bitumasitc, Acid resisting grade. |

**Water Supply, Drainage and Sanitation**

| | |
|---|---|
| IS : 458 | Specification for concrete pipes. |
| IS : 554 | Dimensions for pipe threads, where pressure tight joints are made on thread. |
| IS : 651 | Specification for salt glazed stoneware pipes. |
| IS : 774 | Flushing cisterns for water closets and urinals. |
| IS : 775 | Cast iron brackets and supports for wash basins and sinks. |
| IS : 778 | Copper alloy gate, globe and check valves for water works purposes. |
| IS : 781 | Cast copper alloy screw down bib taps and stop valves for water services. |
| IS : 782 | Caulking lead. |
| IS : 783 | Code of practice for laying of concrete pipes. |
| IS : 1172 | Basic requirements for water supply, drainage and sanitation. |
| IS : 1230 | Cast iron rain water pipes and fittings. |
| IS : 1239 | Mild steel tubes, tubulars and other wrought steel fittings. |

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|---|---|
| IS : 1536 | Centrifugally cast (Spun) iron pressure pipes for water, gas and sewage. |
| IS : 1537 | Vertically cast iron pressure pipes for water, gas and sewage. |
| IS : 1538 | Cast iron fittings for pressure pipe for water, gas and sewage. |
| IS : 1703 | Ball valves (horizontal plunger type) including float for water supply purposes. |
| IS : 1726 | Cast iron manhole covers and frames. |
| IS : 1729 | Sand cast iron spigot and socket, soil, water and ventilating pipes, fittings and accessories. |
| IS : 1742 | Code of practice for building drainage. |
| IS : 1795 | Pillar taps for water supply purposes. |
| IS : 1879 | Malleable cast iron pipe fittings. |
| IS : 2064 | Code of practice for selection, installation and maintenance of sanitary appliances. |
| IS : 2065 | Code of practice for water supply in building. |
| IS : 2326 | Automatic flushing cisterns for urinals. |
| IS : 2470 (Part-I & II) | Code of practice for installation of septic tanks. |
| IS : 2501 | Copper tubes for general engineering purposes. |
| IS : 2548 | Plastic seat and cover for water-closets. |
| IS : 2556 (Part 1 to 15) | Vitreous sanitary appliances (vitreous china). |
| IS : 2963 | Non-ferrous waste fittings for wash basins and sinks. |
| IS : 3114 | Code of practice for laying of cast iron pipes. |

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|---|---|
| IS : 3311 | Waste plug and its accessories for sinks and wash basins. |
| IS : 3438 | Silvered glass mirrors for general purposes. |
| IS : 3486 | Cast iron spigot and socket drain pipes. |
| IS : 3589 | Electrically welded steel pipes for water, gas and sewage (200mm to 2000mm nominal diameter). |
| IS : 3989 | Centrifugally cast (Spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories. |
| IS : 4111 (Part I to IV) | Code of practice for ancillary structure in sewerage system. |
| IS : 4127 | Code of practice for laying of glazed stone-ware pipes. |
| IS : 4764 | Tolerance limits for sewage effluents discharged into inland-surface waters. |
| IS : 4827 | Electro plated coating of nickel and chromium on copper and copper alloys. |
| IS : 5329 | Code of practice for sanitary pipe work above ground for buildings. |
| IS : 5382 | Rubber sealing rings for gas mains, water mains and sewers. |
| IS : 5822 | Code of practice for laying of welded steel pipes for water supply. |
| IS : 5961 | Cast iron grating for drainage purpose. |
| IS : 7740 | Code of practice for road gullies. |
| IS : 8931 | Cast copper alloy fancy bib taps and stop valves for water services. |
| IS : 8934 | Cast copper alloy fancy pillar taps for water services. |
| IS : 9762 | Polyethylene floats for ball valves. |

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|---|---|
| IS : 10446 | Glossary of terms for water supply and sanitation. |
| IS : 10592 | Industrial emergency showers, eye and face fountains and combination units. |
| IS : 12592 | Specification for precast concrete manhole covers and frames. |
| IS : 12701 | Rotational moulded polyethylene water storage tanks. |
| SP: 35 | Hand book on water supply and drainage. |
| - | Manual on Sewerage and sewage treatment (Published by CPH & EEO) As updated. |

**Doors, Windows and Allied Works**

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|---|---|
| IS : 204 | Tower Bolts |
| Part-I | Ferrous metals. |
| Part-II | Nonferrous metals. |
| IS : 208 | Door Handles. |
| IS : 281 | Mild steel sliding door bolts for use with padlocks. |
| IS : 362 | Parliament Hinges. |
| IS : 420 | Specification for putty, for use on metal frames. |
| IS : 1003 Part-I door | Specification for timber panelled and glazed shutters- (Part-I) shutters. |
| IS : 1038 | Steel doors, windows and ventilators. |
| IS : 1081 | Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators. |
| IS : 1341 | Steel butt hinges. |
| IS : 1361 | Steel windows for industrial buildings. |
| IS : 1823 | Floor door stoppers. |

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|---|---|
| IS : 1868 | Anodic coatings on Aluminium and its alloys. |
| IS : 2202 (Part-II) | Specification for wooden flush door shutters (solid core type); particle board face panels and hard board face panels |
| IS:2209 | Mortice locks (vertical type). |
| IS:2553 | Safety glass |
| IS:2835 | Flat transparent sheet glass. |
| IS:3548 | Code of practice for glazing in buildings. |
| IS:3564 | Door closers (Hydraulically regulated). |
| IS : 3614 | Fire check doors; plate, metal covered and rolling type. |
| IS:4351 | Steel door frames. |
| IS:5187 | Flush bolts. |
| IS:5437 | Wired and figured glass |
| IS:6248 | Metal rolling shutters and rolling grills. |
| IS:6315 | Floor springs (hydraulically regulated) for heavy doors. |
| IS:7196 | Hold fasts. |
| IS:7452 | Hot rolled steel sections for doors, windows and ventilators. |
| IS:10019 | Mild steel stays and fasteners. |
| IS:10451 | Steel sliding shutters (top hung type). |
| IS:10521 | Collapsible gates. |

**Roof Water Proofing and AlliedWorks**

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|---|---|
| IS:1203 | Methods of testing tar and bitumen. |

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| IS:1322 | Specification for bitumen felts for water proofing and damp proofing. |
| IS:1346 | Code of practice for water proofing of roofs with bitumen felts. |
| IS:1580 | Specification for bituminous compound for water proofing and caulking purposes. |
| IS:3067 | Code of practice for general design details and preparatory work for damp proofing and water proofing of buildings. |
| IS:3384 | Specification for bitumen primer for use in water proofing and damp proofing. |

**Floor Finishes and Allied Works**

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|---|---|
| IS:1237 | Specification for cement concrete flooring tiles. |
| IS:1443 | Code of practice for laying and finishing of cement concrete flooring tiles. |
| IS:2114 | Code of practice for laying in-situ terrazzo floor finish. |
| IS:2571 | Code of practice for laying in-situ cement concrete flooring. |
| IS:3462 | Specification for unbacked flexible PVC flooring. |
| IS:4971 | Recommendations for selection of industrial floor finishes. |
| IS:5318 | Code of practice for laying of flexible PVC sheet and tile flooring. |
| IS:8042 | Specification for white portland cement. |
| IS:13801 | Specification for chequered cement concrete flooring tiles. |

**Painting and Allied Works**

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|---|---|
| IS:162 | Specification for fire resisting silicate type, brushing, for use on wood, colour as required. |
| IS:1477 | Code of practice for painting of ferrous metals in buildings. |
| Part-I | Pretreatment. |

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|---|---|
| Part-II | Painting. |
| IS:1650 | Specification for colours for building and decorative finishes. |
| IS:2074 | Specification for red oxide-zinc chrome, priming, ready mixed paint air drying. |
| IS:2338 | Code of practice for finishing of wood and wood based materials. |
| Part-I | Operations and workmanship |
| Part-II | Schedules |
| IS:2395 | Code of practice for painting concrete, masonry and plaster surfaces. |
| Part-I | Operations and workmanship. |
| Part-II | Schedule. |
| IS:2524 | Code of practice for painting of nonferrous metals in buildings. |
| Part-I | Pretreatment. |
| Part-II | Painting. |
| IS:2932 | Specification of synthetic enamel paint, exterior, under-coating and finishing. |
| IS:2933 | Specification enamel paint, under coating and finishing. |
| IS:4759 | Code of practice for hot dip zinc coating on structural steel and other allied products. |
| IS:5410 | Specification for cement paint |
| IS:5411 (Part-I) | Specification for plastic emulsion paint-for exterior use |
| IS:6278 | Code of practices for white washing and colour washing. |
| IS:10403 | Glossary of terms relating to building finishes. |

**Piling and Foundation**

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|---|---|
| IS:1080 | Code of practice for design and construction of simple spread foundations. |

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|---|---|
| IS:1904 | Code of practice for design and construction of foundations in Soils; General Requirements. |
| IS:2911 | Code of practice for designs and construction of Pile foundations (Relevant Parts). |
| IS:2950 (Part-I) | Code of practice for designs and construction of Raft foundation. |
| IS:2974 (Part-I TO V) | Code of practice for design and construction of machine foundations. |
| IS:6403 | Code of practice for determination of Allowable Bearing pressure on Shallow foundation. |
| IS:8009 | Code of practice for calculation of settlement of foundation subjected to symmetrical vertical loads. |
| Part-I | Shallow foundations. |
| Part-II | Deep foundations. |
| IS:12070 | Code of practice for design and construction of shallow foundations on rocks. |
| DIN:4024 | Flexible supporting structures for machines with rotating machines. |
| VDI:2056 | Criteria for assessing mechanical vibrations of machines. |
| VDI:2060 | Criteria for assessing rotating imbalances in machines. |

**Stop Log and Trash Rack**

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|---|---|
| IS:4622 | Recommendations for fixed - wheel gates structural design. |
| IS:5620 | Recommendations for structural design criteria for low head slide gates. |
| IS:11388 | Recommendations for design of trash rack for intakes. |
| IS:11855 | General requirements for rubber seals for hydraulic gates. |

**Roads**

| | |
|---|---|
| IRC:5 | Standard specifications and Code of practice for road bridges, section-I general Features of Design. |
| IRC:14 | Recommended practice of 2cm thick bitumen and tar carpets. |
| IRC:16 | Specification for priming of base course with bituminous primers. |

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|---|---|
| IRC:19 | Standard specifications and code of practice for water bound macadam. |
| IRC:21 | Standard specifications and Code of practice for road bridges, section-III - Cement concrete (plain and reinforced). |
| IRC:34 | Recommendations for road construction in waterlogged areas. |
| IRC:36 | Recommended practice for the construction of earth embankments for road works. |
| IRC:37 | Guidelines for the Design of flexible pavements. |
| IRC:56 | Recommended practice for treatment of embankment slopes for erosion control. |
| IRC:73 | Geometric design standards for rural (non-urban) highways. |
| IRC:86 | Geometric Design standards for urban roads in plains. |
| IRC:SP:13 | Guidelines for the design of small bridges & culverts. |
| IRC - Public- | Ministry of Surface Transport (Roads Wing), Specifications |
| ation | for road and bridge works. |
| IS:73 | Specification for paving bitumen |
| **Loadings** | |
| IS:875 | Code of practice for design loads other than earthquake) for |
| (Pt. I to V) | buildings and structures. |
| IS:1893 | Criteria for earthquake resistant design of structures. |
| IS:4091 | Code of Practice for design and construction of foundation for transmission line towers & poles. |
| IRC:6 | Standard specifications & code of practice for road bridges, Section-II Loads and stresses. |
| M.O.T. | Deptt. of railways Bridge Rules. |
| **Safety** | |
| IS:3696 | Safety code for scaffolds and ladders. |
| (Part I & II) | |
| IS:3764 | Safety code for excavation work. |
| IS:4081 | Safety code for blasting and related drilling operations. |
| IS:4130 | Safety code for demolition of buildings. |

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|---|---|
| IS:5121 | Safety code for piling and other deep foundations. |
| IS:5916 | Safety code for construction involving use of hot bituminous materials. |
| IS:7205 | Safety code for erection on structural steelwork. |
| IS:7293 | Safety code for working with construction machinery. |
| IS:7969 | Safety code for handling and storage of building materials |
| IS:11769 | Guidelines for safe use of products containing asbestos. |

- Indian Explosives Act. 1940 as updated.

**Architectural design of buildings**

| | |
|---|---|
| SP:7 | National Building Code of India |
| SP:41 | Hand book on functional requirements of buildings (other than industrial buildings) |

**Miscellaneous**

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|---|---|
| IS:802 | Code of practice for use of structural steel in |
| (Relevant parts) | overhead transmission line towers. |
| IS:803 | Code of practice for design, fabrication and erection of vertical mild steel cylindrically welded in storage tanks. |
| IS:10430 | Creteria for design of lined canals and liner for selection of type of lining. |
| IS:11592 | Code of practice for selection and design of belt conveyors. |
| IS:12867 | PVC handrails covers. |
| CIRIA | Design and construction of buried thin-wall pipes. |
| Publication | |

**REFERENCE CODES AND STANDARDS FOR CONTROL AND INSTRUMENTATION**

The design, manufacture, inspection, testing & installation of all equipment and system covered under this specification shall conform to the latest editions of codes and standards mentioned below and all other applicable VDE, IEEE, ANSI, ASME, NEC, NEMA, ISA AND Indian Standards and their equivalents.

**Temperature Measurements**

1. Instrument and apparatus for temperature measurement - ASME PTC 19.3 (1974).

2. Temperature measurement - Thermocouples ANSI MC 96.1 - 1982.

3. Temperature measuremnet by electrical Resistance thermometers - IS:2806.

4. Thermometer - element - Platinum resistance - IS:2848.

**Pressure Measurements**

1. a) Instruments and apparatus for pressure measurement - ASME PTC 19.2 (1964).

   b) Electonic transmitters BS:6447.

2. Bourdon tube pressure and vacuum gauges - IS:3624 - 1966.

3. Process operated switch devices (Pr. Switch) BS-6134.

**Flow Measurements**

Instruments and apparatus for flow measurements - ASME PTC 19.5 (1972) Interim supplement, Part-II.

Measurement of fluid flow in closed conduits - BS-1042.

**Electronic Measuring Instrument & Control Hardware/ Software**

1. Automatic null balancing electrical measuring instruments - ANSI C 39.4 (Rev. 1973): IS:9319.

2. Safety requirements for electrical and electronic measuring and controling instrument - ANSI C 39.5 - 1974.

3. Compatability of analog signals for electronic industrial process instruments - ISA - S 50.1 (1982) ANSI MC 12.1 - 1975.

4. Dynamic response testing of process control instrumentation ISA - S 26 (1968).

5. Surge Withstand Capability (SWC) tests - ANSI C 37.90 a/IEEE-472 or suitable class of IEC-255-4 equivalent to ANSI C37.90a/IEEE-472.

6. Printed circuit boards - IPC TM - 650, IEC 326 C.

7. General requirement 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 C 73 - 1973 (Supplement ANSI C 73 a - 1980).

11. Direct acting electrical indicating instrument - IS:1248 - 1968 (R).

12. Standard Digital Interface for Programmable Instrumentation - IEEE-488.2 - 1990.

13. Information Processing Systems - Local Area Networks - Part 2 : Logical Link Control - IEEE-802.2 - 1989.

14. Standard for Local Area Networks : Carrier Sense Multiple Access with Collision Detection - IEEE-802.3 - 1985.

15. Supplements A, B, C and E to Carrier Sense Multiple Access with Collision Detection - IEEE-802.3 - 1988.

16. Standard for Local Area Networks : Token - Passing Bus Access Method - IEEE-802.4 - 1985.

17. Standard for Local Area Networks : Token - Ring Access Method and Physical Layer Specification - IEEE-802.5 - 1985.

18. IEEE Guide to Software Requirements Specifications - IEEE-830 - 1984.

19. Hardware Testing of Digital Process Computers - ISA RP55.1 - 1983.

20. Electromagnetic Susceptibility of Process Control Instrumentation - SAMA PMC 33.1 - 1978.

21. Interface Between the Data Terminal Equipment and Data Circuit - Terminating Equipment Employing Serial Binary Data Interchange - EIA-232-D-1987.

22. Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment, Part 3 : Radiated Electromagnetic Field Requirements - IEC 801-3-1984.

**Instrument Switches and Contact**

1. Contact rating - AC services NEMA ICS 2 - 1978 (with revision through May 1983), Part - 2-125, A6000.

2. Contact rating - DC services NEMA ICS 2-1978 Part-2 125, N600.

**Enclosures**

1. Type of Enclosures - NEMA ICS Part - 6 - 1978 (with Rev. 1 4/80) through 110.22 (Type 4 to 13).

2. Racks, panels and associated equipment - EIA : RS - 310 C- 1983 (ANSI C 83.9 - 1972).

3. Protection class for Enclosures, cabinets, control panels & desks - IS:2147 - 1962.

**Apparatus, enclosures and installation practices in hazardous area**

1. Classification of hazardous area - NFPA 70 - 1984, Article 500.

2. Electrical Instruments in hazardous dust location - ISA - 512.11, 1973.

3. Instrinsically safe apparatus - NFPA 493 1978.

4. Purged and pressurised enclosure for electrical equipment in hazardous location - NFPA 496-1982.

5. Enclosures for Industrial Controls and Systems - NEMA IS 1.1 - 1977.

**Sampling System**

1. Stainless steel material of tubing and valves for sampling system - ASTMA 296-82, Grade 7 P 316.

2. Submerged helical coil heat exchangers for sample coolers ASTM D11 92-1977.

3. Water and steam in power cycle - ASME PTC 19.11.

4. Standard methods of sampling system - ASTM D 1066-99.

**Annunciators**

1. Specifications and guides for the use of general purpose annunciators - ISA S 19.1, 1979.

2. Surge withstand capability tests - ANSI C 37.90a - 1989/IEEE-472 or suitable class of IEC 255-4 equivalent to ANSI C37.90a 1989/IEEE-472

3. Damp heat cycling test - IS:2106

4. Specification for Electromagnetic Susceptibility - SAMA DMC 33, 1/78

**Protections**

1. Relays and relay system associated with electric power apparatus. ANSI C 37.90, 1 - 1989.

2. General requirements & tests for switching devices for control and auxiliary circuits including contactor relays - IS:6875 (Part-I) - 1973.

3. Turbine water damage prevention - ASME TDP-1-1980.

4. Boiler safety interlocks - NFPA Section 85 B - 1984, 85 C - 1991.

**UPS System**

1. Practices and requirements for semi-conductor power rectifiers - ANSI C 34.2, 1973.

2. Relays and relays system associated with electrical power apparatus - ANSI C 3.90 - 1983.

3. Surge withstand capability test - ANSI C 37.90 1 -1989.

4. Performance testing of UPS - IEC 146.

5. Stationary cells & Batteries Lead Acid type (with tubular positive plates) specification IS-1651-1991.

6. Recommended practice for sizing large lead storage batteries for generating stations & sub-stations - IEEE-485-1985.

7. Printed Circuit Board - IPC TM 650, IEC 326C.

8. General Requirements & tests for printed wiring boards, IS:7405 (Part-I) 1973.

**Control Valves**

1. Control valve sizing - Compressible & Incompressible fluids - ISA S 75.01-1985.

2. Face to face dimensions of control valves - ANSI B 16.00 - 1973.

3. ISA Hand Book of Control Valves - (ISBN : B: 1047-087664-234-2).

4. Codes for pressure piping - ANSI B 31.1

5. Control Valve leak class - ISA RP 39.6

**Process Connection & Piping**

1. Codes for pressure piping "power piping" - ANSI B 31.1.

2. Seamless carbon steel pipe ASTM - A - 106.

3. Forged & Rolled Alloy steel pipe flanges, forged fittings and valves and parts - ASTM - A - 182.

4. Material for socket welded fittings - ASTM - A - 105.

5. Seamless ferritic alloy steep pipe - ASTM - A - 335.

6. Pipe fittings of wrought carbon steel and alloy steel - ASTM - A - 234.

7. Composition bronze of ounce metal castings - ASTM - B - 62.

8. Seamless Copper tube, bright annealed - ASTM - B - 168.

9. Seamless copper tube - ASTM - B - 75.

10. Dimension of fittings - ANSI - B - 16.11.

11. Valves flanged and butt welding ends - ANSI - B - 16.34.

**Instrument Tubing**

1. Seamless carbon steel pipe - ASTM - A 106.

2. Material of socketweld fittings - ASTM - A105.

3. Dimensions of fittings - ANSI - B - 16.11.

4. Code for pressure piping, welding, hydrostatic testing - ANSI B 31.1.

**Cables**

1. Thermocouples extension wires/cables - ANSI MC 96.1 - 1992.

2. Requirements for copper conductor-Wiring cables for telecommunications & information processing system - VDE:0815.

3. Colour coding of single or multi-pair cables - ICEA - S - 61-402 (third edition) NEMA WCS - 1979 with revisions thorugh 2/83.

4. Insulation & Sheathing compounds for cables : VDE 0207 (Part-4, 5 & 6).

5. Guide design and installation of cable systems in power generating stations ( insulation, jacket materials) - IEEE Std. 422-1977.

6. Rules for Testing insulated cables and flexible cables : VVDE - 0472

7. Requirements of vertical flame propagation test - IEEE 383 - 1974 (R 1980)

8. Standard specification for tinned soft or annealed copper wire for electrical purpose - ASTM B-33-81.

9. Oxygen index and temperature index test - ASTM D - 2863.

10. Smoke density measurement test - ASTMD - 2843.

11. Acid gas generation test - IEC - 754 - 1.

12. Swedish Chimney test - SEN - 4241475 (F3).

13. Teflon (FEP) insulation & sheath test - ASTMD - 2116.

14. Thermocouple compensating cables - Testing requirements & sampling plan IS:8784.

15. PVC insulated electric cables for working voltage upto and including 1100 V - IS:1554 (Part-I).

**Cable Trays, Conduits**

1. Guide for design and installation of cable systems in power generating staiton (Cable trays, support systems, conduits) - IEEE Std. 422, 1977, NEMA VE-1 1979, NFPA 70-1984.

2. -do- Test Standards. NEMA VE-1-1979.

3. Zinc coating "hot dip" on assembled products for galvanising of carbon steel cable trays - ASTMA - 386-78.

**Public Address System**

1. Specifications for lod speakers - IS:7741 (Part-I, II and III)

2. Code of safety requirement for electric mains operated audio amplifiers - IS:1301

3. Specification for Public Address Amplifiers - IS:10426.

4. Code of practice for outdoor installation of PA system - IS:1982.

5. Code of practice for installation for indoor amplifying and sound distribution system - IS:1881.

6. Basic environmental testing procedures for electronic and electrical items - IS:9000.

7. Characteristics and methods of measurements for sound system equipment - IS:9302

8. Code of practice of electrical wiring installations (System voltage not exceeding 650 volts) - IS:732

9. Rigid steel conduits for electric wiring - IS:9537 (Part-I and II)

10. Fittings for rigid steel conduits for electrical wiring - IS:2667

11. Degree of protection provided by enclosure for low voltage switchgear and control gear - IS:2147.

**Vibration Monitoring System**

1. API 670 - 1994

2. BS : 4675 Part-2

ANNEXURE - III

| | | | |
|---|---|---|---|
| एनटीपीसी NTPC | Project : Stage :<br>Package :<br>Supplier :<br>Contractor 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.No. | ITEM | QP/ Insp. Cat. | QP No. | QP Sub-Schedule | QP approval schedule | Proposed sub-supplier | Place | Sub-Suppliers approval status/ category | Sub-supplier Details submission schedule | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
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LEGENDS :

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

A - For these items proposed vendor is acceptable to NTPC. To be indicated with letter "A" in the list alongwith the condition of approval, if any.

DR - For these items "Detailed required" for NTPC review. To be identified with letter "DR" in the list.

NOTED - For these items vendors are approved by Main Supplier and accepted by NTPC without specific vendor approval from NTPC. To be identified with "NOTED".

2. **QP/INSPN CATEGORY :**

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

CAT-II : For these items the Quality Plans approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC 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 NTPC 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.

FORMAT NO. : QS-01-QAI-P-1/F3-R0 1 / 1 Engg.Div./QA&I

ANNEXURE - IV

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

| S.No. | 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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FORMAT NO. : QS-01-QAI-P-02/F1-R0 1 / 1 Engg.Div./QA&I

ANNEXURE - V

| | | | |
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| एनटीपीसी NTPC | Project : Stage :<br>Contractor :<br>Contractor No. :<br>System : | FIELD WELDING SCHEDULE<br>(To be raised by the contractor)<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 | RFF | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Temp. | Holding time | | Spec. No. | ACC Norm Ref. | |
| | | | | | | | | | | | | | | | | |

NOTES:

SIGNATURE

| | | |
|---|---|---|
| FORMAT NO.: QS-01-QAI-P-02/F2-R0 | 1/1 | Engg. Div./QA&I |

| MFGR.s LOGO | Manufacturer's Name & Address | MANUFACTURING QUALITY PLAN<br>ITEM<br>SUB-SYSTEM | QP NO. :<br>REV.NO. :<br>DATE :<br>PAGE : OF | PROJECT :<br>PACKAGE :<br>CONTRACT NO. :<br>MAIN-SUPPLIER : |
|---|---|---|---|---|

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

| MANUFACTURER / SUB-SUPPLIER | MAIN-SUPPLIER |
|---|---|
| SIGNATURE | |

LEGEND : * RECORDS, IDENTIFIED WITH "TICK" ( ) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION
** M : MANUFACTURER / SUB-SUPPLIER
C : MAIN SUPPLIER, N : NTPC
P : PERFORM W : WITNESS AND V : VERIFICATION, AS APPROPRIATE
CHP : NTPC SHALL IDENTIFIED IN COLUM "N" AS 'W'

FOR NTPC USE

| DOC. NO. : | | REV.....CAT..... |
|---|---|---|
| REVIEWED BY | APPROVED BY | APPROVAL SEAL |

FORMAT - QS-01-QAI-P-09/F1-R1 1/1 ENGINEERING DIV. / QA&I

| | Supplier's Name & Address | FIELD QUALITY PLAN | | PROJECT : |
|---|---|---|---|---|
| | | ITEM | QP NO. : | PACKAGE : |
| | | | REV.NO. : | CONTRACT NO. : |
| | | SUB-SYSTEM | DATE : | MAIN-SUPPLIER : |
| | | | 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 | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D* | 10. |
| | | | | | | | | | | |

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|---|---|---|---|---|---|
| MANUFACTURER / SUB-SUPPLIER | MAIN-SUPPLIER | LEGEND : * RECORDS, IDENTIFIED WITH "TICK" ( ) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION LEGEND TO BE USED : CLASS # : A - CRITICAL, B = MAJOR, C = MINOR; "A' SHALL BE WITNESSED BY NTPC FQA, 'B' SHALL BE WITNESSED BY NTPC ERECTION / CONSTRUCTION DEPTT. AND 'C' SHALL BE WITNESSED BY ERECTION SUPPLIER (A & B CHECK SHALL BE NTPC CHP STAGE) | FOR NTPC USE | DOC. NO. : | REV.....CAT..... |
| SIGNATURE | | | | REVIEWED BY | APPROVED BY / APPROVAL SEAL |

FORMAT - QS-01-QAI-P-09/F2-R0 1/1 ENGINEERING DIV. / QA&I

# FUNCTIONAL GUARANTEES & LIQUIDATED DAMAGES

**FUNCTIONAL GUARANTEES, LIQUIDATED DAMAGES**

**FOR**

**SHORTFALL IN PERFORMANCE AND GUARANTEE TESTS**

(The term "Performance Guarantees" wherever appears in this Sub-Section shall have the same meaning and shall be synonymous to "Functional Guarantees". Similarly the term "Performance Tests" wherever appears in this Sub-Section shall have the same meaning and shall be synonymous to "Guarantee Test(s)". The term "TMCR" (Turbine maximum continuous rating) appearing in the Technical Specification shall mean 660 MW electrical power output at generator terminals (power at generator terminals as per clause indicated in this sub-section) under rated steam parameters, 0% cycle make-up and 77 mm Hg (abs) condenser pressure unless used in conjunction with a different cycle make-up and/or a different condenser pressure.

**1.00.00 PERFORMANCE GUARANTEES**

1.00.01 **General Requirements**

(a) The Contractor shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in these specifications.

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

(c) The Contractor shall conduct performance test and demonstrate all the guarantees covered herein during functional guarantee / acceptance test. The various tests which are to be carried out during performance guarantee/acceptance test are listed in this Sub-section. The guarantee tests shall be conducted by the Contractor at site in presence of Employer on each unit individually.

(d) All costs associated with the tests including cost associated with the calibration shall be included in the bid price.

Refer Amendment attached at the end of Sub Section C2B

(e) It is the responsibility of the contractor to perform the Performance Guarantee/Acceptance test as specified in this subsection. The performance tests will be performed using only the normal number of Employer supplied operating staff. Contractor, vendor or other subcontractor personnel shall only be used for instructional purposes or data collection. At all times during the Performance Tests the emissions and effluents if any as per scope from the Plant shall not exceed the Guaranteed Emission and Effluent Limits.

Refer Amendment attached at the end of Sub Section C2B

f) The Contractor shall make their system ready for the performance guarantee tests before start of initial operation.

g) The instruments to be used for process control shall also be used for PG test. Minimum number of instruments to be used for PG test has been identified in respective P&IDs with accuracy class meeting the code requirement. All instruments required for performance testing shall be of the type and accuracy required by the ASME PTC code. Prior to the start of the initial operation, the contractor shall get these instruments calibrated in an independent test Institute approved by the Employer. All test instrumentation, Personal computer(s), necessary server and required interface, software for on line computation of test results & report as required for PG tests shall be supplied by the contractor and shall be retained by the Employer. Separate system shall be supplied for each unit. All calibration procedures and standards shall be subjected to the approval of the Employer. The protecting tubes, pressure connections and other test connections required for conducting guarantee test shall conform to the relevant codes.

h) Tools and tackles, instruments/devices including flow devices, matching flanges, impulse piping & valves etc. and any special equipment, required for the successful completion of the tests, shall be provided by the contractor free of cost.

i) The Performance / Acceptance test shall be carried out as per the agreed procedure. The PG test procedure including demonstration tests shall be submitted within 90 days of the date of Notification of Award and finalization of the PG test procedure shall be done within 180 days from the date of Notification of Award. After the conductance of Performance test, the preliminary test results shall be calculated automatically by the server/software provided by the contractor. The correction curves approved by the employer shall be fed/inbuilt in the PG test program/software. Preliminary test reports shall be submitted to the Employer instantly after completing each test run. The contractor shall also submit the detailed test evaluation report of Performance test results to Employer promptly but not later than one months from the date of conductance of Performance test.

The PG test procedures shall be submitted for equipment/ system & subsystem under Contractor's scope for all Guarantees under category I, II & III as per latest International codes / standard meeting the specification requirements. The procedure shall also include correction curves, detailed activity plan of conductance of test and sample calculations.

j) The contractor shall submit for Employer's approval the detailed Performance Test procedure containing the following:

a) Object of the test.

b) Various guaranteed parameters & tests as per contract.

c) Method of conductance of test and test code.

d) Duration of test, frequency of readings & number of test runs.

e) Method of calculation.

f) Correction curves and respective equations for graphs to be fed for the online computation

g) Instrument list consisting of range, accuracy, least count, and location of instruments along with reference approved P&IDs.

h) Scheme showing measurement points.

i) Sample calculation.

j) Acceptance criteria.

k) Any other information required for conducting the test.

k) In case during performance guarantee tests it is found that the equipment/system has failed to meet the guarantees, the Contractor shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to the Employer and re-conduct the performance guarantee test(s) with Employer's consent. However if the specified performance guarantee(s) are still not met but are achieved within the Acceptable Shortfall Limit specified at clause 1.01.02 of this subsection, Employer will accept the equipment/system/plant after levying liquidated damages as per clause 1.01.02 of this sub-section. If, however, the demonstrated guarantee(s) continue to be more than the stipulated Acceptable Shortfall Limit, even after the above modifications/replacements within ninety (90) days or a reasonable period allowed by the Employer, after the tests have been completed, the Employer will have the right to either of the following:

(i) For Category-I Guarantees

Reject the equipment / system / plant and recover from the Contractor the payments already made

OR

Accept the equipment /system/ plant after levying Liquidated Damages as specified hereunder. The liquidated damages for shortfall in performance indicated in clause 1.01.02 of this sub-section shall be levied separately for

each unit. The liquidated damages shall be prorated for the fractional parts of deficiencies .The performance guarantees coming under this category are called 'Category-I' Guarantees.

(ii) For Category-II Guarantees

Reject the equipment / system/ plant and recover from the Contractor the payments already made. The performance guarantees under this category shall be called 'Category-II' Guarantees. Conformance to the performance requirements under Category-II is mandatory.

(iii) For Category-III Guarantees

Reject the equipment /system / plant and recover from the Contractor the payments already made.

OR

Accept the equipment/system after assessing the deficiency in respect of the various ratings, performance parameters and capabilities and recover from the contract price an amount equivalent to the damages as determined by the Employer. Such damages shall, however be limited to the cost of replacement of the equipment(s) / system(s), replacement of which shall remove the deficiency so as to achieve the guaranteed performance. These parameters/capacities shall be termed as Category-III Guarantees.

1.01.03

**Auxiliary Power Consumption**

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

Pa = Pu + TL

Pa = Guaranteed Auxiliary Power Consumption.

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

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

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

**UNIT AUXILIARIES (to be considered for calculating Pu)**

(p) Power consumption of fans of Air washer units for TG building at its rated duty point.

(q) Power consumption of any other continuously operating auxiliaries for unit operation at different guarantee point loads.

**GUARANTEES UNDER CATEGORY - III**

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

1.03.01 **Noise**

All the plant, equipment and systems covered under this specification shall perform continuously without exceeding the noise level over the entire range of output and operating frequency specified in General Technical Requirement, Part-C Section-VI of the technical specifications.

Noise level measurement shall be carried out using applicable and internationally acceptable standards. The measurement shall be carried out with a calibrated integrating sound level meter meeting the requirement of IEC 61672-1 and IEC-61672-2 (latest edition)

Sound pressure shall be measured all around the equipment at a distance of 1.0 m horizontally from the nearest surface of any equipment/ machine and at a height of 1.5 m above the floor level in elevation.

A minimum of 6 points around each equipment shall be covered for measurement. Additional measurement points shall be considered based on the applicable standards and the size of the equipment. The measurement shall be done with slow response on the A - weighting scale. The average of A-weighted sound pressure level measurements expressed in decibels to a reference of 0.0002 micro bar shall not exceed the guaranteed value. Corrections for background noise shall be considered in line with the applicable standards. All the necessary data for determining these corrections, in line with the applicable standards, shall be collected during the tests.

1.03.06 **Ventilation System**

**A. Following shall be demonstrated at Shop**

1) Capacity and discharge pressure of pumps of air washer units at its rated duty point of Ventilation system.

2) Capacity and static pressure of air washer unit fans, roof exhausters of TG building at its rated duty point of Ventilation system.

**B. Following shall be demonstrated at Site**

1) Vibration & Noise level of centrifugal fans & pumps of air washer units.

# PART-B

# QUALITY ASSURANCE

# SUB–SECTION – E-10

# AC & VENTILATION SYSTEM

## QA MODULE FOR AIR CONDITIONING AND VENTILATION SYSTEM

| | |
|---|---|
| 2.00.00 | **FANS** |
| 2.01.00 | 20% DPT of welding on fan hub, blades, casing and impeller as applicable shall be carried out. |
| 2.02.00 | DPT of fan shafts shall be carried out after machining. |
| 2.03.00 | UT of fan shafts (diameter equal to or above 50mm) shall be carried out. |
| 2.04.00 | Rotating components of all fans shall be dynamically balanced to ISO-1940 Gr. 6.3 |
| 2.05.00 | All Fans shall be subjected to run test for 4 hrs. or till temperature stabilization is reached. Vibration, Noise level, Temp. rise and current drawn shall be measured during the run test. |
| 2.06.00 | One fan of each type and size will be performance tested as per corresponding BIS /AMCA for Air flow, Static Pressure, Speed, Efficiency, Power Consumption, Noise, Vibration and Temp. Rise. |

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| 4.00.00 | **CENTRIFUGAL PUMP** |
| 4.01.00 | UT on pump shaft (dia equal to or above 40 mm) and MPI/DPT on pump shaft and impeller after machining shall be carried out. |
| 4.02.00 | All rotating components of the pumps shall be dynamically balanced to ISO-1940 Gr. 6.3 |
| 4.03.00 | A standard hydrostatic test shall be conducted on the pump casing with water at 1.5 times the shut off pressure on the head characteristics curve or twice the rated pressure whichever is higher, for a minimum duration of 30 minutes. |
| 4.04.00 | Standard Running Test |
| 4.05.01 | All pumps shall be tested in the manufacturer's works preferably with contract motor for capacity, efficiency, head and brake horse power. Pump shall be given running test over the entire operating range covering from the shut-off head to the maximum flow. The duration of test shall be minimum one (1) hr. A minimum of seven readings approximately equidistant shall be taken for plotting the curves with one point at design flow. Testing of pumps shall be in accordance with stipulations of Hydraulic Institute Standard (HIS) and/or as per applicable Indian Standard or equivalent. Acceptance norms shall be as per approved datasheet & HIS standard only. |
| 4.05.02 | Noise and vibration shall be measured at shop for reference purpose only. |
| 4.05.03 | Pumps shall be subjected to strip down examination visually to check for mechanical damages after testing at shop in case abnormal noise level and/or excessive vibration are observed during the shop test. |
| 4.05.04 | NPSH test shall be conducted with water as the medium, if required as per approved data sheets. |
| | |
| 5.00.00 | **LOW PRESSURE AIR DISTRIBUTION SYSTEM** |
| 5.01.00 | Functional test for fire damper along with solenoid shall be done. |
| 5.02.00 | Prototype tests report of fire damper (duly approved/accepted by ENGG) for each type and size as per UL-555 for fire rating shall be furnished. |
| 5.03.00 | Site Test- After completion, all ducting system shall be checked/tested for air leakages/tightness (smoke test) at site. |
| | |
| 6.00.00 | **INSULATION** |

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| 6.01.00 | Insulation material shall be tested for all mandatory tests only as per relevant code/standard. |
| 6.02.00 | Thermal conductivity tests (for thermal insulation only) shall be done once in 12 months for insulation material manufactured during 12 months period for the same density and thickness of material as applicable as per IS:3346 or equivalent standard. |
| 6.03.00 | XLPE/Nitrile Rubber: Thermal conductivity tests (for thermal insulation only) shall be done as per relevant code for the same density and thickness of material and validity of test shall be as per relevant standard. |
| | |
| 8.00.00 | **AIR FILTERS** |
| 8.01.00 | Pre/Fine filters shall be tested for initial and final pressure drop Vs flow and average synthetic dust weight arrestance as per the requirement of BS 6540/ASHARE-52-76/EN779.<br>HEPA (Absolute) filters shall be tested as per applicable code. |
| | |
| 9.00.00 | **PIPES & FITTINGS** |
| 9.01.00 | All pipes and fittings shall be tested as per applicable codes / standard. |
| 9.02.00 | Site test- Pipes shall be tested at site hydraulically/pneumatically as per application requirement |
| | |
| 10.00.00 | **VALVES & SPECIALTIES** |
| 10.01.00 | Visual and dimensional check of valves as per relevant codes and approved drawing. |
| 10.02.00 | All the water line valves shall be hydraulically tested for body, seat and back seat (wherever provided) as per the relevant standard to which these valves are supplied irrespective of the working pressure for which these valves are selected. Check valves shall also be tested for leak tightness test at 25% of the specified seat test pressure. |
| 10.03.00 | Refrigerant line valves shall be pneumatically tested for body and seat leakage test. |
| 10.04.00 | Valves shall be offered for hydro test and pneumatic test in unpainted |

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| | condition. |
| 10.05.00 | Functional check of the valves for smooth opening and closing shall be done. |
| 10.06.00 | Performance test to check pressure drop Vs flow shall be carried out for one valve of each type, size and rating for 'Balancing Valve'/Globe Valves with orifice. |
| 12.00.00 | **Air Washer and Unitary Air Filter (UAF)** |
| 12.01.00 | Random 10% DPT on weld joints shall be carried out |
| 12.02.00 | Hydraulic test of pressure parts atq 1.5 times the design. Pressure and water fill test of tanks shall be carried out |
| 12.03.00 | Trial assembly of Air washer/UAF for one of each size shall be done in shop. |

| | | | | | | |
|---|---|---|---|---|---|---|
| 38. | VI/A | Functional Gurantee & Liquidated damage | 2 of 20 | 1.00.01 (g) | The instruments to be used for process control shall also be used for PG test. Minimum number of instruments to be used for PG test has been identified in respective P&IDs with accuracy class meeting the code requirement. All instruments required for performance testing shall be of the type and accuracy required by the ASME PTC code. Prior to the start of the initial operation, the contractor shall get these instruments calibrated in an independent test Institute approved by the Employer. All test instrumentation, Personal computer(s), necessary server and required interface, software for on line computation of test results & report as required for PG tests shall be supplied by the contractor and shall be retained by the Employer. | ~~**The instruments to be used for process control shall also be used for PG test.**~~ Minimum number of instruments to be used for PG test has been identified in respective P&IDs with accuracy class meeting the code requirement. All instruments required for performance testing shall be of the type and accuracy required by the ASME PTC code. Prior to the start of the initial operation, the contractor shall get these instruments calibrated in an independent test Institute approved by the Employer. All test instrumentation, Personal computer(s), necessary server and required interface, software for on line computation of test results & report as required for PG tests shall be supplied by the contractor and shall be retained by the Employer. Separate system shall be supplied for each unit. All calibration procedures and standards shall be subjected to the approval of the Employer. The protecting tubes, pressure connections and other test connections required for conducting guarantee test shall conform to the relevant codes. |
| 40. | VI/A | IV ,Functional Guarantee | 1.00.01 /(d) | 1 of 20 | All costs associated with the tests including cost associated with the calibration shall be included in the bid price. | All costs associated with the tests including cost associated with the **supply,** calibration, shall be included in the bid price. |

# SECTION: I

# SUB-SECTION: C 2C

# CUSTOMER SPECIFICATIONS
# PAINTING SPECIFICATIONS

# SUB–SECTION – A-7

# SURFACE PREPARATION & PAINTING

**1.00.00** **Specification of surface preparation & painting**

**1.01.00** Surface preparation methods and paint/primer materials shall be of the type specified herein. If the contractor desires to use any paint/primer materials other than that specified, specific approval shall be obtained by the contractor in writing from the employer for using the substitute material.

**1.02.00** All paints shall be delivered to job site in manufacturers sealed containers. Each container shall be labeled by the manufacturer with the manufacturer's name, type of paint, batch number and colour.

**1.03.00** Unless specified otherwise, paint shall not be applied to surfaces of insulation, surfaces of stainless steel/nickel/ copper/brass/ monel/ aluminum/ hastelloy/lead/ galvanized steel items, valve stem, pump rods, shafts, gauges, bearing and contact surfaces, lined or clad surfaces.

**1.04.00** All pipelines shall be Colour coded for identification as per the NTPC Colour-coding scheme, which will be furnished to the contractor during detailed engineering.

**1.05.0** **SURFACE PREPARATION**

1.05.01 All surfaces to be painted shall be thoroughly cleaned of oil, grease and other foreign matter. Surfaces shall be free of moisture and contamination from chemicals and solvents.

1.05.02 The following surface schemes are envisaged here. Depending upon requirement any one or a combination of these schemes may be used for surface preparation before application of primer.

| | |
|---|---|
| SP1 | Solvent cleaning |
| SP2 | Application of rust converter (Ruskil or equivalent grade) |
| SP3 | Power tool cleaning |
| SP4 | Shot blasting (shot blasting shall be used as surface preparation method for hot worked pipes prior to application of primer) |
| SP4* | Shot blast cleaning/ abrasive blast cleaning to SA21/2 (near white metal) 35-50 microns |
| SP5 | Phospating |
| SP6 | Emery sheet cleaning/Manual wire brush cleaning. |

**1.06.00** **APPLICATION OF PRIMER/PAINT**

**1.06.01** The paint/primer manufacturer's instructions covering thinning, mixing, method of application, handling and drying time shall be strictly followed and considered as part of this specification. The Dry film thickness (DFT) of primer/paint shall be as specified herein.

**1.06.02** Surfaces prepared as per the surface preparation scheme indicated herein shall be applied with primer paint within 6 hours after preparation of surfaces.

**1.06.03** Where primer coat has been applied in the shop, the primer coat shall be carefully examined, cleaned and spot primed with one coat of the primer before applying intermediate and finish coats. When the primer coat has not been applied in the shop, primer coat shall be applied by brushing, rolling or spraying on the same day as the surface is prepared. Primer coat shall be applied prior to intermediate and finish coats.

**1.06.04** Steel surfaces that will be concealed by building walls shall be primed and finish painted before the floor is erected. Tops of structural steel members that will be covered by grating shall be primed and finish painted before the grating is permanently secured.

**1.06.05** Following are the Primer/painting schemes envisaged herein:

PS3 - Zinc Chrome Primer (Alkyd base) by brush/Spray to IS104.

PS3* - Zinc Chrome primer (Alkyd base) by dip coat.

PS4 - Synthetic Enamel (long oil alkyd) to IS2932.

PS5 - Red Oxide Zinc Phosphate primer (Alkyd base) to IS 12744

PS9 - Aluminium paint to IS 2339.

PS9* - Heat resistant Aluminum paint to IS-13183 Gr.-I (for temperature 400 degC – 600 degC), IS-13183 Gr.-II (for temperature 200 degC- 400 degC and IS-13183 Gr.-III (for temperature upto 200 degC)

PS13 - Rust preventive fluid by spray, dip or brush.

PS14 - Weldable primer-Deoxaluminate or equivalent.

PS16 - High Build Epoxy CDC mastic `15'.

PS17 - Aliphatic Acrylic Polyurethane CDE134 ,%V=40.0(min.)

PS18 - Epoxy based TiO2 pigmented coat

PS19 - Epoxy based Zinc phosphate primer (92% zinc in dry film (min.), %VS=35.0(min.).

PS-20 - Epoxy based finish paint

**1.06.06** All weld edge preparation for site welding shall be applied with one coat of wieldable primer.

**1.06.07** For internal protection of pipes/tubes, VCI pellets shall be used at both ends after sponge testing and ends capped. VCI pellets shall not be used for SS components and composite assemblies.

**1.06.08 Primer/Painting Schedule**

| Sl. No | Description | | Surface Preparation | Primer Coat | | | Intermediate Coat | | | Finish Coats | | | Total Min. Painting DFT (Microns) | Colour Shade |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Type of Primer | No. of Coats | Min. DFT / coat (Microns) | Type of coating | No. Coats | Min. DFT/ Coat (Microns) | Type of coating | No. Coats | Min. DFT/ Coat (Microns) | | |
| **A) Power Cycle Piping** | | | | | | | | | | | | | | As per NTPC Colour shade/ coding scheme |
| 1. | All insulated Pipings, fittings/ components, Pipe clamps, Vessels/Tanks, Equipments etc. | | SP3/SP4 | PS 9* | 1 | 20 | - | - | - | PS9* | 1 | 20 | 40 | |
| 2. | All un -insulated Pipings, fittings/ components, Pipe clamps, Vessels/Tanks, Equipments etc. | Design temperature < or equal to 60$^0$C | SP3/SP4 | PS 5 | 2 | 25 | - | - | - | PS 4 | 3 $ | 35 $ | 155 $ | |
| | | Design temperature above 60 $^0$C-200$^0$C | SP3/SP4 | PS 9* | 1 | 20 | - | - | - | PS9* | 1 | 20 | 40 | |
| | | Design temperature > 200$^0$C | SP3/SP4 | PS9* | 1 | 20 | - | - | - | PS9* | 1 | 20 | 40 | |
| 3 | Constant Load Hanger (CLH), Variable Load Hanger (VLH). | | SP4* | PS19 | 1 | 40 | - | - | - | PS17 | 1 | 30 | 70 | |
| 4. | Piping hangers/ supports (other than (3) above.<br><br>(un-insulated) | | SP3/SP5 | PS 5 | 2 | 25 | - | - | - | PS4 | 2 | 25 | 100 | |
| 5. | Valves | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cast/Forged | Design temperature < or equal to 60 degC<br>#<br>Design temperature above 60 degC | SP3/SP5<br>SP3/SP5 | PS 5<br>PS 9* | 2<br>1 | 35<br>20 | -<br>- | -<br>- | -<br>- | PS4<br>PS9* | 2<br>1 | 25<br>20 | 120<br>40 | |
| 6. | All auxiliary Structural Steel components for pipe supports | Outside TG building and in SG envelope | SP4* | Inorganic Ethyl Zinc Silicate | 1 | 75 | PS18 | 1 | 75 | a))Epoxy coat<br>b)Final coat of paint PS17 | 2<br>1 | 35<br>30 | 250 | |
| | | Within TG building | SP4* | -do- | 1 | 35 | PS18 | 1 | 35 | a))Epoxy coat<br>b)Final coat of paint PS17 | 2<br>1 | 25<br>30 | 150 | |
| 7. | Weld Edges | | SP6 (Hand cleaning by wire brushing) | PS13 (Weldable primer) | 1 | 25 | - | - | - | - | - | - | 25 | |

1. $ The first 2 finished coats (total min.DFT of 70 microns) shall be done at shop and the 3rd finish coat (min.DFT 35 Microns) shall be applied at site.
2. For valves below 65NB and temperature upto and including 540 Deg.C, Parkerizing/zinc phosphate corrosion resistant coating as per ASTM F1137 is also acceptable in lieu of Aluminum paint.
3. For corrosion protection of threaded hanger rods and variable spring cages, electro galvanizing in full compliance to minimum Corrosion category C3 as per EN ISO12944 is also acceptable.
4. For spring cages, 2 coats of 30 µm(min) zinc-rich epoxy resin primer with zinc content> 80 weight% in dry film followed by 2 coats of 30 µm(min) top coat of Acrylic resin Co-polymerisate with a total combined minimum DFT of 120µm is also acceptable in lieu of above specified paint scheme.
5. For corrosion protection for all inner parts of the hangers shall be atleast in full compliance to Corrosion category C3 as per EN ISO12944.
6. # - For Cast/forged valves upto & including design temperature 60Deg.C, Aluminium painting as per IS-13183 Gr-3 or better with total DFT 40Micron is also acceptable.

**B) LOW PRESSURE PIPING**

| | | Surface Preparation | Type of Primer | No. of Coats | Min. DFT / coat (Microns) | Type of coating | No. Coats | Min. DFT/ Coat (Microns) | Type of coating | No. Coats | Min. DFT/ Coat (Microns) | Min. Total DFT (Microns) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | All Piping, fittings / components, valves, Equipments etc. | SP3/SP5 | PS3/ PS5 | 2 | 25 | PS 4 | 1 | 30 | PS 4 | 2 | 35 | 150 | As per NTPC Colour shade/ coding scheme |
| | | | | | | | | | | | | | |
| 2 | Stainless steel surface, Galvanized steel surface and gun metal surface. | No Painting | | | | | | | | | | | |
| 3 | On the internal surface for pipes 1000 Nb and above | A coat of primer followed by hot coal-tar enamel or coal tar epoxy painting (cold) shall be applied. | | | | | | | | | | | |

# SECTION: I

# SUB-SECTION: C 3

# TECHNICAL SPECIFICATION (ELECTRICAL PORTION)

# TECHNICAL SPECIFICATION FOR VENTILATION SYSTEM (ELECTRICAL PORTION)

**1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:**

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

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

Refer "Electrical Scope between BHEL and Vendor".

**3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID**

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

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

**4.0 List of enclosures :**

a) Electrical scope between BHEL & vendor (Annexure –I)
b) Customer specification for motors

c) Customer cabling spec 9to be referred by vendor for their scope of work (as per electrical scope between BHEL & vendor)
d) Quality plan for motors
e) Datasheet (Annexure-I)
f) Datasheets -C
g) Electrical Load data format (Annexure –II)
h) BHEL cable listing format (Annexure –III)

## ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

**PACKAGE: VENTILATION SYSTEM**
**SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT**
**PROJECT: KHURJA STPP (2X660 MW) TG & ASSOCIATED PKG**

| S.NO | DETAILS | SCOPE SUPPLY | SCOPE E&C | REMARKS |
|---|---|---|---|---|
| 1 | 415V MCC | BHEL | BHEL | 1. 415 V AC (3 Phase, 4 Wire) /240 V AC 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><br>BHEL<br>BHEL<br>BHEL | <br><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, fibre optical 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 equipments supplied by vendor | Vendor | Vendor | Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537. |
| 9 | Lighting | BHEL | BHEL | |

## ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

**PACKAGE: VENTILATION SYSTEM**
**SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT**
**PROJECT: KHURJA STPP (2X660 MW) TG & ASSOCIATED PKG**

| S.NO | DETAILS | SCOPE SUPPLY | SCOPE E&C | REMARKS |
|---|---|---|---|---|
| 10 | Equipment grounding (including electronic earthing) & lightning protection | BHEL | BHEL | Refer note no. 4 for electronic earthing |
| 11 | Below grade grounding | BHEL | BHEL | |
| 12 | LT Motors with base plate and foundation hardware | Vendor | Vendor | Makes shall be subject to customer/ BHEL approval at contract stage. |
| 13 | Mandatory spares | Vendor | - | Vendor to quote as per specification. |
| 14 | Recommended O & M spares | Vendor | - | As specified elsewhere in specification |
| 15 | Any other equipment/material/service required for completeness of system but not specified above (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. |

## ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

**PACKAGE: VENTILATION SYSTEM**
**SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT**
**PROJECT: KHURJA STPP (2X660 MW) TG & ASSOCIATED PKG**

NOTES:

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

# SUB–SECTION – B-2

# MOTORS

## MOTORS

**1.00.00 GENERAL REQUIREMENTS**

1.01.00 For the purpose of design of equipment/systems, an ambient temperature of 50 deg. Centigrade and relative humidity of 95% (at 40 deg C) shall be considered. The equipment shall operate in a highly polluted environment.

1.02.00 All equipment shall be suitable for rated frequency of 50 Hz with a variation of +3% & -5%, and 10% combined variation of voltage and frequency unless specifically brought out in the specification.

1.03.00 Contractor shall provide fully compatible electrical system, equipment, accessories and services.

1.04.00 All the equipment, material and systems shall, in general, conform to the latest edition of relevant National and international Codes & Standards, especially the Indian Statutory Regulations.

1.05.00 Paint shade shall be as per RAL 5012 (Blue) for indoor and outdoor equipment.

1.06.00 The responsibility of coordination with electrical agencies and obtaining all necessary clearances for contractors equipment and systems shall be under the contractor scope.

1.07.00 Degree of Protection

Degree of protection for various enclosures as per IEC60034-05 shall be as follows:-

| | | | |
|---|---|---|---|
| i) | Indoor motors | - | IP 54 |
| ii) | Outdoor motors | - | IP 55 |
| iii) | Cable box-indoor area | - | IP 54 |
| iv) | Cable box-Outdoor area | - | IP 55 |

**2.00.00 CODES AND STANDARDS**

| | | | |
|---|---|---|---|
| 1) | Three phase induction motors | : | IS/IEC:60034 |
| 2) | Single phase AC motors | : | IS/IEC:60034 |
| 3) | Crane duty motors | : | IS:3177, IS/IEC:60034 |
| 4) | DC motors/generators | : | IS/IEC:60034 |
| 5) | Energy Efficient motors | : | IS 12615, IEC: 60034-30 |

**3.00.00** **TYPE**

3.01.00 **AC Motors:**

a) Squirrel cage induction motor suitable for direct-on-line starting.

b) Continuous duty LT motors upto 200 KW Output rating (at 50 deg.C ambient temperature), shall be Premium Efficiency class-IE3, conforming to IS 12615, or IEC:60034-30. HT motors shall have minimum design efficiency of 95 % Tolerance on efficiency value applicable as per IEC 60034.

c) Crane duty motors shall be squirrel cage Induction motor as per the requirement.

d) Motor operating through variable frequency drives shall be suitable for inverter duty with VPI insulation. Also these motors shall comply the requirements stipulated in IEC: 60034-18-41 and IEC: 60034-18-42 as applicable.

e) Motors operating through variable frequency drives shall also meet the requirements mentioned in subsection for VFD.

3.02.00 DC Motors Shunt wound

**4.00.00** **RATING**

(a) Continuously rated (S1). However, crane motors shall be rated for S4 duty, 40% cyclic duration factor.

(b) Whenever the basis for motor or driven equipment ratings are not specified in the corresponding mechanical specification sub-sections, maximum continuous motor ratings shall be at least 10% above the maximum load demand of the driven equipment under entire operating range including voltage and frequency variations.

**5.00.00** **TEMPERATURE RISE**

**Air cooled motors**

70 deg. C by resistance method for both thermal class 130(B) & 155(F) insulation.

**Water cooled**

80 deg. C over inlet cooling water temperature mentioned elsewhere, by resistance method for both thermal class 130(B) & 155(F) insulation.

41 deg.C over inlet cooling water maximum temperature of 39 deg.C for thermal class 90 (Y) wet wound Boiler circulation pump motor.

**6.00.00** **OPERATIONAL REQUIREMENTS**

| | |
|---|---|
| 6.01.00 | **Starting Time** |
| 6.01.01 | For motors with starting time upto 20 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 secs. more than starting time. |
| 6.01.02 | For motors with starting time more than 20 secs. and upto 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 secs. more than starting time. |
| 6.01.03 | For motors with starting time more than 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time. |
| 6.01.04 | Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met. |
| 6.02.00 | **Torque Requirements** |
| 6.02.01 | Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque. |
| 6.02.02 | Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty motors. |
| 6.03.00 | **Starting voltage requirement** |
| | (a) Up to 85% of rated voltage for ratings below 110 KW |
| | (b) Up to 80% of rated voltage for ratings from 110 KW to 200 KW |
| | (c) Up to 85% of rated voltage for ratings from 201 KW to 1000 KW |
| | (d) Up to 80% of rated voltage for ratings from 1001 KW to 4000 KW |
| | (e) Up to 75 % of rated voltage for ratings above 4000KW |
| | Except AOP & JOP motors running on D.G emergency supply, starting voltage shall be 80%. |
| **7.00.00** | **DESIGN AND CONSTRUCTIONAL FEATURES** |
| 7.01.00 | Suitable single phase space heaters shall be provided on motors rated 30KW and above to maintain windings in dry condition when motor is standstill. Separate terminal box for space heaters & RTDs shall be provided. However for flame proof motors, space heater terminals inside the main terminal box may be acceptable. |
| 7.02.00 | All motors shall be either Totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or Closed air circuit air cooled (CACA) type. However, motors rated 3000KW or above can be Closed air circuit water cooled (CACW). The method of movement |

of primary and secondary coolant shall be self-circulated by fan or pump directly mounted on the rotor of the main motor as per IEC 60034-6. However VFD driven motors can be offered with forced cooling type with machine mounted fan or pump driven by separate electric motor. Motors and EPB located in hazardous areas shall have flame proof enclosures conforming to IS: 2148 as detailed below

(a) Fuel oil area : Group – IIB

(b) Hydrogen generation : Group - IIC or (Group-I, Div-II as per plant area NEC) or (Class-1, Group-B, Div-II as per NEMA / IEC60034)

7.03.00 Winding and Insulation

(a) Type : Non-hygroscopic, oil resistant, flame resistant

(b) Starting duty : Two hot starts in succession, with motor initially at normal running temperature.

(c) 11kV & 3.3 kV AC motors : Thermal class 155 (F) insulation.
The winding insulation process shall be Global Vacuum Pressure Impregnated i.e. resin poor method. The lightning Impulse & interturn insulation surge withstand level shall be as per IEC-60034 part-15.

However winding insulation for wet wound Boiler circulation pump motor shall be thermal class 90 (Y) or better.

(d) 240VAC, 415V AC & 220V DC motors : Thermal Class ( B ) or better

7.04.00 Motors rated above 1000KW shall have insulated bearings/housing to prevent flow of shaft currents.

7.05.00 Motors with heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate inlet and outlet primary air temperature.

7.06.00 Noise level for all the motors shall be limited to 85dB (A) except for BFP motor for which the maximum limit shall be 90 dB(A). Vibration shall be limited within the limits prescribed in IS/IEC 60034-14. Motors shall withstand vibrations produced by driven equipment. HT motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting 80mmX80mm vibration pads.

7.07.00 In HT motors, at least four numbers simplex / two numbers duplex platinum resistance type temperature detectors shall be provided in each phase stator winding. Each bearing of HT motor shall be provided with dial type thermometer and 2 numbers duplex platinum resistance type temperature detectors.

| | |
|---|---|
| 7.08.00 | Motor body shall have two earthing points on opposite sides. |
| 7.09.00 | 11 KV motors shall be offered with Separable Insulated Connector (SIC) as per IEEE 386. The offered SIC terminations shall be provided with protective cover and trifurcating sleeves. SIC termination kit shall be suitable for fault level of 25 KA for 0.17 seconds. |
| 7.10.00 | 3.3 KV motors shall be offered with dust tight phase separated double walled (metallic as well as insulated barrier) Terminal box. Suitable termination kit shall be provided for the offered Terminal box. The offered Terminal Box shall be suitable for fault level of 250 MVA for 0.12 sec. Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non-magnetic material for single core cables) shall be provided. |
| 7.11.00 | The spacing between gland plate & center of bottom terminal stud shall be as per Table-I. |
| 7.12.00 | All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment. |
| 7.13.00 | The motors shall be suitable for bus transfer schemes provided on the 11kV, 3.3 kV /415V systems without any injurious effect on its life. |
| 7.14.00 | For motors rated 2000 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box. |
| 7.15.00 | The size and number of cables (for HT and LT motors) to be intimated to the successful bidder during detailed engineering and the contractor shall provide terminal box suitable for the same. |
| 8.00.00 | The ratio of locked rotor KVA at rated voltage to rated KW shall not exceed the following (without any further tolerance) except for BFP motor.<br>(a) From 50KW & upto 110KW : 11.0<br>(b) From 110 KW & upto 200 KW : 9.0<br>(c) Above 200 KW & upto 1000KW : 10.0<br>(d) From 1001KW & upto 4000KW : 9.0<br>(e) Above 4000KW : 6 to 6.5 |
| 9.00.00 | CW motor shall be designed with minimum power factor of 0.8 at design duty point. |
| **10.00.00** | **TYPE TEST** |
| 10.01.00 | **HT MOTORS** |
| 10.01.01 | The contractor shall carry out the type tests as listed in this specification on the equipment to be supplied under this contract. The bidder shall indicate the charges for each of these type |

tests separately in the relevant schedule of Section - VII- (BPS) and the same shall be considered for the evaluation of the bids. The type tests charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the employer's engineer.

10.01.02 The type tests shall be carried out in presence of the employer's representative, for which minimum 15 days notice shall be given by the contractor. The contractor shall obtain the employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set–up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.

10.01.03 In case the contractor has conducted such specified type test(s) within last ten years as on the date of bid opening, he may submit during detailed engineering the type test reports to the employer for waival of conductance of such test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The employer reserves the right to waive conducting of any or all the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the contractor.

10.01.04 Further the Contractor shall only submit the reports of the type tests as listed in "LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED "and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the employer either at third party lab or in presence of client/ employer's representative and submit the reports for approval.

10.01.05 **LIST OF TYPE TESTS TO BE CONDUCTED**

**The following type tests shall be conducted on each type and rating of HT motor**

(a) No load saturation and loss curves upto approximately 115% of rated voltage.

(b) Measurement of noise at no load.

(c) Momentary excess torque test (subject to test bed constraint).

(d) Full load test (subject to test bed constraint)

(e) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp., coolant flow and its temp. shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the

test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose.

10.01.06 **LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED**

**The following type test reports shall be submitted for each type and rating of HT motor**

(a) Degree of protection test for the enclosure followed by IR, HV and no load run test.

(b) Terminal box-fault level withstand test for each type of terminal box of HT motors only.

(c) Lightning Impulse withstand test on the sample coil shall be as per clause no. 4.3 IEC-60034, part-15

(d) Surge-withstand test on interturn insulation shall be as per clause no. 4.2 of IEC 60034, part-15

10.02.00 **LT Motors**

10.02.01 LT Motors supplied shall be of type tested design. During detailed engineering, the contractor shall submit for employer's approval the reports of all the type tests as listed in this specification and carried out within last *ten* years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

10.02.02 However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the employer either at third party lab or in presence of client/ employer's representative and submit the reports for approval.

10.02.03 **LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED**

**The following type test reports shall be submitted for each type and rating of LT motor of above 100 KW only**

1. Measurement of resistance of windings of stator and wound rotor.
2. No load test at rated voltage to determine input current power and speed
3. Open circuit voltage ratio of wound rotor motors ( in case of Slip ring motors)
4. Full load test to determine efficiency power factor and slip.
5. Temperature rise test.
6. Momentary excess torque test.

7. High voltage test.

8. Test for vibration severity of motor.

9. Test for noise levels of motor(Shall be limited as per clause no 7.06.00 of this section)

10. Test for degree of protection and

11. Over speed test.

12. Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1

10.03.00 All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

10.04.00 The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any shall be highlighted on the endorsement sheet.

**TABLE - I**

**DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS**

| **Motor MCR in KW** | **Minimum distance between centre of bottom terminal stud and gland plate in mm** |
|---|---|
| **UP to 3 KW** | **As per manufacturer's practice.** |
| Above 3 KW - upto 7 KW | 85 |
| Above 7 KW - upto 13 KW | 115 |
| Above 13 KW - upto 24 KW | 167 |
| Above 24 KW - upto 37 KW | 196 |
| Above 37 KW - upto 55 KW | 249 |
| Above 55 KW - upto 90 KW | 277 |
| Above 90 KW - upto 125 KW | 331 |
| Above 125 KW-upto 200 KW | 385/203 (For Single core cables only) |

For HT motors the distance between gland plate and the terminal studs shall not be less than 500 mm.

**PHASE TO PHASE/ PHASE TO EARTH AIR CLEARANCE:**

NOTE: Minimum inter-phase and phase-earth air clearances for LT motors with lugs installed shall be as follows:

| **Motor MCR in KW** | **Clearance** |
|---|---|
| UP to 110 KW | 10mm |
| Above 110 KW and upto 150 KW | 12.5mm |
| Above 150 KW | 19mm |

# SUB–SECTION – B-5

# CABLING EARTHING LIGHTNING AND PROTECTION

**1.00.00 CODES AND STANDARDS**

1.01.00 All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards/ codes as applicable .

| | |
|---|---|
| IS:513 | Cold rolled low carbon steel sheets and strips. |
| IS:802 | Code of practice for the use of Structural Steel in Overhead Transmission Line Towers. |
| IS:1079 | Hot Rolled carbon steel sheet & strips |
| IS:1239 | Mild steel tubes, tubulars and other wrought steel fittings |
| IS:1255 | Code of practice for installation and maintenance of power cables upto and including 33 KV rating |
| IS:1367 Part-13 | Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners). |
| IS:2147 | Degree of protection provided by enclosures for low voltage switchgear and control gear |
| IEC:62305 | Code of Practice for the protection of building and allied structures against lightning. |
| IS:2309 | Code of Practice for the protection of building and allied structures against lightning. |
| IS:2629 | Recommended practice for hot dip galvanising of iron & steel |
| IS:2633 | Method for testing uniformity of coating on zinc coated articles. |
| IS:3043 | Code of practice for Earthing |
| IS:3063 | Fasteners single coil rectangular section spring washers. |
| IS:6745 | Methods for determination of mass of zinc coating on zinc coated iron & steel articles. |
| IS:8308 | Compression type tubular in- line connectors for aluminium conductors of insulated cables |
| IS:8309 | Compression type tubular terminal ends for aluminium conductors of insulated cables. |
| IS:9537 | Conduits for electrical installation. |
| IS:9595 | Metal - arc welding of carbon and carbon manganese steels - recommendations. |
| IS:13573 | Joints and terminations for polymeric cables. |
| BS:476 | Fire tests on building materials and structures |

| | | |
|---|---|---|
| | IEEE:80 | IEEE guide for safety in AC substation grounding |
| | IEEE:142 | Grounding of Industrial & commercial power systems |
| | DIN 46267 (Part-II) | Non tension proof compression joints for Aluminium conductors. |
| | DIN 46329 | Cable lugs for compression connections, ring type ,for Aluminium conductors |
| | BS:6121 | Specification for mechanical Cable glands for elastomers and plastic insulated cables. |
| | | Indian Electricity Act. |
| | | Indian Electricity Rules. |

1.02.00 Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE, NEMA etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards alongwith copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

**2.00.00 DESIGN AND CONSTRUCTIONAL FEATURE**

2.01.00 **Inter Plant Cabling**

2.01.01 Interplant cabling for main routes shall be laid along overhead trestles/duct banks. Cables from main plant to switchyard control room shall be laid in overhead trestles or duct bank. In case of Duct banks, pull-pits shall be filled with sand and provided with a PCC covering. Directly buried cables, if essential, shall not have concentration of more than 4 cables in one route. All HT, LT and Control cables shall be armored.

2.01.02 **Transformer yard**

In transformer yard cables shall be laid in overhead trestle. The main cable routes coming out from Main plant building and crossing the Transformer yard shall be laid in overhead trestles. In transformer yard, trestle height for rail/road crossing shall be suitable for movement of Generator Transformer with bushing.

2.01.03 **Trenches**

PCC flooring of built up trenches shall be sloped for effective drainage with sump pits and sump pumps.

2.01.04 No sub zero level cable vault/trenches shall be provided below control building/switchgear rooms in main plant.

2.01.05 **Cable Vault**

The cable vault/ / cable spreader room space below the HT / LT switchgear room, Control Rooms, unit control equipment room, Programmer room, UPS, Charger & Battery Rooms, Boiler MCC room shall have **800 mm wide** and 2.1 m high movement passage all around the cable trays in the cable vault/ cable spreader room for easy laying/maintenance of cables

Cable vaults shall be provided with adequate drainage facilities for drainage of fire water.

Each cable vault should have at least two doors.

Exit signs shall be provided near doors for personnel escape in case of emergency

2.01.06 **Boiler Area**

Two separate cable routes one on each side shall be provided for each boiler unit. Cables for on set of auxiliaries such as ID, FD, PA fan & half of the coal mills shall be routed in one route & for other set of auxiliaries through other route.

Cable trays in boiler & ESP area shall be supported from the boiler and ESP structures. The same shall be coordinated with SG/ESP contractor.

Cable trays in these areas shall be in vertical formation to avoid dust accumulation. No cable trenches shall be provided in boiler/ESP area.

2.01.07 **Turbine Hall Area**

a)Two separate cable routes shall be provided for cable routing of working and standby drives or different set/group (say 50% capacity) of auxiliaries.

2.01.08 **OffSite Area**

In offsite pumphouses, overhead cable tray arrangement shall be followed. However cable trenches may be considered below switchgear/mcc.
Trestle In fuel oil pump house, overhead cable tray arrangement shall be provided. RCC trenches provided in MCC room shall be separated from fuel oil area to avoid oil accumulation.

2.01.09 The cable slits to be used for motor/equipment power/control supply shall be sand filled & covered with PCC after cabling.

2.01.10 Sizing criteria, derating factors for the cables shall be met as per respective chapters. However for the power cables, the minimum conductor size shall be 6 sq.mm. for aluminium conductor and 2.5 sq.mm. for copper conductor cable.

2.01.11 Conscious exceptions to the above guidelines may be accepted under special conditions but suitable measures should be taken at such location to:

- Meet all safety requirements
- Safeguard against fire hazards, mechanical damage, flooding of water, oil accumulation, electrical faults/interferences, etc

**3.00.00 EQUIPMENT DESCRIPTION**

3.01.00 **Cable trays, Fittings & Accessories**

3.01.01 Cable trays shall be ladder/perforated type as specified complete with matching fittings (like brackets, elbows, bends, reducers, tees, crosses, etc.) accessories (like side coupler plates, etc. and hardware (like bolts, nuts, washers, G.I. strap, hook etc.) as required. Cable tray shall be ladder type for power & control cables and perforated for instrumentation cables.

3.01.02 Cable trays, fittings and accessories shall be fabricated out of rolled mild steel sheets free from flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per Clause No. 3.13.00 of this chapter.

3.01.03 Cable trays shall have standard width of 150 mm, 300 mm & 600 mm and standard lengths of 2.5 metre. Thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2 mm. The thickness of side coupler plates shall be 3 mm.

3.01.04 Cable troughs shall be required for branching out few cables from main cable route. These shall be U-shaped, fabricated of mild steel sheets of thickness 2 mm and shall be hot dip galvanised as per Clause No. 3.13.00 of this chapter. Troughs shall be standard width of 50 mm & 75 mm with depth of 25 mm.

3.01.05 The tolerance for cable tray and accessories shall be as per IS 2102 (Part-1).
Tolerance Class: - Coarse

3.02.00 **Support System for Cable Trays**

3.02.01 Cable tray support system shall be pre-fabricated out of single sheet as per enclosed tender drawings.

3.02.02 Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of two types : (i) C1:- having provision of supporting cable trays on one side and (ii) C2:-having provision of supporting cable trays on both sides. The support system shall be the type described hereunder

a. Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor plates, all hardwares such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc.

b. The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardwares fitings and accessories shall be prefabricated factory galvanised.

c. The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc. to form various arrangements required to support the cable trays. Welding of the components shall not be allowed. However, welding of the bracket (to which the main support channel is bolted) to the overhead beams, structural steel, insert plates or reinforcement bars will be permitted. Any cutting or welding of the galvansied surface shall be brushed and red lead primer, oil primer & aluminium paint shall be applied

d. All steel components, accessories, fittings and hardware shall be hot dip galvanised after completing welding, cutting, drilling and other machining operation.

e. The typical arrangement of flexible support system is shown in the enclosed drawings and described briefly below:

The main support channel and cantilever arms shall be fabricated out of 2.5 thick rolled steel sheet conforming to IS 1079.

f. Cantilever arms of 320 mm, 620mm and 750 mm in length are required, and shall be as shown in the enclosed drawing. The arm portion shall be suitable for assembling the complete arm assembly on to component constructed of standard channel section. The back plate shall allow sufficient clearance for fixing bolt to be tightened with tray in position.

g. Support system shall be able to withstand

- weight of the cable trays
- weight of the cables (75 Kg/Metre run of each cable tray)
- Concentrated load of 75 Kg between every support span.
- Factor of safety of minimum 1.5 shall be considered.

3.02.03 The size of structural steel members or thickness of sheet steel of main support channel and cantilever arms and other accessories as indicated above or in the enclosed drawings are indicative only. Nevertheless, the support system shall be designed by the bidder to fully meet the requirements of type tests as specified. In case the system fails in the tests, the components design modification shall be done by the Bidder without any additional cost to the Employer. The bidder shall submit the detailed drawings of the system offered by him alongwith the bid.

3.02.04 Four legged structure shall be provided wherever there is change in elevation and change in direction

3.03.04 FOR COAL, LIMESTONE AND GYPSUM HANDLING PLANT THE FOLLOWING SHALL ALSO BE APPLICABLE:

a) All overhead cable routes shall be along the route of the conveyor gallery on separate supporting structures and cables shall be laid in vertical trays. The bottom of the steel shall be such that the existing facilities, movement of trucks/human beings etc. does not get affected. The cable trestle shall have a minimum 600mm clear walk way and shall have maintenance platforms as required. The bottom of the steel supporting structure shall be generally at 3.0M above the grade level except for rail/road crossings where it shall be at 8.0M above grade level. Tap offs from the overhead cable trestle can be through shallow trenches with prior approval of the Employer. Directly buried cable, if essential, shall not have concentration of more than 4 cables on one route.

b) Cable trenches shall be provided only in Switchgear/MCC rooms.

c) Cables shall not be routed through the conveyor galleries except for the equipment located in the conveyor galleries for a particular conveyor i.e. protection switches, receptacles etc.

d) Cables for PCS and BSS shall be routed along the conveyors through GI conduits.

3.04.00 **Pipes, Fittings & Accessories**

3.03.01 Pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.) The size of the pipe shall be selected on the basis of maximum 40% fill criteria

3.03.02 GI Pipes shall be of medium duty as per IS: 1239

3.03.03 Duct banks shall be PVC conduits encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes and with proper sealing arrangement consisting of fire retardant sealing compound.

3.03.04 Hume pipes shall be NP3 type as per IS 458.

3.03.05 TERNE Coated Flexible Steel Conduits shall be water proof and rust proof made of heat resistant lead coated steel. Conduit diameter shall be uniform throughout its length. Internal surface of the conduit shall be free from burrs and sharp edges. Conduits shall be complete

with necessary accessories for proper termination of the conduit with junction boxes and lighting fixtures.

3.03.06 HDPE pipes and conduits shall be PE-80, PN-10 type as per IS 4984/IS 8008 Part-I.

3.04.00 **Junction Boxes**

3.04.01 Junction box shall be made of Fire retardant material. Material of JB shall be Thermoplastic or thermosetting or FRP type. The box shall be provided with the terminal blocks, mounting bracket and screws etc. The cable entry shall be through galvanized steel conduits of suitable diameter. The JB shall have suitable for installing glands of suitable size on the bottom of the box. The JB shall be suitable for surface mounting on ceiling/structures. The JB shall be of grey color RAL 7035. All the metal parts shall be corrosion protected. Junction box surface should be such that it is free from crazings, blisterings, wrinkling, colour blots/striations. There should not be any mending or repair of surface. JB's will be provided with captive screws so that screws don't fall off when cover is opened. JB's mounting brackets should be of powder coated MS. Type test reports for the following tests shall be furnished:-

(a) Impact resistance for impact energy of 2 Joules (IK07)as per BS EN50102

(b) Thermal ageing at 70deg C for 96 hours as per IEC60068-2-2Bb.

(c) Class of protection shall be IP 55.

(d) HV test.

3.04.02 Terminal blocks shall be 1100V grade, of suitable current rating, made up of unbreakable polyamide 6.6 grade. The terminals shall be screw type or screw-less (spring loaded) / cage clamp type with lugs. Marking on terminal strips shall correspond to the terminal numbering in wiring diagrams. All metal parts shall be of non-ferrous material. In case of screw type terminals the screw shall be captive, preferably with screw locking design. All terminal blocks shall be suitable for terminating on each side the required cables/wire size. All internal wiring shall be of cu. Conductor PVC wire.

3.05.00 **Terminations & Straight Through Joints**

3.05.01 Termination and jointing kits for 33kV, 11 kV, 6.6 KV and 3.3 kV grade XLPE insulated cables shall be of proven design and make which have already been extensively used and type tested. Termination kits and jointing kits shall be Pre-moulded type or heat shrinkable type. Further Cold shrinkable type termination and jointing kits are also acceptable. The Cold shrinkable type kits shall be type tested as per relevant standards. Calculation to withstand the required fault level shall also be furnished in case of cold shrinkable type kits. 33 kV, 11 kV, 6.6 KV and 3.3kV grade joints and terminations shall be type tested and Type test reports as per IS:13573 Part-II and IEC60502 shall be furnished. Also, heat shrink material shall comply with requirements of ESI 09-13 (external tests). Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ESI specification. Cable joints and terminations should be with FRLS properties as per IEC 60754-1&2. Kit contents shall be supplied from the same source as were used for type testing. The kit shall be complete with the tinned copper solderless crimping type cable lugs & ferrule or mechanical connectors (wherein bolts are tightened that shear off at an appropriate torque) as per DIN standard suitable for aluminium compacted conductor cables. (Tender drg. no 0000-211-POE –A-51-RA of cable lug attached at the end of this chapter)..

3.05.02 Straight through joint and termination shall be capable of withstanding the fault level of 21 KA for 0.12 Sec. with dynamic peak of 52 KA for 33 KV system & of 40 kA for 0.12 sec with a dynamic peak of 100 kA for 11 kV, 6.6 KV & 3.3 KV system. Straight through joints shall

have provisions for shield connection and earthing wherever required and complete with all accessories and consumables suitable for storage without deterioration at a temperature of 50 deg. C with shelf life of more than five years. 1.1 kV grade straight through joints shall also be of proven design

3.05.03 1.1 KV grade Straight Through Joint shall be of proven design.

3.06.00 **Cable glands**

3.06.01 Cable shall be terminated using double compression type cable glands. Testing requirements of Cable glands shall conform to BS:6121 and gland shall be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating Rubber components shall be of neoprene or better synthetic material and of tested quality. Cable glands shall be suitable for the sizes of cable supplied/erected.

**3.07.00 Cable lugs/ferrules**

3.07.01 Cable lugs/ferrules for power cables shall be tinned copper solderless crimping type suitable for aluminium compacted conductor cables. Cable lugs and ferrules for control cables shall be tinned copper type. The cable lugs for control cables shall be provided with insulating sleeve and shall suit the type of terminals provided on the equipments. Cable lugs and ferrule shall conform to DIN standards.

3.08.00 **Trefoil clamps**

3.08.01 Trefoil clamps for single core cables shall be pressure die cast aluminum or fibre glass or nylon and shall include necessary fixing accessories like G.I. nuts, bolts, washers, etc. Trefoil clamps shall have adequate mechanical strength, when installed at 1 mtr intervals, to withstand the forces generated by the peak value of maximum system short circuit current.

3.09.00 **Cable Clamps & Ties**

3.09.01 The cable clamps/ties required to clamp multicore cables shall be of SS-316 material, 12mm wide, polyster coated ladder lock type. The clamps/ties shall have self locking arrangement & shall have sufficient strength. The cable clamps/ties shall be supplied in finished individual pieces of suitable length to meet the site requirements.

3.10.00 **Receptacles**

3.10.01 Receptacles boxes shall be fabricated out of MS sheet of 2mm thickness and hot dipped gavanised or of die-cast aluminium alloy of thickness not less than 2.5 mm. The boxes shall be provided with two nos. earthing terminals, gasket to achieve IP55 degree of protection, terminal blocks for loop-in loop-out for cable of specified sizes, mounting brackets suitable for surface mounting on wall/column/structure, gland plate etc. The ON-OFF switch shall be rotary type heavy duty, double break,AC23 category, suitable for AC supply. Plug and Socket shall be shrouded Die-cast aluminium. Socket shall be provided with lid safety cover. Robust mechanical interlock shall be provided such that the switch can be put ON only when the plug is fully engaged and plug can be withdrawn only when the switch is in OFF position. Also cover can be opened only when the switch is in OFF position. Wiring shall be carried out with 1100 V grade PVC insulated stranded aluminium/copper wire of adequate size. The Terminal blocks shall be of 1100 V grade. The Terminal blocks shall be of 1100 V grade made up of unbreakable polymide 6.6 grade with adequate current rating and size. The welding receptacles shall be provided with RCCB/RCD of 30mA sensitivity having facility for manual testing/checking of operation of RCCB/RCD

3.12.00 **Cable Drum Lifting Jack**

The jack for cable drum lifting shall be of screw type with 10 ton capacity. The cable drum jacks shall be manufactured from fabricated steel. The spindles supplied with the cable drum jack shall be manufactured using BSEN-24 grade steel bar with locking collars. Jack nests shall be of SG cast steel. Cable drum jack supplied shall have undergone load testing and reports for the same shall be submitted. At least Two Nos. of jacks shall be supplied for NTPC use. Contractor has to make arrangements for his own jacks for cable reeling/unreeling under his scope of installation.

3.13.00 **Galvanising**

3.13.01 Galvanising of steel components and accessories shall conform to IS:2629 , IS4759 & IS:2633. Additionally galvanising shall be uniform, clean smooth, continuous and free from acid spots.

3.13.02 The amount of zinc deposit over threaded portion of bolts, nuts, screws and washers shall be as per IS:1367 . The removal of extra zinc on threaded portion of components shall be carefully done to ensure that the threads shall have the required zinc coating on them as specified

3.14.00 **Welding**

3.14.01 The welding shall be carried out in accordance with IS:9595. All welding procedures and welders qualification shall also be followed strictly in line with IS:9595

**4.00.00 INSTALLATION**

4.01.00 **Cable tray and Support System Installation**

4.01.01 Cables shall run in cable trays mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures.

4.01.02 Horizontally running cable trays shall be clamped by bolting to cantilever arms and vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 2000 mm in general. For vertical cable risers/shafts cable trays shall be supported at an interval of 1000mm in general. Fixing of cable trays to cantilever arms or main support channel by welding shall not be accepted. Cable tray installation shall generally be carried out as per the approved guidelines/ drawings. Vendor shall design the support system along with tray, spacing etc in line with tray loadings/drawings.

4.01.03 The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm unless otherwise indicated.

4.01.04 The contractor shall fix the brackets/ clamps/ insert plates using anchor fasteners. Minimum size of anchor fasteners shall be M 8 X 50 and material shall be stainless steel grade 316 or better. Anchor fastener shall be fixed as recommended by manufacturer and as approved by site engineer. For brick wall suitable anchor fasteners shall be used as per the recommendations of manufacturer. Make of anchor fasteners subject to QA approval and the same shall be finalized at pre-award stage.

4.01.05 All cable way sections shall have identification, designations as per cable way layout drawings and painted/stenciled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 75 mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted/stenciled with identification numbers at every floor.

4.01.06 In certain cases it may be necessary to site fabricate portions of trays, supports and other non standard bends where the normal prefabricated trays, supports and accessories may not be suitable. Fabricated sections of trays, supports and accessories to make the installation complete at site shall be neat in appearance and shall match with the prefabricated sections in the dimensions. They shall be applied with one coat of red lead primer, one coat of oil primer followed by two finishing coats of aluminium paint.

4.02.00 **Conduits/Pipes/Ducts Installation**

4.02.01 The Contractor shall ensure for properly embedding conduit pipe sleeves wherever necessary for cabling work. All openings in the floor/roof/wall / cable tunnel/cable trenches made for conduit installation shall be sealed and made water proof by the Contractor.

4.02.02 GI pull wire of adequate size shall be laid in all conduits before installation. Metallic conduit runs at termination shall have two lock nuts wherever required for junction boxes etc.

4.02.03 Conduit runs/sleeves shall be provided with PVC bushings having round edge at each end. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed with Glass wool/Cement Mortar/Putty to prevent entrance of moisture and foreign material

4.02.04 Exposed conduit/pipe shall be adequately supported by racks, clamps, straps or by other approved means. Conduits /pipe support shall be installed square and true to line and grade with an average spacing between the supports as given below, unless specified otherwise

| **Conduit /pipe size (dia).** | **Spacing** |
|---|---|
| Upto 40 mm | 1 M |
| 50 mm | 2.0 M |
| 65-85 mm | 2.5 M |
| 100 mm and above | 3.0 M |

4.02.05 For bending of conduits, bending machine shall be arranged at site by the contractor to facilitate cold bending. The bends formed shall be smooth.

4.03.00 **Junction Boxes Installation**

4.03.01 Junction boxes shall be mounted at a height of 1200mm above floor level or as specified in the drawings and shall be adequately supported/mounted on masonry wall by means of anchor fasteners/ expandable bolts or shall be mounted on an angle, plate or other structural supports fixed to floor, wall, ceiling or equipment foundations.

4.04.00 **Cable Installation**

4.04.01 Cable installation shall be carried out as per IS:1255 and other applicable standards.

4.04.02 For Cable unloading, pulling etc following guidelines shall be followed in general:

a) Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall be drum be stored flat i.e. with flange horizontal. Rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cables. For unreeling the cable, the drum shall be mounted on suitable jacks or on

cable wheels and shall be rolled slowly so that cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.

b) While laying cable, ground rollers shall be used at every 2 meter interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangements. Pulling tension shall not exceed the values recommended by cable manufacturer. Selection of cable drums for each run shall be so planned so as to avoid using straight through joints. Care should be taken while laying the cables so as to avoid damage to cables. If any particular cable is damaged, the same shall be repaired or changed to the satisfaction of Project Manager.

4.04.03 Cables shall be laid on cable trays strictly in line with cable schedule . Where specific cable layouts are not shown on drawings, Contractor shall route these as directed by the Project Manager

4.04.04 Power and control cables shall be laid on separate tiers inline with the approved guidelines/drawings. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables. In horizontal tray stacks, H.T. cables shall be laid on top most tier and cables of subsequent lower voltage grades on lower tiers of trays. Single core cable in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil center lines and clamped at every-one metre. All multicore cables shall be laid in touching formation. Power and control cables shall be secured fixed to trays/support with cable clamps/ties with self locking arrangement. For horizontal trays arrangements, multicore power cables and control cables shall be secured at every five meter interval. For vertical tray arrangement, individual multicore power cables and control cables shall be secured at every one meter. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by cable clamps/ties with self locking arrangement at every five meter interval and at every bend.
Fibre Optical cable shall be laid in trenches/trays or as decided by Employer.

4.04.05 Bending radii for cables shall be as per manufacturer's recommendations and IS:1255.

4.04.06 Where cables cross roads/rail tracks, the cables shall be laid in hume pipe/ HDPE pipe.

4.04.07 No joints shall be allowed in trip circuits, protection circuits and CT/PT circuits. Also joints in critical equipment in main plant area shall not be permitted. Vendor shall identify and accordingly procure the cable drum length.

4.04.08 In each cable run some extra length shall be kept at suitable point to enable one LT/two HT straight through joints to made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.

4.04.09 Wherever few cables are branching out from main trunk route troughs shall be used.

4.04.10 Wind loading shall be considered for designing support as well Cable trays wherever required.

4.04.11 Where there is a considerable risk of steam, hot oil or mechanical damage cable routes shall be protected by barriers or enclosures.

4.04.12 The installation work shall be carried out in a neat workman like manner & areas of work shall be cleaned of all scraps, water, etc. after the completion of work in each area every

day. Contractor shall replace RCC/Steel trench covers after the Installation work in that particular area is completed or when further work is not likely to be taken up for some time.

4.04.13 **Separation**

At least 300mm clearance shall be provided between:

- HT power & LT power cables,
- LT power & LT control/instrumentation cables,

4.04.14 **Segregation**

1) Segregation means physical isolation to prevent fire jumping.

2) All cables associated with the unit shall be segregated from cables of other units.

3) Interplant cables of station auxiliaries and unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire. Power and control cables for AC drives and corresponding emergency AC or DC drives shall be laid in segregated routes. Cable routes for one set of auxiliaries of same unit shall be segregated from the other set.

4) In switchyard, control cables of each bay shall be laid on separate racks/trays.

4.04.15 Minimum number of spare cores required to be left for interconnection in control cables shall be as follows:

Minimum number of spare cores required to be left for interconnection in control cables shall be as follows:

| No. of cores in cable | No. of spare cores |
|---|---|
| 2C,3C | NIL |
| 5C | 1 |
| 7C-10C | 2 |
| 14C and above | 3 |

4.04.16 **Directly Buried Cables**

a) Cable trenches shall be constructed for directly buried cables. Construction of cable trench for cables shall include excavation, preparation of sieved sand bedding, riddled soil cover, supply and installation of brick or concrete protective covers, back filling and compacting, supply and installation of route markers and joint markers. Laying of cables and providing protective covering shall be as per IS:1255 and the enclosed drawings showing cabling details.

b) RCC cable route and RCC joint markers shall be provided wherever required. The voltage grade of the higher voltage cables in route shall be engraved on the marker. Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable Joint". The marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road crossings and drain crossings. Top of cable marker/joint marker shall be sloped to avoid accumulation of water/dust on marker.

4.04.17 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry, and at every 20 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centers, control and relay panels etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2 mm thick aluminum with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. Alternatively, the Contractor may also provide cable tags made of nylon, cable marking ties with cable number heat stamped on the cable tags. The cable tag requirements mentioned above shall prevail over Tag requirements mentioned elsewhere in this document for HT power, LT power & control cables.

4.04.18 While crossing the floors, unarmoured cables shall be protected in conduits upto a height of 500 mm from floor level if not laid in tray.

4.05.00 **Cable Terminations & Connections**

4.05.01 The termination and connection of cables shall be done strictly in accordance with cable termination kit manufacturer" instructions, drawings and/or as directed by Project Manager. Cable jointer shall be qualified to carryout satisfactory cable jointing/termination. Contractor shall furnish for review documentary evidence/experience reports of the jointers to be deployed at site.

4.05.02 Work shall include all clamps, fittings etc. and clamping, fitting, fixing, plumbing, soldering, drilling, cutting, taping, preparation of cable end, crimping of lug, insulated sleeving over control cable lugs, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job to the satisfaction of the Project Manager.

4.05.03 The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for punching of gland plates, painting and touching up. Holes shall not be made by gas cutting. The holes shall be true in shape. All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively sealed by 2mm thick aluminium sheets.

4.05.04 Control cable cores entering control panel/switchgear/MCC/miscellaneous panels shall be neatly bunched, clamped and tied with self locking type nylon cable ties with de interlocking facility to keep them in position.

4.05.05 All the cores of the control cable to be terminated shall have identification by providing ferrules at either end of the core, each ferrule shall be indelible, printed single tube ferrule and shall include the complete wire number and TB number as per the drawings. The ferrule shall fit tightly on the core. Spare cores shall have similar ferrules with suffix sp1, sp2, ---etc along with cable numbers and coiled up after end sealing.

4.05.06 All cable terminations shall be appropriately tightened to ensure secure and reliable connections.

**5.00.00 EARTHING SYSTEM**

5.01.00 Earthing system shall be in strict accordance with IS:3043 and Indian Electricity Rules/Acts.

Earthing system network/earthmat shall be interconnected mesh of mild steel rods buried in ground in the plant. All off-site areas shall be interconnected together by minimum two parallel conductors. The Contractor shall furnish the detailed design and calculations for

Employer's approval. Contractor shall obtain all necessary statutory approvals for the system.

5.02.00 The earth conductors shall be free from pitting, laminations, rust, scale and other electrical, mechanical defects

5.03.00 The material of the earthing conductors shall be as follows :

| | | | |
|---|---|---|---|
| 1) | Conductors above ground level and in built up trenches. | - | Galvanized steel |
| 2) | Conductors buried in earth | - | Mild steel |
| 3) | Earth electrodes | - | Mild steel rod |

5.04.00 The sizes of earthing conductors for various electrical equipments shall be as below:

| | Equipment | Earth conductor buried in earth | Earth conductor above ground level & in built-up trenches |
|---|---|---|---|
| a) | Main earth grid | MS rod -Min 40 mm dia. or as per actual calculation whichever is more | 65 x 8mm GS flat |
| b) | 33kV/11kV/6.6kV/3.3 kV/ switchgear equipment and 415V switchgear | --- | 65 x 8mm GS flat |
| c) | 415 V MCC/ Distribution boards / Transformers | --- | 50 x 6mm GS flat |
| d) | LT Motors above 125 KW | --- | 50 x 6mm GS flat |
| | 25 KW to 125 KW | --- | 25 x 6mm GS flat |
| | 1KW to 25 KW | --- | 25 x 3mm GS flat |
| | Fractional House power motor | --- | 8 SWG GS wire |
| e) | Control panel & control desk | --- | 25 x 3 mm GS flat |
| f) | Push button station / Junction Box | --- | 8 SWG GI wire |
| g) | Columns, structures, cable trays and bus ducts enclosures | --- | 50 x 6mm GS flat |
| h) | Crane, rails, rail tracks & other non-current carrying metal parts | | 25 x 6mm GS flat |

5.05.00 Metallic frame of all electrical equipment shall be earthed by two separate and distinct connections to earthing system, each of 100% capacity, Crane rails, tracks, metal pipes and conduits shall also be effectively earthed at two points. Steel RCC columns, metallic stairs, and rails etc. of the building housing electrical equipment shall be connected to the nearby

earthing grid conductor by one earthing ensured by bonding the different sections of hand rails and metallic stairs. Metallic sheaths/screens, and armour of multi-core cables shall be earthed at both ends. Metallic Sheaths and armour of single core cables shall be earthed at switchgear end only unless otherwise approved. Every alternate post of the switchyard fence shall be connected to earthing grid by one GS flat and gates by flexible lead to the earthed post. Railway tracks within the plant area shall be bonded across fish plates and connected to earthing grid at several locations. Portable tools, appliances and welding equipment shall be earthed by flexible insulated cable.

5.06.00 Each continuous laid lengths of cable tray shall be earthed at minimum two places by G.S. flats to earthing system, the distance between earthing points shall not exceed 30 meter. Wherever earth mat is not available, necessary connections shall be done by driving an earth electrode in the ground

5.07.00 Neutral points of HT transformer shall be earthed through NG resistors. The Contractor shall connect the NGR earthing point to earth electrodes by suitable earth conductors.

5.08.00 Neutral connections and metallic conduits/pipes shall not be used for the equipment earthing. Lightning protection system down conductors shall not be connected to other earthing conductors above the ground level.

5.09.00 Connections between earth leads and equipment shall normally be of bolted type. Contact surfaces shall be thoroughly cleaned before connections. Equipment bolted connections after being tested and checked shall be painted with anti corrosive paint/compound.

5.10.00 Suitable earth risers as approved shall be provided above finished floor/ground level, if the equipment is not available at the time of laying of main earth conductor.

5.11.00 Connections between equipment earthing leads and between main earthing conductors shall be of welded type. For rust protection the welds should be treated with red lead compound and afterwards thickly coated with bitumen compound. All welded connections shall be made by electric arc welding.

5.12.00 Resistance of the joint shall not be more than the resistance of the equivalent length of conductors.

5.13.00 Earthing conductors buried in ground shall be laid minimum 600 mm below grade level unless otherwise indicated in the drawing. Back filling material to be placed over buried conductors shall be free from stones and harmful mixtures. Back filling shall be placed in layers of 150 mm.

5.14.00 Earthing conductors embedded in the concrete floor of the building shall have approximately 50 mm concrete cover.

5.15.00 A minimum earth coverage of 300 mm shall be provided between earth conductor and the bottom of trench/foundation/underground pipes at crossings. Earthing conductors crossings the road can be installed in pipes. Wherever earthing conductor crosses or runs at less than 300 mm distance along metallic structures such as gas, water, steam pipe lines, steel reinforcement in concrete, it shall be bonded to the same.

5.16.00 Earthing conductors along their run on columns, walls, etc. shall be supported by suitable welding / cleating at interval of 1000mm and 750mm respectively.

5.17.00 Earth pit shall be of treated type & shall be constructed as per IS:3043. Electrodes shall be embedded below permanent moisture level. Minimum spacing between electrodes shall be 600mm. Earth pits shall be treated with salt and charcoal as per IS:3043. Test links shall be

provided with bolted arrangement alongwith each earth pit, in order to facilitate measurement of earth resistance as & when required.

5.18.00 On completion of installation continuity of earth conductors and efficiency of all bonds and joints shall be checked. Earth resistance at earth terminations shall be measured and recorded. All equipment required for testing shall be furnished by contractor.

5.19.00 Earthing conductor shall be buried at least 2000mm outside the fence of electrical installations. Every alternate post of the fences and all gates shall be connected to earthing grid by one lead.

5.20.00 Other Requirements of Earthing System:

| | |
|---|---|
| Standard/Code | IEEE 80, IS 3043 |
| Earthing System | |
| Life expectancy | 40 Years |
| System Fault Level | As per system requirement (B0) |
| Soil resistivity | Actual as per site conditions. |
| Min. Steel corrosion | 0.12mm/year |
| Depth of burial of main earth conductor | 600mm below grade level; where it crosses trenches, pipes, ducts, tunnels, rail tracks, etc., it shall be at least 300mm below them. |
| Conductor joints | By electric arc welding, with resistance of joint not more than that of the conductor. |

Welds to be treated with red lead for rust protection and then coated with bitumen compound for corrosion protection.

| | | |
|---|---|---|
| Surface resistivity | - Gravel | 3000 ohm-meter |
| | - Concrete | 500 ohm-meter |

**6.00.00 LIGHTNING PROTECTION SYSTEM**

6.01.01 Lightning protection system shall be in strict accordance with IEC:62305 .

6.01.02 Lightning conductor shall be of 25x6mm GS strip when used above ground level and shall be connected through test link with earth electrode/earthing system

6.01.03 Lightning system shall comprise of air terminations, down conductors, test links, earth electrode etc. as per approved drawings.

6.02.00 **Down Conductors**

1. Down conductors shall be as short and straight as practicable and shall follow a direct path to earth electrode.

2. Each down conductor shall be provided with a test link at 1000 mm above ground level for testing but it shall be in accessible to interference. No connections other than the one direct to an earth electrode shall be made below a test point.

3. All joints in the down conductors shall be welded type.

4. Down conductors shall be cleated on outer side of building wall, at 750 mm interval or welded to outside building columns at 1000 mm interval.

5. Lightning conductor on roof shall not be directly cleated on surface of roof. Supporting blocks of PCC/insulating compound shall be used for conductor fixing at an interval of 1500 mm.

6. All metallic structures within a vicinity of two meters of the conductors shall be bonded to conductors of lightning protection system.

7. Lightning conductors shall not pass through or run inside GI Conduits.

8. Testing link shall be made of galvanized steel of size 25x 6mm.

9. Pulser system for lightning shall not be accepted.

10. Hazardous areas handling inflammable/explosive materials and associated storage areas shall be protected by a system of aerial earths.

**7.00.00 TESTS**

7.01.01 All equipment to be supplied shall be of type tested design. During detail engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

7.01.02 However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/owners representative and submit the reports for approval.

7.01.03 All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

7.01.04 The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any shall be highlighted on the endorsement sheet.

7.02.00 **Type Test reports shall be furnished for the following**

7.02.01 Type tests on Cable Trays support system

a) **Test 1A:**

On main support channel type-C2 for cantilever arms fixed on one side only. A 3.5 meter length of main support channel shall be fixed vertically at each end to a rigid structure as per the fixing arrangement as shown in the enclosed drawing. Eight (8) nos. 750 mm cantilever arms shall be fixed to the main channel and each arm shall be loaded over the outboard 600 mm with a uniform working load of 100 kg. Subsequently a point load of 100 kg shall be applied on arm 2. A uniform proof load on all the arms equal to twice the working load shall be then be applied. Deflections shall be measured at the points shown in the enclosed drawings and at the following load intervals:

i) Working load

ii) Working load + point load

iii) Off load

iv) Proof load + point load

v) Off load

The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied.

B) **Test 1B:**

Test 1A shall be repeated with Eight Cantilever arms uniformly loaded and with the same point load on arm 2

**Test 2: On Main support channel type -C2 for cantilever arms fixed on both sides**

**a) Test 2A:** A 3.5 m length of main support channel C2 for cantilever arms fixing on both sides shall be fixed at each end to rigid structure as per the fixing arrangement as shown in the enclosed drawing. Six (6), 750 mm cantilever arms shall be attached to each sides and each arm uniformly loaded to a working load of 100 kg over the out board 600 mm. A point load of 100 kg shall than be applied to arm 2, followed by a uniform proof load of twice the working load on all the arms; deflection shall be measured at points shown in the enclosed drawings at the following load intervals.

i) Working load

ii) Working load + Point load

iii) Off load

iv) Proof load + Point load

v) Off load

The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied

**b) Test 2 B:** The test 2 A shall be repeated with the assembly but with an asymmetrical load on the C2 column and point load applied to arm 8. The 100 kg and 200 kg uniformly distributed loads shall be applied to the upper three arms on one side and the lower three arms on the opposite side.

**Test 3 : Tests on Channel Fixed on Beam/Floor**

A length of main support channel section shall be fixed to steel structure/floor and have loads applied as shown in the drawing enclosed and as detailed below

a) **Test 3A :** A length of steel structure shall be rigidly supported. It should be fitted on a meter length of channel section using beam clamps welded/bolted. A point load of 1200 kg shall be applied to the centre point via two brackets. No distortion or pulling of the components shall take place.

b) **Test 3B:** With the components assembled as in Test 3A, two perpendicular point loads of 600 kg shall be simultaneously applied at positions 150 mm either side of the centre line, no distortion or pulling of the components shall take place.

c) **Test 3C:** With the components assembled as in Test 3A, a perpendicular point load shall be applied at a point 150 mm on one side of the centre line.

The load shall be gradually increased to the maximum value that can be applied without causing distortion or pulling of the components. This value shall be recorded.

**Test 4 : Channel Insert Test**

A 2.5 m length of C1 channel fixed to the concrete wall/ steel structure as per actual site installation conditions. 6 nos. of 750 mm cantilever arms shall be attached to C1 channel as shown in enclosed drawing. Each arm uniformly loaded to a working load of 100 kg over the out board 600 mm. A point load of 100 kg shall than be applied to arm 2, followed by a uniform proof load of twice the working load on all the arms; deflection shall be measured at points shown in the enclosed drawings at the following load intervals.

i) **Working Load**

ii) **Working Load + Point Load**

iii) **Off Load**

iv) **Proof Load + Point Load**

v) **Off load**

The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied

**Test 5 : Channel nut slip characteristics (what ever applicable)**

**Tests 5A1,5A2,5A3 :** A length of channel C1 section 200mm long shall have fitted bracket with the two bolt fixing as shown in drawing enclosed.
With loads applied at the position shown in drawing enclosed nut slip shall be determined with bolt torque of 30NM, 50 NM and 65 NM No fewer than three measurements shall be made for each torque setting.

A minimum loading of 720 kg shall be obtained before nut slip with bolt torque of 65 NM.

**Tests 5B1,5B2,5B3:** The length of channel C1 section 200 mm long shall have fitted bracket with the one bolt fixing as shown in drawing enclosed. With loads applied at the position shown in drawing, nut slip shall be determined with bolt torques of 30 NM, 50 NM and 65 NM. No fewer than three measurements shall be made for each torque setting.

A minimum loading of 350 kg shall be obtained before nut slip with a bolt torque of 65 NM.

**Test 6 Weld Integrity Test**

After deflection test as per test 1A, 1B, 2, 3 & 4 weld integrity shall be checked by magnetic particle inspection to detect sub-surface cracks developed, if any.

7.02.02 Cable termination kit and straight through joints should have been tested as per IS:13573 for 3.3kV grade & above.

7.03.00 **Routine/ Acceptance Tests**

7.03.01 **Routine Tests**

a) Routine tests as per specification and applicable standards shall be carried out on all requirements/items covered in the specification.

b) Physical & dimensional check on all equipments as per approved drawings/standards

.

c) HV/IR as applicable.

d) Check/measurement of thickness of paint/zinc coating/nickel-chrome plating as per specification & applicable standard.

7.03.02 **Acceptance Test**

a) Galvanising Tests as per applicable standards

b) Welding checks

c) Deflection tests on cable trays:

d) One piece each of 2.5m length of cable tray of 300mm & above shall be taken as sample from each offered lot. It shall be supported at both end & loaded with uniform load of 76 kg/meter along the length of cable tray. The maximum deflection at the mid-span of each size shall not exceed 7mm.

d) Proof load tests on cable tray support system

i) Tests on Main Support Channel shall be done if only C1 Channel are in scope of supply and cantilever arms shall be fitted on one side. This test shall be same as test 4 of type test.

ii) Test on Main Support Channel shall be done with C2 channel and cantilever arms fitted on both sides, if C2 channels are in scope of supply. This test shall be same as test 2A of type test. Then test (i) above shall not be done.

iii) Nut slip characteristic test (it shall support minimum load of 350kg before nut slips with a bolt torque of 65 NM). This test shall be same as test 5B3 of type test.
The procedure for carrying out tests at "d" above shall be as per details given in Type Tests in specification thereafter Die-Penetration test shall be carried out to check weld integrity.

d) The above acceptance tests shall be done only on one sample from each offered lot.

**8.00.00** **COMMISSIONING**

8.01.01 The Contractor shall carry out the following commissioning tests and checks after installation at site. In addition the Contractor shall carry out all other checks and tests as recommended by the Manufacturers or else required for satisfactory performance..

8.01.02 **Cables**

a) Check for physical damage

b) Check for insulation resistance before and after termination/jointing.

c) HT cables shall be pressure tested (test voltage as per IS:7098) before commissioning.

d) Check of continuity of all cores of the cables.

e) Check for correctness of all connections as per relevant wiring diagrams. Any minor modification to the panel wiring like removing/inserting, shorting, change in terminal connections, etc., shall be carried out by the Contractor.

f) Check for correct polarity and phasing of cable connections.

g) Check for proper earth connections for cable glands, cable boxes, cable armour, screens, etc.

h) Check for provision of correct cable tags, core ferrules, tightness of connections.

8.02.00 **Cable trays / supports and accessories**

1) Check for proper galvanizing/painting and identification number of the cable trays/supports and accessories.

2) Check for continuity of cable trays over the entire route.

3) Check that all sharp corners, burrs, and waste materials have been removed from the trays supports.

4) Check for earth continuity and earth connection of cable trays.

8.03.00 **Earthing and Lightning protection system**

1) Earth continuity checks.

2) Earth resistance of the complete system as well as sub-system.

8.04.00 Below Ground Earth Mat:

The earthing system for plant shall be designed as per Clause No:- 3.07.00 of Sub Section B-0 of Technical Specification Section-VI, Part-B

Grounding for TG and other areas or buildings covered in the specification shall be provided in accordance with IS 3043, IEC 62305, IEEE 80.

Earthing system network/earthmat shall be interconnected mesh of mild steel rods buried in ground in the plant. All areas under contractor scope of supply shall be interconnected

together by minimum two parallel conductors. The Contractor shall furnish the detailed design and calculations for Employer's approval. Contractor shall obtain all necessary statutory approvals for the system. All the columns shall be earthed by nearby risers and earthmat grid spacing shall be maximum 10 X 10 mts.. Minimum two nos of risers shall be provided for each equipment in his scope of area. Separate dedicated riser shall be provided for C&I earthing purpose and also for Lightning down conductor connection purpose. Sufficient nos of risers near the equipment shall be provided as per the system requirement.

**9.00.00** **ELECTRICAL LAYOUT PHILOSOPHY**:

While developing the layout the bidder must give due consideration to the following requirements:

a) Adequate distance shall be maintained between the transformers. As basic guidelines following norms will be adhered to:

1) Transformers shall be separated from the adjacent building/structures and from each other by a minimum distance as defined below or by a fire wall of two hours of fire resisting of height at least 600 mm above bushing / pressure relief vent whichever is higher.

| Oil capacity of individual transformer (in liters) | Clear separating distance (in meters) |
|---|---|
| 5,000 to 10,000 | 8.0 |
| 10,001 to 20,000 | 10.0 |
| 20,001 to 30,000 | 12.5 |
| Over 30,001 | 15.0 |

2) In case of auxiliary transformers having an aggregate oil capacity in excess of 2300 liters but individual oil capacity of less than 5000 liters, the maximum separating distance between transformers and surrounding building shall be at least 6M unless they are separated by fire separating walls or are protected by high velocity spray system.

3.) Rail track shall be provided in Transformer yard for movement of each transformer. The rail track in Transformer yard shall be connected with TG area rail track The Foundation top of transformer & rail top shall be at EL +/- 0.0M. Bus duct support or Transformer body shall be at least 8.0M from A-Row of TG building to clear the movement of GT/ Stator/UT/ST/UAT on rail line. Jacking pads shall be provided where the rail track changes the direction. Mooring post shall be provided on rail track for handling the transformers.

4) For each transformer a pit shall be provided all around at a distance of 1.5 m (minimum) from transformer outer edge. A sump pit shall be provided for each pit. A common oil retention pit per unit shall be provided to hold oil quantity of the largest transformer (by volume) & 10 minutes of water quantity of HVW spray system for the largest transformer. Sump pit of individual transformer shall be connected to common oil retention pit of that unit.

5) Rail track shall be provided for all outdoor transformers up to road for movement of each transformer of size more than or equal to 7.5MVA Transformer. Jacking pads shall be provided where the rail track changes the direction. Jacking pad shall also be provided at the location of installation of transformer and mooring post shall be provided on rail track for handling the transformers.

6.) The Transformer fencing shall be at 1.0 M (minimum) distance from the pit wall. The Height of fencing shall be 2.5 M (minimum) and fencing shall have personal entry gate and removable type fencing/gate for transformer withdrawal.

7) The transformer firewall, pit sizing and clearances from adjacent building/structures etc. shall be as per IS 1646/CBIP manual on Transformer

8) However, for all outdoor transformers of oil capacity less than 2000 litre, a trench of suitable size shall be provided all around at a distance of 1.0 m (minimum) from transformer outer edge. A sump pit shall be provided for each trench.

b) Layout requirements for Electrical MCC/switchgear rooms

**1.** Separate Switchgear Rooms shall be provided for each unit. For TG building, all HT boards shall be provided in HT switchgear room at only one floor and all LT boards shall be provided in LT switchgear room only.

***2. The following clearances shall be maintained for HT Switchboard.***

***a.) Front Clearance***

i) For one Row of Swgr. - 2.0 M (Min)

ii) For two Rows of Swgr. - 2.5 M (Min)

***b.) Back Clearance - 1.5 M (Min.)***

***c.) Side Clearance***

Min. 800 mm, however provision to be made for any additional panel in future at both ends. Therefore end clearance shall be 800+width of panel (including spare panels/dummy panels etc.)

***3. The following clearances shall be maintained for LT Switchboard.***

a.) Front Clearance

i) For one Row of Swgr - 1.5M (Min)
ii) For two Rows of Swgr - 1.5/1.75M depending upon the depth of panels etc

b.) Back Clearance
i) For single front - 1.0M (Min)
ii) For double front - 1.5M (Min)

c.) Side Clearance

Min. 800 mm, however provision to be made for any additional panel in future at both ends. Therefore end clearance shall be 800 mm + width of panel.

For offsite areas, HT Switchboard clearances shall be followed wherever both LT & HT switch boards are in the same MCC room.

4. Height of HT/LT Switchgear Room and Boiler MCC room

i) With Bus Duct – 4.5 m (min)
ii) Without Bus Duct – 4.0 m (min)

Further no vertical bracings shall be envisaged in HT/LT switchgear room and associated cable vault area.

5. Cable trench/Cable vault

For LT switchgear/MCC room at EL 0.0M, minimum 1400 wide x 1400 deep cable trench shall be provided to route the cables. Horizontal cable trays shall be routed in cable trenches.

c) Minimum clear working space 1200mm around the equipment

e) In buildings having MCC, minimum 2 fire door along with one rolling shutter of adequate size/capacity shall be provided.

f) The cable entry and exit from switchgear room shall be from 1.5 mtr (minimum) above FGL.

| | MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS | STANDARD QUALITY PLAN | | SPEC. NO : | DATE: |
|---|---|---|---|---|---|
| | | CUSTOMER : | | QP NO.: PE-QP-999-Q-006, REV-02 | DATE: 17.04.2020 |
| | | PROJECT: | | PO NO.: | DATE: |
| | | ITEM: AC ELECT. MOTORS UPTO 55KW (LV (415V)) | SYSTEM: | SECTION: II | SHEET 1 of 2 |

| S. NO. | COMPONENT & OPERATIONS | CHARACTERISTICS | CLASS | TYPE OF CHECK | QUANTUM OF CHECK | | REFERENCE DOCUMENT | ACCEPTANCE NORMS | FORMAT OF RECORD | AGENCY | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | | 7 | 8 | 9 | * | ** | | | |
| | | | | | M | C/ N | | | | D | M | C | N | |
| 1.0 | ASSEMBLY | 1.WORKMANSHIP | MA | VISUAL | 100% | - | MFG. SPEC. | MFG. SPEC. | LOG BOOK | | P | - | - | |
| | | 2.DIMENSIONS | MA | VISUAL | 100% | - | MFG. DRG./ MFG. SPEC. | MFG. DRG./ MFG. SPEC. | LOG BOOK | | P | - | - | |
| | | 3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE | MA | VISUAL | 100% | - | MFG.SPEC./ | MFG.SPEC. | LOG BOOK | | P | - | - | |
| | | | | | | | | | | | | | | |
| 2.0 | PAINTING | 1.SHADE | MA | VISUAL | SAMPLE | - | MFG. SPEC/ APPROVED DATASHEET | MFG. SPEC/ APPROVED DATASHEET | LOG BOOK | ✓ | P | V | - | |
| | | | | | | | | | | | | | | |
| 3.0 | TESTS | 1.ROUTINE TEST INCLUDING SPECIAL TEST | MA | VISUAL | 100% | - | IS-325 / IS-12615/ APPROVED DATA SHEET | IS-325 / IS-12615/ APPROVED DATA SHEET | TEST/ INSPN. REPORT | ✓ | P | V * | - | * NOTE -1 |
| | | 2.OVERALL DIMENSIONS & ORIENTATION | MA | MEASUREMENT & VISUAL | 100% | - | APPROVED DRG/ DATA SHEET | APPROVED DRG/ DATA SHEET | TEST/ INSPN. REPORT | ✓ | P | V * | - | * NOTE -1 & NOTE-2 |

| BHEL | | | | | |
|---|---|---|---|---|---|
| ENGINEERING | | | QUALITY | | |
| | Sign & Date | Name | | Sign & Date | Name |
| Prepared by: | | HEMA KHUSHWAHA | Checked by: | | KUNAL GANDHI |
| Reviewed by: | | PRAVEEN DUTTA | Reviewed by: | | RITESH KUMAR JAISWAL |

| BIDDER/ SUPPLIER | |
|---|---|
| Sign & Date | |
| Seal | |

| FOR CUSTOMER REVIEW & APPROVAL | | | |
|---|---|---|---|
| Doc No: | | | |
| | Sign & Date | Name | Seal |
| Reviewed by: | | | |
| Approved by: | | | |

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| | | 3.NAMEPLATE DETAILS | MA | VISUAL | 100% | - | IS-325 / IS-12615 / APPROVED DATA SHEET | SAME AS COL. 7 | TEST/ INSPN. REPORT | ✓ | P | V | - | |
| | | | | | | | | | | | | | | |
| 4.0 | PACKING | SURFACE FINISH & COMPLETENESS | MA | VISUAL | 100% | 100% | AS PER MFG. STANDARD / (#) | AS PER MFG. STANDARD / (#). | INSPC. REPORT | ✓ | P | W | - | (#) REFER NOTE-8 |
| | | | | | | | | | | | | | | |

NOTES:
1. Routine tests on 100% motors shall be done by the vendor. However, BHEL/ Customer shall witness routine tests on random samples. The sampling plan shall be mutually agreed upon.
2. For exhaust/ventilation fan motors of rating up to 1.5 KW, only routine test certificates shall be furnished for scrutiny.
3. In case test certificates for these tests on similar type, size and design of motor from independent laboratory are available, the same is valid for 5 years.
4. BHEL reserves the right to perform repeat test, if required.
5. After packing and prior to issue MDCC, photographs of items to be despatched shall be sent to BHEL for review.
6. In case of any changes in QP commented by customer at contract stage, same shall be carried out by bidder without any implication to BHEL/ Customer.
7. Project specific QP to be developed based on customer requirement.
8. For export job, BHEL technical specification for seaworthy packing to be followed.
9. Packing shall be suitable for storage at site in tropical climate conditions.
10. Latest revision/ year of issue of all the standards (IS/ ASME/ IEC etc.) indicated in QP shall be referred.

**LEGENDS:**
*RECORDS, INDENTIFIED WITH "TICK"(√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,
** **M**: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, B: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **C**: CUSTOMER,
**P**: PERFORM, **W**: WITNESS, **V:** VERIFICATION, AS APPROPRIATE
**MA**: MAJOR, **MI**: MINOR**, CR:** CRITICAL
**D:** DOCUMENTATION

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| ENGINEERING | | | QUALITY | | |
| | Sign & Date | Name | | Sign & Date | Name |
| Prepared by: | | HEMA KHUSHWAHA | Checked by: | | KUNAL GANDHI |
| Reviewed by: | | PRAVEEN DUTTA | Reviewed by: | | RITESH KUMAR JAISWAL |

| BIDDER/ SUPPLIER | |
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| बीएचईएल BHEL | MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS | STANDARD QUALITY PLAN | SPEC. NO : | DATE:17.04.2020 |
| | | CUSTOMER : | QP NO.: PE-QP-999-Q-007, REV-04 | |
| | | PROJECT: | PO NO.: | |
| | | ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V)) / SYSTEM: | SECTION: II | SHEET 1 OF 9 |

| Sl No. | Component & Operations | Characteristics | Class | Type of Check | Quantum Of check | | Reference Document | Acceptance NORMS | FORMAT OF RECORD | | AGENCY | | | |
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| | | | | | M | C/N | | | | D | M | C | N | |
| 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 | | P | - | - | |
| | | 2.DIMENSIONS | MA | MEASUREMENT | SAMPLE | - | MANUFACTURER'S DRG./SPEC | MANUFACTURER'S DRG./SPEC | LOG BOOK | | P | - | - | |
| | | 3.PROOF LOAD TEST (EYE BOLT) | MA | MECH. TEST | SAMPLE | - | MANUFACTURER'S DRG./SPEC | MANUFACTURER'S DRG./SPEC | TEST REPORT | | P/V | - | | |
| 1.2 | HARDWARES | 1.SURFACE CONDITION | MA | VISUAL | 100% | - | | FREE FROM CRACKS, UN-EVENNESS ETC. | TEST REPORT | | P | - | - | |
| | | 2.PROPERTY CLASS | MA | VISUAL | SAMPLES | - | MANUFACTURER'S DRG./SPEC | MANUFACTURER'S DRG./SPEC | TC | | P/V | - | - | PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR |
| 1.3 | CASTING | 1.SURFACE CONDITION | MA | VISUAL | 100% | - | MANUFACTURER'S DRG./SPEC | FREE FROM CRACKS, BLOW HOLES ETC. | LOG BOOK | | P/V | - | | |
| | | 2.CHEM. & PHY. PROP. | MA | CHEM & MECH TEST | 1/HEAT NO. | - | MANUFACTURER'S DRG./SPEC | MANUFACTURER'S DRG./SPEC | TC | | P/V | - | | HEAT NO. SHALL BE VERIFIED |
| | | 3.DIMENSIONS | MA | MEASUREMENT | 100% | - | MANUFACTURER'S DRG. | MANUFACTURER'S DRG. | LOG BOOK | | P/V | - | | |
| 1.4 | PAINT & VARNISH | 1.MAKE, SHADE, SHELF LIFE & TYPE | MA | VISUAL | 100% CONTINUOUS | - | MANUFACTURER'S DRG./SPEC | MANUFACTURER'S DRG./SPEC | LOG BOOK | | P/V | - | | |

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| Reviewed by: | | PRAVEEN DUTTA | Reviewed by: | | R K JAISWAL |

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| | | CUSTOMER : | QP NO.: PE-QP-999-Q-007, REV-04 | |
| | | PROJECT: | PO NO.: | |
| | | ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V)) / SYSTEM: | SECTION: II | SHEET 2 OF 9 |

| Sl No. | Component & Operations | Characteristics | Class | Type of Check | Quantum Of check | | Reference Document | Acceptance NORMS | FORMAT OF RECORD | | AGENCY | | | |
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| | | | | | M | C/N | | | | D | M | C | N | |
| 1.5 | SHAFT (FORGED OR ROLLED) | 1. SURFACE COND. | MA | VISUAL | 100% | - | - | FREE FROM VISUAL DEFECTS | LOG BOOK | | P | - | - | VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED |
| | | 2. CHEM. & PHYSICAL PROPERTIES | MA | CHEM. & PHYSICAL TESTS | 1/HEAT NO. OR HEAT TREATMENT BATCH NO | - | MANUFACTURER'S DRG./ SPEC. | MANUFACTURER'S DRG./ STD. | TC | | P/V | - | | |
| | | 3. DIMENSIONS | MA | MEASUREMENT | 100% | - | MANUFACTURER'S DRG./ SPEC. | MANUFACTURER'S DRG. | LOG BOOK | | P/V | - | | |
| | | 4.INTERNAL FLAWS | CR | ULTRASONIC TEST | 100% | - | ASTM-A388 | MANUFACTURER'S STD. | INSPECTION REPORT | ✔ | P/W | V | - | 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 | 100% | - | MANUFACTURER'S DRG./STD. | MANUFACTURER'S DRG./STD. | INSPECTION REPORT | | P/V | - | - | |
| | | 2. PHYSICAL COND. | MA | VISUAL | 100% | - | MANUFACTURER'S DRG./STD. | NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY | INSPECTION REPORT | | P/V | - | - | |
| | | 3.DIMENSIONS (WHEREVER APPLICABLE) | MA | MEASUREMENT | SAMPLE | - | MANUFACTURER'S DRG./ STD | MANUFACTURER'S DRG. / STD. | INSPECTION REPORT | | P/V | - | - | |
| | | 4.PERFORMANCE/ CALIBRATION | MA | TEST | 100% | - | MANUFACTURER'S DRG./ STD | MANUFACTURER'S DRG. / STD. | TEST REPORT | | P/V | - | - | |

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| 1.7 | OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC. | 1. SURFACE COND. ETC. | MA | VISUAL | 100% | - | - | NO VISUAL DEFECTS | TEST REPORT | | P/V | - | - | |
| | | 2.DIMENSION(BORE DIA, WALL THICKNESS, BDV AS RECEIVED, BDV AFTER FOLDING AT 180º | MA | TEST | SAMPLE | - | MANUFACTURER'S STD. | MANUFACTURER'S STD. | LOG BOOK AND OR SUPPLIER'S TC | | P/V | - | - | |
| 1.8 | SHEET STAMPING (PUNCHED) | 1. SURFACE COND. | MA | VISUAL | 100% | - | - | NO VISUAL DEFECTS (FREE FROM BURS) | LOG BOOK | | P | - | - | |
| | | 2.DIMENSIONS INCLUDING BURS HEIGHT | MA | MEASUREMENT | SAMPLE | - | MANUFACTURER'S DRG. . | MANUFACTURER'S DRG. | LOG BOOK | | P/V | - | - | |
| | | 3. ACCEPTANCE TESTS | MA | ELECT. & MECH TESTS | SAMPLE | - | MANUFACTURER'S DRG./ STD. | MANUFACTURER'S DRG./ STD. | TC | | P/V | - | - | |
| 1.9 | CONDUCTORS | 1. SURFACE FINISH | MA | VISUAL | 100% | - | - | FREE FROM VISUAL DEFECTS | LOG BOOK | | *P/V | - | - | * MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY |
| | | 2.ELECT. PROP, & MECH. PROP | MA | ELECT. & MECH.TEST | SAMPLES | - | MANUFACTURER'S DRG./ SPEC. | MANUFACTURER'S / SPEC. | TC & VENDOR'S TEST REPORTS | | P/V | - | - | |

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| Reviewed by: | | PRAVEEN DUTTA | Reviewed by: | | R K JAISWAL |

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| MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS | STANDARD QUALITY PLAN | | SPEC. NO : | DATE:17.04.2020 |
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| | ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V)) | SYSTEM: | SECTION: II | SHEET 4 OF 9 |

| Sl No. | Component & Operations | Characteristics | Class | Type of Check | Quantum Of check | | Reference Document | Acceptance NORMS | FORMAT OF RECORD | | AGENCY | | | |
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| | | 3.DIMENSIONS | MA | MEASUREMENT | SAMPLES | - | MANUFACTURER'S DRG./ SPEC. | MANUFACTURER'S / SPEC. | LOG BOOK<br>LOG BOOK | | P/V | - | - | |
| 1.10 | BEARINGS | 1.MAKE & TYPE | MA | VISUAL | 100% | - | MANUFACTURER'S DRG./ APPROVED DATASHEET | MANUFACTURER'S DRG./ APPROVED DATASHEET | | | P/V | - | - | |
| | | 2.DIMENSIONS | MA | MEASUREMENT | SAMPLE | - | APPROVED DATASHEET | APPROVED DATASHEET/ BEARING MANUF'S CATALOGUES | LOG BOOK | | P/V | - | - | |
| | | 3.SURFACE FINISH | MA | VISUAL | 100% | - | - | FREE FROM VISUAL DEFECTS | LOG BOOK | | P/V | - | - | |
| 1.11 | SLIP RING (WHEREVER APPLICABLE) | 1.SURFACE COND. | MA | VISUAL | 100% | - | - | FREE FROM VISUAL DEFECTS | LOG BOOK | | P | - | - | |
| | | 2.DIMENSIONS | MA | MEASUREMENT | SAMPLE | - | MANUFACTURER'S DRG | MANUFACTURER'S DRG | LOG BOOK | | P | - | - | |
| | | 3.TEMP.WITH-STAND CAPACITY | MA | ELECT.TEST | SAMPLE | - | MANUFACTURER'S STD./ APPROVED DATASHEET | MANUFACTURER'S STD./ APPROVED DATASHEET | LOG BOOK | | P/V | - | - | |
| | | 4.HV/IR | MA | -DO- | 100% | - | MANUFACTURER'S STD./ APPROVED DATASHEET | MANUFACTURER'S STD./ APPROVED DATASHEET | LOG BOOK | | P/V | - | - | |
| 1.12 | OIL SEALS & GASKETS | 1.MATERIAL OF GASKET | MA | VISUAL | 100% | - | MANUFACTURER'S DRG/SPECS | MANUFACTURER'S DRG./ SPECS. | LOG BOOK | | P | - | - | |
| | | 2.SURFACE COND. | MA | VISUAL | 100% | - | - | FREE FROM VISUAL DEFECTS | LOG BOOK | | P | - | - | |
| | | 3.DIMENSIONS | MA | MEASUREMENT | SAMPLE | - | MANUFACTURER'S DRG | MANUFACTURER'S DRG | LOG BOOK | | P | - | - | |

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| Sl No. | Component & Operations | Characteristics | Class | Type of Check | Quantum Of check | | Reference Document | Acceptance NORMS | FORMAT OF RECORD | | AGENCY | | | |
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| 2.0 | IN PROCESS | | | | | | | | | | | | | |
| 2.1 | STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR ) | 1.WORKMANSHIP & CLEANNESS | MA | VISUAL | 100% | - | MANUFACTURER'S DRG | GOOD FINISH | LOG BOOK | | P/W | - | - | |
| | | 2.DIMENSIONS | MA | MEASUREMENT | 100% | - | MANUFACTURER'S DRG | MANUFACTURER'S DRG | LOG BOOK | | P | - | - | |
| 2.2 | MACHINING | 1.FINISH | MA | VISUAL | 100% | - | -DO- | GOOD FINISH | LOG BOOK | | P | - | - | |
| | | 2.DIMENSIONS | MA | MEASUREMENT | 100% | - | MANUFACTURER'S DRG | MANUFACTURER'S DRG | LOG BOOK | | P | - | - | |
| | | 3.SHAFT SURFACE FLOWS | MA | PT | 100% | - | MANUFACTURER'S STD./ ASTM-E165 | MANUFACTURER'S STD./ APPROVED DATASHEET. | LOG BOOK | ✔ | P | V | - | |
| 2.3 | PAINTING | 1.SURFACE PREPARATION | MA | VISUAL | 100% | - | MANUFACTURER'S STD./APPROVED DATASHEET | MANUFACTURER'S STD./APPROVED DATASHEET | LOG BOOK | | P | - | - | |
| | | 2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT) | MA | MEASUREMENT BY ELCOMETER | SAMPLE | - | MANUFACTURER'S STD./APPROVED DATASHEET | MANUFACTURER'S STD./APPROVED DATASHEET | LOG BOOK | | P | - | - | |
| | | 3.SHADE | MA | VISUAL | SAMPLE | - | MANUFACTURER'S STD./APPROVED DATASHEET | MANUFACTURER'S STD./APPROVED DATASHEET | LOG BOOK | | P | - | - | |
| | | 4.ADHESION | MA | CROSS CUTTING & TAPE TEST | SAMPLE | - | MANUFACTURER'S STD./APPROVED DATASHEET | MANUFACTURER'S STD./APPROVED DATASHEET | LOG BOOK | | P | - | - | |

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| SI No. | Component & Operations | Characteristics | Class | Type of Check | Quantum Of check | | Reference Document | Acceptance NORMS | FORMAT OF RECORD | | AGENCY | | | |
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| | | | | | M | C/N | | | | D | M | C | N | |
| 2.4 | SHEET STACKING | 1.COMPLETENESS | MA | MEASUREMENT | SAMPLE | - | MANUFACTURER'S STD. | MANUFACTURER'S STD. | LOG BOOK | | P | - | - | |
| | | 2.COMPRESSION & TIGHTENING | MA | MEASUREMENT | 100% | - | MANUFACTURER'S STD. | MANUFACTURER'S STD. | LOG BOOK | | P | - | - | |
| 2.5 | WINDING | 1.COMPLETENESS | CR | VISUAL | 100% | - | MANUFACTURER'S STD./APPROVED DATASHEET | MANUFACTURER'S STD./APPROVED DATASHEET | LOG BOOK | | P | - | - | |
| | | 2.CLEANLINESS | CR | VISUAL | 100% | - | MANUFACTURER'S STD./APPROVED DATASHEET | MANUFACTURER'S STD./APPROVED DATASHEET | LOG BOOK | | P | - | - | |
| | | 3.IR-HV-IR | CR | ELECT. TEST | 100% | - | IS-325//IS-12615/IEC-60034 PART-1 | IS-325//IS-12615/IEC-60034 PART-1 | TEST/INSPC. REPORT | ✔ | P | V | - | |
| | | 4.RESISTANCE | CR | ELECT. TEST | 100% | - | IS-325//IS-12615/IEC-60034 PART-1 | IS-325//IS-12615/IEC-60034 PART-1 | TEST/INSPC. REPORT | ✔ | P | V | - | |
| | | 5.INTERTURN INSULATION | CR | ELECT. TEST | 100% | - | IS-325//IS-12615/IEC-60034 PART-1 | IS-325//IS-12615/IEC-60034 PART-1 | TEST/INSPC. REPORT | | P | - | - | |
| 2.6 | IMPREGNATION | 1.VISCOSCITY | MA | PHY. TEST | AT STARTING | - | MANUFACTURER'S STANDARD | MANUFACTURER'S STANDARD | LOG BOOK | | P | - | - | |
| | | 2.TEMP. PRESSURE VACCUM | MA | PROCESS CHECK | CONTINUOUS | - | MANUFACTURER'S STANDARD | MANUFACTURER'S STANDARD | LOG BOOK | | P | - | - | |
| | | 3.NO. OF DIPS | MA | PROCESS CHECK | CONTINUOUS | - | MANUFACTURER'S STANDARD | MANUFACTURER'S STANDARD | LOG BOOK | ✔ | P | V | - | THREE DIPS TO BE GIVEN |

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| 1 | 2 | 3 | 4 | 5 | 6 | | 7 | 8 | 9 | * | ** | | | |
| | | | | | M | C/N | | | | D | M | C | N | |
| | | 4.DURATION | MA | PROCESS CHECK | CONTINUOUS | - | MANUFACTURER'S STANDARD | MANUFACTURER'S STANDARD | LOG BOOK | ✔ | P | V | - | |
| 2.7 | COMPLETE STATOR ASSEMBLY | 1.COMPACTNESS & CLEANLINESS | MA | VISUAL | 100% | - | MANUFACTURER'S STANDARD | MANUFACTURER'S STANDARD | LOG BOOK | | P | - | - | |
| 2.8 | BRAZING/COMPRESSION JOINT | 1.COMPLETENESS | CR | VISUAL | 100% | - | MANUFACTURER'S STANDARD | MANUFACTURER'S STANDARD | LOG BOOK | | P | - | - | |
| | | 2.SOUNDNESS | CR | MALLET TEST & UT | 100% | - | MANUFACTURER'S STANDARD | MANUFACTURER'S STANDARD | TEST/INSPC. REPORT | ✔ | P | V | - | |
| | | 3.HV | MA | ELECT. TEST | 100% | - | MANUFACTURER'S STANDARD | MANUFACTURER'S STANDARD | TEST/INSPC. REPORT | ✔ | P | V | - | |
| 2.9 | COMPLETE ROTOR ASSEMBLY | 1.RESIDUAL UNBALANCE | CR | DYN. BALANCE | 100% | - | MANUFACTURER'S SPEC./ ISO 1940 | MANUFACTURER'S DWG. | LOG BOOK | | P | - | - | |
| | | 2.SOUNDNESS OF DIE CASTING | CR | ELECT. (GROWLER TEST) | 100% | - | MANUFACTURER'S SPEC. | MANUFACTURER'S SPEC. | TEST/INSPC. REPORT | ✔ | P | V | - | |
| 2.10 | ASSEMBLY | 1.ALIGNMENT | MA | MEAS. | 100% | - | MANUFACTURER'S SPEC. | MANUFACTURER'S SPEC. | LOG BOOK | | P | - | - | |
| | | 2.WORKMANSHIP | MA | VISUAL | 100% | - | MANUFACTURER'S SPEC. | MANUFACTURER'S SPEC. | LOG BOOK | | P | - | - | |
| | | 3.AXIAL PLAY | MA | MEAS. | 100% | - | MANUFACTURER'S SPEC. | MANUFACTURER'S SPEC. | LOG BOOK | ✔ | P | V | - | |
| | | 4.DIMENSIONS | MA | MEAS. | 100% | - | MANUFACTURER'S DRG./ MANUFACTURER'S SPEC. | MANUFACTURER'S DRG./ MANUFACTURER'S SPEC. | LOG BOOK | | P | - | - | |
| | | 5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE | MA | VISUAL | 100% | - | MANUFACTURER'S SPEC. | MANUFACTURER'S SPEC. | LOG BOOK | | P | - | - | |
| | | 6. RTD, BTD & SPACE HEATER MOUNTING. | MA | VISUAL | 100% | - | MANUFACTURER'S SPEC. | MANUFACTURER'S SPEC. | LOG BOOK | ✔ | P | V | - | |

| BHEL | | | | | |
|---|---|---|---|---|---|
| ENGINEERING | | | QUALITY | | |
| | Sign & Date | Name | | Sign & Date | Name |
| Prepared by: | | HEMA KHUSHWAHA | Checked by: | | KUNAL GANDHI |
| Reviewed by: | | PRAVEEN DUTTA | Reviewed by: | | R K JAISWAL |

| BIDDER/ SUPPLIER | |
|---|---|
| Sign & Date | |
| Seal | |

| FOR CUSTOMER REVIEW & APPROVAL | | | |
|---|---|---|---|
| Doc No: | | | |
| | Sign & Date | Name | Seal |
| Reviewed by: | | | |
| Approved by: | | | |

| | | | | |
|---|---|---|---|---|
| MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS | STANDARD QUALITY PLAN | | SPEC. NO : | DATE:17.04.2020 |
| | CUSTOMER : | | QP NO.: PE-QP-999-Q-007, REV-04 | |
| | PROJECT: | | PO NO.: | |
| | ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V)) | SYSTEM: | SECTION: II | SHEET 8 OF 9 |

| Sl No. | Component & Operations | Characteristics | Class | Type of Check | Quantum Of check | | Reference Document | Acceptance NORMS | FORMAT OF RECORD | | AGENCY | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | | 7 | 8 | 9 | * | ** | | | |
| | | | | | M | C/N | | | | D | M | C | N | |
| 3.0 | TESTS | 1.TYPE TESTS INCLUDING SPECIAL TESTS | MA | ELECT.TEST | 1/TYPE/SIZE | 1/TYPE/SIZE | IS-325//IS-12615/APPROVED DATASHEET | IS-325/IS-12615/APPROVED DATASHEET | TEST REPORT | ✔ | P | W* | - | * NOTE - 1 |
| | | 2.ROUTINE TESTS INCLUDING SPECIAL TEST | MA | ELECT.TEST | 100% | - | IS-325//IS-12615/APPROVED DATASHEET | IS-325/IS-12615/APPROVED DATASHEET | TEST REPORT | ✔ | P | V$ | - | $ NOTE - 2 |
| | | 3.VIBRATION & NOISE LEVEL | MA | ELECT.TEST | 100% | - | IS: 12075 / IEC 60034-14 & IS-12065 | IS: 12075 / IEC 60034-14 & IS-12065 | TEST REPORT | ✔ | P | V$ | - | $ NOTE - 2 |
| | | 4.OVERALL DIMENSIONS AND ORIENTATION | MA | MEASUREMENT & VISUAL | 100% | 100% | APPROVED DRG/DATA SHEET | APPROVED DRG/DATA SHEET & | TEST/INSPC. REPORT | ✔ | P | W | - | |
| | | 5.DEGREE OF PROTECTION | MA | ELECT. & MECH. TEST | 1/TYPE/ SIZE | - | IEC 60034-5/IS-12615 | APPROVED DATASHEET | TC | ✔ | P | V | - | TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3 |
| | | 6. MEASUREMENT OF RESISTANCE OF RTD & BTD | MA | ELECT. & MECH. TEST | 100% | - | IS-325//IS-12615/IEC-60034 PART-1/IS: 12802 | IS-325/IS-12615/IEC-60034 PART-1/IS: 12802 | TC | ✔ | P | V$ | - | $ NOTE - 2 |
| | | 7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER | MA | ELECT. & MECH. TEST | 100% | - | IS-325//IS-12615/IEC-60034 PART-1 | IS-325/IS-12615/IEC-60034 PART-1 | TC | ✔ | P | V$ | - | $ NOTE - 2 |
| | | 8. NAME PLATE DETAILS | MA | VISUAL | 100% | - | IS-325//IS-12615& DATA SHEET | IS-325//IS-12615 & DATA SHEET | TEST/INSPC. REPORT | ✔ | P | V$ | - | $ NOTE - 2 |
| | | 9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED) | MA | EXPLOSION FLAME PROOF TEST | 1/TYPE | - | IS 2148 / IEC 60079-1 | IS 2148 / IEC 60079-1 | TC | ✔ | P | V | - | TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3 |
| | | 10. PAINT SHADE, THICKNESS & FINISH | MA | VISUAL & MEASUREMENT BY ELKOMETER | SAMPLE | SAMPLE | APPROVED DATASHEET | APPROVED DATASHEET | TC | ✔ | P | W$ | - | SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY $ NOTE - 2 |

| BHEL | | | | | |
|---|---|---|---|---|---|
| ENGINEERING | | | QUALITY | | |
| | Sign & Date | Name | | Sign & Date | Name |
| Prepared by: | | HEMA KHUSHWAHA | Checked by: | | KUNAL GANDHI |
| Reviewed by: | | PRAVEEN DUTTA | Reviewed by: | | R K JAISWAL |

| BIDDER/ SUPPLIER | |
|---|---|
| Sign & Date | |
| Seal | |

| FOR CUSTOMER REVIEW & APPROVAL | | | |
|---|---|---|---|
| Doc No: | | | |
| | Sign & Date | Name | Seal |
| Reviewed by: | | | |
| Approved by: | | | |

| | MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS | STANDARD QUALITY PLAN | | SPEC. NO : | DATE:17.04.2020 |
|---|---|---|---|---|---|
| | | CUSTOMER : | | QP NO.: PE-QP-999-Q-007, REV-04 | |
| | | PROJECT: | | PO NO.: | |
| | | ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V)) | SYSTEM: | SECTION: II | SHEET 9 OF 9 |

| Sl No. | Component & Operations | Characteristics | Class | Type of Check | Quantum Of check | | Reference Document | Acceptance NORMS | FORMAT OF RECORD | | AGENCY | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | | 7 | 8 | 9 | * | ** | | | |
| | | | | | M | C/N | | | | D | M | C | N | |
| 4.0 | PACKING | SURFACE FINISH & COMPLETENESS | MA | VISUAL | 100% | 100% | AS PER MANUFACT. STANDARD / (#) | AS PER MANUFACT. STANDARD / (#) | INSPC. REPORT | ✔ | P | W | - | (#): REFER NOTE-8 |

**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/CUSTOMER 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, THE SAME IS VALID FOR 5 YEARS.

4 BHEL RESERVES THE RIGHT TO PERFORM REPEAT TEST, IF REQUIRED.

5 AFTER PACKING AND PRIOR TO ISSUE MDCC, PHOTOGRAPHS OF ITEMS TO BE DESPATCHED SHALL BE SENT TO BHEL PURCHASE GROUP FOR REVIEW.

6 IN CASE , ANY CHANGES IN QP COMMENTED BY CUSTOMER AT CONTRACT STAGE SHALL BE CARRIED OUT BY BIDDER WITHOUT ANY IMPLICATION TO BHEL/ CUSTOMER.

7 PROJECT SPECIFIC QP TO BE DEVELOPED BASED ON CUSTOMER REQUIREMENT.

8 FOR EXPORT JOB, BHEL TECHNICAL SPECIFICATION FOR SEAWORTHY PACKING TO BE FOLLOWED.

9 PACKING SHALL BE SUITABLE FOR STORAGE AT SITE IN TROPICAL CLIMATE CONDITIONS.

10 LATEST REVISION/ YEAR OF ISSUE OF ALL THE STANDARDS (IS/ ASME/ IEC ETC.) INDICATED IN QP SHALL BE REFERRED.

**LEGENDS:**

*RECORDS, INDENTIFIED WITH "TICK"(√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,

** **M**: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, B: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **C**: CUSTOMER,

**P**: PERFORM, **W**: WITNESS, **V:** VERIFICATION, AS APPROPRIATE

**MA**: MAJOR, **MI**: MINOR, **CR:** CRITICAL

**D:** DOCUMENT

| BHEL | | | | | |
|---|---|---|---|---|---|
| ENGINEERING | | | QUALITY | | |
| | Sign & Date | Name | | Sign & Date | Name |
| Prepared by: | | HEMA KHUSHWAHA | Checked by: | | KUNAL GANDHI |
| Reviewed by: | | PRAVEEN DUTTA | Reviewed by: | | R K JAISWAL |

| BIDDER/ SUPPLIER | |
|---|---|
| Sign & Date | |
| Seal | |

| FOR CUSTOMER REVIEW & APPROVAL | | | |
|---|---|---|---|
| Doc No: | | | |
| | Sign & Date | Name | Seal |
| Reviewed by: | | | |
| Approved by: | | | |

| | TITLE | SPECIFICATION NO. |
|---|---|---|
| | **LV MOTORS** | VOLUME |
| | | SECTION |
| | **DATA SHEET-A** | REV NO. 00 DATE |
| | | SHEET 1 OF 1 |

| | | | |
|---|---|---|---|
| 1.0 | Design ambient temperature | : | 50 °C |
| 2.0 | Maximum acceptable kW rating of LV motor | : | Upto 200KW |
| 3.0 | Installation (Indoors/ Outdoors) | : | As required |
| 4.0 | Degree Of Protection | : | IP55 |
| 5.0 | Cooling | : | Refer Clause 5.0.of Motor customer Specification |
| 6.0 | Details of supply system | | |
| | a) Rated voltage (with variation) | : | 415V ± 10% |
| | b) Rated frequency (with variation) | : | 50 Hz (Variation: +3% TO –5%) |
| | c) Combined voltage & freq. variation | : | 10% (sum of absolute values) |
| | d) System fault level at rated voltage | : | 50 kA for 1 sec |
| | e) Short time rating for terminal box | : | 50 kA for 1 sec |
| | f) LV System grounding | : | Solidly |
| 7.0 | Class of insulation | : | Refer clause 7.0 of Motor cust. spec. |
| 8.0 | Minimum voltage for starting (As percentage of rated voltage) | : | **Refer clause 6.0 of Motor cust. spec.** |
| 9.0 | Power cables data | : | Shall be given during Detailed engg. |
| 10.0 | Earth Conductor Size & Material | : | Shall be given during Detailed engg. |
| 11.0 | Space heater supply **(30KW & ABOVE)** | : | 240 V, 1Φ , 50 Hz |
| 12.0 | Rating up to which Single phase motor | : | Acceptable below 0.20 KW |
| 13.0 | Tests | : | As per QP/ As per clause10 of cust. Motor spec. |
| 14.0 | Flame-proof motor | | |
| | a) Enclosure suitable (As per IS:2148) | : | As per requirement |
| | b) Classification of Hazardous area (As per IS: 5572 part-I) | : | As per requirement |
| | c) Degree of protection | : | IP65 |
| 15.0 | Paint shade | : | RAL 5012 (Blue) |
| 16.0 | Efficiency class | : | IE3 |

**Also detailed Customer spec. for Motors is to be referred as enclosed with technical spec.**

| | TITLE | SPECIFICATION NO. |
|---|---|---|
| | LV MOTOR | VOLUME II B |
| | DATA SHEET - C | SECTION D |
| | | REV NO. 00 DATE |
| | | SHEET 1 OF 2 |

| S. No. | Description | | Data to be filled by successful bidder |
|---|---|---|---|
| **A.** | **General** | | |
| 1 | Manufacturer & country of origin | | |
| 2 | Motor type | | |
| 3 | Type of starting | | |
| 4 | Name of the equipment driven by motor & Quantity | | |
| 5 | Maximum Power requirement of driven equipment | | |
| 6 | Rated speed of Driven Equipment | | |
| 7 | Design ambient temperature | | |
| **B.** | **Design and Performance Data** | | |
| 1 | Frame size & type designation | | |
| 2 | Type of duty | | |
| 3 | Rated Voltage | | |
| 4 | Permissible variation for | | |
| 5 | a | Voltage | |
| 6 | b | Frequency | |
| 7 | c) | Combined voltage & frequency | |
| 8 | Rated output at design ambient temp (by resistance method) | | |
| 9 | Synchronous speed & Rated slip | | |
| 10 | Minimum permissible starting voltage | | |
| 11 | Starting time in sec with mechanism coupled | | |
| 12 | a) At rated voltage | | |
| 13 | b) At min starting voltage | | |
| 14 | Locked rotor current as percentage of FLC (including IS tolerance) | | |
| 15 | Torque | | |
| | a) Starting | | |
| | b) Maximum | | |
| 16 | Permissible temp rise at rated output over ambient temp & method | | |
| 17 | Noise level at 1.0 m (dB | | |
| 18 | Amplitude of vibration | | |
| 19 | Efficiency & P.F. at rated voltage & frequency | | |
| | a) At 100% load | | |
| | c) At 75% load | | |

| NAME OF VENDOR | | | | | |
|---|---|---|---|---|---|
| | | | SEAL | REV. | |
| NAME | SIGNATURE | DATE | | | |

| 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 | | | | | |
|---|---|---|---|---|---|
| | | | SEAL | REV. | |
| 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. | VERIFICATION FROM MOTOR DATASHEET (Y/N) | KKS 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 | 20 | 21 |

ANNEXURE-II

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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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)/ CUSTOMER
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 (cc): 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)

| LOAD DATA (ELECTRICAL) | JOB NO. | 408 | ORIGINATING AGENCY | | PEM (ELECTRICAL) | |
|---|---|---|---|---|---|---|
| | PROJECT TITLE | KHURJA STPP (2X660 MW) TG PKG | NAME | | DATA FILLED UP ON | |
| | SYSTEM | VENTILATION SYSTEM | SIGN. | | DATA ENTERED ON | |
| | DEPTT. / SECTION | MAX | SHEET 1 OF 1 | REV. 00 | DE'S SIGN. & DATE | |

**CABLE SCHEDULE FORMAT** **ANNEXURE III**

| UNITCABLENO | FROM | TO | PURPOSE | CABLE SCOPE (BHEL PEM/ VENDOR) | REMARKS | CABLESIZE | PATHCABLENO | TENTATIVE CABLE LENGTH |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
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**Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.**

1. For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.
2. The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT_CAB_SCH_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.
3. The field properties shall be as under:
    a. UNITCABLENO: A/N, up to sixteen (16) characters; each cable shall have its own unique, unduplicated cable number. In case this rule is violated, the cable cannot be taken up for routing.
    b. FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    c. TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    d. PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication/ measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    e. REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
    f. CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
    g. PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.
4. One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).
5. The cables shall be described as per the scheme listed below:

| A | NN | A | NNN |
|---|---|---|---|
| \| | \| | \| | \| |
| Cable Voltage Code (see B below) | No. of cores (e.g. 01,03,3H, 07) | Cable code (See C below) | Cable size (e.g. 035,185,2.5, 0.5) |

(A) SYSTEM VOLTAGE CODES:
(ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V
(dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

(B) CABLE VOLTAGE CODES:
A = 11KV (Power cables)

**Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.**

B = 6.6KV (Power cables)
C = 3.3KV (Power cables)
D = 1.1KV (LV & DC system power & control cables)
E = 0.6KV (0.5 sq. mm. Control cables)

(C) CABLE CODES

PVC Copper

| | |
|---|---|
| A = Armoured FRLS | B = Armoured Non-FRLS |
| C = unarmoured FRLS | D = Unarmoured Non-FRLS |

PVC Aluminium

| | |
|---|---|
| E = Armoured FRLS | F = Armoured Non-FRLS |
| G = unarmoured FRLS | H = Unarmoured Non-FRLS |

XLPE Copper

| | |
|---|---|
| J = Armoured FRLS | K = Armoured Non-FRLS |
| L = unarmoured FRLS | M = Unarmoured Non-FRLS |

XLPE Aluminium

| | |
|---|---|
| N = Armoured FRLS | P = Armoured Non-FRLS |
| Q = unarmoured FRLS | R = Unarmoured Non-FRLS |

S = FIRE SURVIVAL CABLES
T = TOUGH RUBBER SHEATH
U = OVERALL SCREENED
V = PAIRED OVERALL SCREENED
W = PAIRED INDIVIDUAL SCREENED
Y = COMPENSATING CABLES
I = PRE-FABRICATED CABLES
Z = JELLY FILLED CABLES

# SECTION: I

# SUB-SECTION: C 4

# TECHNICAL SPECIFICATION (C&I PORTION)

`

# TECHNICAL SPECIFICATION (CONTROL AND INSTRUMENTATION) FOR VENTILATION SYSTEM

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# C&I SPECIFIC TECHNICAL REQUIREMENT

## Specific Technical Requirements (C&I):

1. Complete C&I system for Ventilation System is in bidder's scope of supply. Items not specifically mentioned however required for the completeness of the system shall be supplied by bidder without any commercial implication.

2. Ventilation System shall be operated from DDCMIS (BHEL's scope) for Area's/Building indicated elsewhere in the specification.

3. The Contractor shall provide complete Instrumentation for control, monitoring and operation of entire Ventilation system. The requirements given are to be read in conjunction with detailed Technical specification enclosed in the specification. Further in case of any discrepancy in the requirement within the same section noted by the bidder in the specification, the same will be brought to the notice of BHEL in the form of pre- bid clarification. In absence of any pre-bid clarification, the more stringent requirement as per interpretation of customer shall prevail without any commercial implication.

4. Interface of MCC, field Equipment, Actuators etc. with DDCMIS based control system shall be as per Drive Control Philosophy enclosed in specification.

5. Bidder to supply all the instruments required for the package along with necessary fittings, accessories and valve manifold etc. for control monitoring and operation of Ventilation system. All instruments shall be provided with durable epoxy coating for housing and all exposed surfaces of the instruments.

6. Electrical Actuators (as applicable) shall be Non-Intrusive type electric actuators envisaged with integral starter. The interface of these actuators with DCS shall be with PROFIBUS DP interface. All actuator settings including torque, limit shall be possible without opening the actuator cover and LCD indication shall be available integral to actuator body. Open/Close command termination logic suitably built inside the actuator Details shall be referring in the specification.

7. All ON, OFF, INCHING Type electric actuators shall be PROFIBUS DP compatible. However, the exact protocol shall be based on finalized protocol of DCS. If PROFIBUS DP protocol is envisaged, then actuator shall have two (redundant) PROFIBUS DP ports for connecting the redundant PROFIBUS DP cables. That is if one PROFIBUS DP cable is cut or not working/not available, then complete actuator functionality shall be available through the second redundant cable without any manual intervention.

8. All the Electronic Transmitter for Pressure, Temperature, Differential Pressure and DP based Flow /Level measurements shall be genuine, verifiable PROFIBUS PA protocol compatible instruments. The transmitters shall be connected to DDCMIS through PROFIBUS PA protocol complying to IEC 61158 directly from transmitter. This is subject to customer approval and BHEL decision shall be final.

9. The PROFIBUS protocol design shall be further validated by BHEL and approved by NTPC during detailed engineering and any variation/ changes required based on DDCMIS system requirements and actual field installation, operational philosophy etc. shall be considered by bidder without any implications.

10. The quantity of instruments for the 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.

11. Redundancy of sensors shall be provided by bidder
    (i) Triple redundancy for all analog and binary inputs required for protection of system/drives.
    (ii) For all other control functions dual redundancy of the sensors shall be provided by the bidders.

12. All Temperature sensors shall be Duplex type and temperature transmitter shall be provided for all temperature measurement applications. Bidder to provide temperature transmitter along with compensating cable, JB/Rack & other erection hardware.

13. Use of process actuated switch shall be avoided unless unavoidable.

14. All the transmitters supplied by Bidder shall be rack mounted. The transmitter racks shall be in Bidder's scope of supply.

15. All transmitters shall be suitably grouped together and mounted inside (i) Local Instruments Enclosures (LIEs) in case of open areas of the plant and (ii) In Local Instrument Racks (LIRs) in case of covered areas.

16. For measurement of level of tanks/vessels/sumps containing oil, chemicals or water, Ultrasonic type level transmitters shall be provided. However, other type of level transmitters, if any, shall be acceptable only if there are constraints on account of process/equipment/device for having an effective measurement using the above. The acceptability of the same shall be subject to BHEL/NTPC's approval.

17. All instruments (except PROFIBUS PA compatible transmitters) and control elements shall be terminated on JB/LCP in field and both instrument and JB/LCP are in bidder scope. Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 12-15 mtrs) and trunk cable.

18. Instrument installation and accessories required for the same shall be in Bidder's scope. However, any instrument/ analyzer installation not covered in the specification, same shall be subject to customer and BHEL approval during detailed engineering. All instruments required for the package shall be supplied, mounted on the gauge board racks, along with accessories like impulse pipe, fittings & valve manifolds etc.

19. All field instruments enclosure shall be IP65 local panel/cabinet enclosure shall be IP 55, unless otherwise specified.

20. Bidder to perform tests of C&I items/instruments/systems as per Quality plans/type test attached in the specification. However, if any test not specified in the quality plan but specified in specification Tests for I&C equipment included elsewhere in specification will have to perform by Bidder without any cost implication. The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial and delivery 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.

21. All transmitters (except PROFIBUS PA compatible transmitters) shall be smart type and shall have 4-20mA DC signal with superimposed digital communication (HART) as per this specification.

22. Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg./sq.cm.

23. Epoxy coated painting is required for all I & C Equipment & Instruments.

24. 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.

25. 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. 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 (SS316 material), nuts & bolts etc. shall also be included, wherever required with the field instruments.

26. Material described in the specification (for instrument, equipment, accessories etc.) are the minimum requirements, which shall be complied by bidder. Any other better material shall also be considered to suit the process and environmental conditions at site subject to owner's approval. Material, if found not suitable shall be changed by vendor without any price/time implication.

27. The contacts of equipment mounted instruments; sensors, switches etc. For external connection including spare contacts shall be wired out to suitably located junction boxes by bidder.

28. Local control panel if any required for operation shall be in bidder scope.

29. LCP (If applicable) shall have the provision of command (start/stop) & feedback interface with DDCMIS.

30. The solenoid operated valves/Dampers/Gate shall have a limit switch for open/close feedback.

31. Bidder to include IO from fire protection system (supplied by others) for closing the dampers in the event of fire, the no of IO & other specifications in this regard shall be finalized during detail engineering.

32. VFD panels for applicable drives are in Bidders scope. Typical signal exchange with DCS has been indicated in the specification elsewhere.

33. Drive control philosophy/signal exchange list attached elsewhere in the specification are Tentative. Shall be finalized during detailed engineering.

34. Signal exchange between equipment /instrument and DDCMIS indicated in the specification are minimum and the same Shall be finalized during detail Engineering. Any addition of signal at equipment (supplied by bidder) end shall be complied without any implication.

35. All panels, cabinets shall be provided with a continuous bare copper ground bus. The ground bus shall be bolted to the panel structure on bottom on both sides. The bolts shall face inside of panels. The system ground shall be isolated from the panel ground with suitable isolators. All internal component grounds or common shall be connected to the system ground, which shall be fabricated of copper flat (size 25mm x 6mm min., length as applicable).

36. The design, manufacture, inspection, testing, site calibration and installation of all C&I equipment and systems covered under this specification shall conform to the latest editions of applicable codes and standards.

37. Bidder to provide erection hardware including junction boxes, canopies, structural steel as required.

38. Every panel-mounted instrument, requiring power supply, shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.

39. Provision for separate Terminal block/wiring diagram for power and control blocks of control panel to be ensured.

40. To ensure availability, adequate redundancy in system design shall be provided at hardware, software and sensor level. For the protection system, independent sensing device shall be provided to ensure adequate safety of plant equipment.

41. The design of the control systems and related equipment shall adhere to the principle of 'Fail Safe' Operation wherever safety of personnel / plant equipment is involved and shall not cause a hazardous condition. However, it shall also be ensured that occurrence of false trips are avoided/ minimized.

42. For instruments which are not located inside covered building, suitable canopy/ protective arrangement shall be provided which shall be approved during detail engineering.

43. All the wetted parts of the instruments including the accessories like root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifolds and all the other accessories required for mounting/erection of these local instruments as well as valves shall be of SS-316 material, suitable pressure class and same shall be in bidder's scope .

44. All instruments should be supplied with valid calibration and test certificates provided by OEM.

45. Bidder to provide mandatory spares as per mandatory spares list. Attached elsewhere in the specification.

46. At least 20% spare unused terminals shall be provided everywhere including local junction boxes, instrument racks/enclosures, termination/marshalling cabinets, etc

47. All the instruments PG/DPG/DPT/PT etc. (as applicable) having contact with corrosive media shall be provided with chemical/diaphragm seal.

48. JB provided on the valves for manually operated valves Limit switches wherever specified.

49. Supply air diffusers/grills with volume control dampers be provided for all areas provided with evaporative cooling system.

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

51. Bidder shall ensure that various C&I instruments /equipment like electronic transmitters / transducers, Temperature elements and other instruments/ local devices etc. that are being furnished by the Bidder, are of the same make, series and family of hardware to the extent possible so as to ensure smooth and optimal maintenance.

52. Limit switches shall be silver plated with high conductivity and non-corrosive type Contact rating shall be sufficient to meet the requirement of DDCMIS subject to a minimum of 60 V, 6 VA rating. Protection class shall be IP 55.

53. For cable scope refer to electrical scope between BHEL and vendor defined in electrical specification.

54. Number of pairs to be selected for Screen/ Control cable
    F-Type: 2P/4P/8P/12P(Size : 0.5 mm2)
    G-Type: 2P/4P/8P/12P(Size : 0.5 mm2)
    Core Cable: 3CX2.5sqmm2/ 5CX2.5sqmm2/ 12CX1.5sqmm

55. Bidder's presence is required for 1 Man days (Excluding travel time) at EDN Bangalore during FAT of DDCMIS for certifying correctness & completeness of implementation of Control logic. Intimation to attained FAT shall be informed in 2 days advance. All the expenses like boarding, lodging and travel, Air fare etc. shall be in bidder's scope.

56. Bidder's presence is required for 6 Man days (in two visit) at site during commissioning of DDCMIS for assistance related to process correctness. Two visit with total 6 Man days (Excluding travel time) in which one visit shall be of 3 Man days each. All the expenses like boarding, lodging and travel, Air fare etc. shall be in bidder's scope.

57. Contractor's C&I representative shall be present at BHEL-PEM for 3 man-days, for preparation of Control scheme of Ventilation system. All the expenses like boarding, lodging and travel, Air fare etc. shall be in bidder's scope.

58. In case of any conflict and repetition of clauses in the specification, BHEL discretion will prevail.

59. The bidders shall specifically mention any deviation they would like to take on the C&I specification. In absence of deviation, a No deviation certificate is to be furnished.

60. The specifications for instruments mentioned in the specification are minimum requirements. The detail specifications shall be finalized during detail engineering.

61. Bidder to furnish electrical load/UPS load data during detailed engineering.

62. 415V AC/ 230V UPS Power supply shall be provided by BHEL at a single point, further distribution to various instruments/equipment of the system shall be in bidder scope. Bidder to include necessary power distribution board/change over switch in his scope. Any power supply other than the above, if required by any instrument/equipment has to be derived by the bidder from the above supply & all necessary hardware for the same shall be in bidder scope. Bidder to submit the power requirement along with the bid.

63. All the equipments 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. 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. BHEL/NTPC shall have right to insist for completion of works in shops before despatch of materials for transportation.

64. Contractor shall furnish Instrument Schedule, I/O list, Drive list, Cable Schedule, Cable interconnection, JB grouping, Annunciation list, recommended control logics / write-up, SOE list, List of Instruments/devices in BHEL approved format. Plant schematic for monitoring & operation shall be available on OWS, bidder to further submit list of important signal along with applicable schematic for monitoring in DCS. Also reusable database format like MS Excel, MS Access etc. of these documents shall also be provided by Contractor in BHEL approved format. Soft copy of the formats shall be provided to the successful bidder.

**Note:-**

1. All equipment items shall be of latest design with proven on track record.

2. 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.

3. 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.

# LIST OF DOCUMENTS/DELIVERABLES

**LIST OF DELIVERABLES OF PEM - C&I DEPARTMENT**

| Sl.No. | DRAWING NO. | DRAWING/DOCUMENT TITLE | CATEGORY |
|---|---|---|---|
| | | | |
| 1 | PE-V0-475-145-I901 | CONTROL & OPERATIONAL WRITE-UP FOR THE SYSTEM | A |
| 2 | PE-V0-475-145-I902 | CONTROL SCHEME/LOGIC DIAGRAM(TO BE IMPLEMENTED IN DDCMIS) | A |
| 3 | PE-V0-475-145-I903 | HMI PICTURES/PLANT SCHEMATICS | A |
| 4 | PE-V0-475-145-I904 | INSTRUMENT SCHEDULE WITH SET POINTS | A |
| 5 | PE-V0-475-145-I905 | I/O LIST (ANALOG & BINARY) | A |
| 6 | PE-V0-475-145-I906 | DRIVE LIST/SOLENOID/ACTUATOR VALVE LIST WITH LOCATION DATA | A |
| 7 | PE-V0-475-145-I907 | FIELD JB/LIE/LIR,DRIVES TERMINATIONS | A |
| 8 | PE-V0-475-145-I908 | DATASHEETS FOR INSTRUMENTS, JBs, etc. | A |
| 9 | PE-V0-475-145-I909 | QUALITY PLANS (INSTRUMENTS, VMS, etc.) | A |
| 10 | PE-V0-475-145-I910 | INSTRUMENT HOOK-UP DRAWING | A |
| 11 | PE-V0-475-145-I911 | THERMOWELL SIZING CALCULATION | A |
| 13 | PE-V0-475-145-I913 | CABLE SCHEDULE & INTERCONNECTION | A |
| 14 | PE-V0-475-145-I914 | ANNUNCIATION & SOE LIST | A |

NOTES:
ANY OTHER DOCUMENT DECIDED DURING DETAILED ENGINEERING SHALL BE PROVIDED BY BIDDER WITHOUT ANY COMMERCIAL/TECHNICAL IMPLICATION.

CONTRACTOR TO SUBMIT REUSABLE DATABASE FORMATS IN BHEL/CUSTOMER APPROVED FORMATS LIKE MS EXCE, MS ACCESS OF DOCUMENTS LIKE INSTRUMENT SCHEDULE, I/O LIST, DRIVE LIST, FIELD JB TERMINATIONS, CABLE SCHEDULE & INTERCONNECTION, etc.
SOFT COPY OF FORMATS SHALL BE PROVIDED TO SUCCESSFUL BIDDERS.

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# GENERAL TECHNICAL REQUIREMENTS

**GENERAL REQUIREMENT**

1.0 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.

2.0 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.

3.0 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.

4.0 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.

5.0 The customer specification attached as Specific Technical Requirement will supercede the Data sheets, if there is any mismatch.

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# SPECIFICATION FOR MEASURING INSTRUMENTS (PRIMARY & SECONDARY)

| | |
|---|---|
| 1.00.00 | **MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)** |
| 1.01.00 | 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. Refer Sub-section Basic Design Criteria. Further, all instruments shall be of proven reliability, accuracy, and repeatability requiring a minimum of maintenance and shall comply with the acceptable international standards and shall be subject to Employer's approval. |
| 1.02.00 | Every panel-mounted instrument requiring power supply shall be provided with easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus. |
| 1.03.00 | All transmitters, sensors, switches and gauges for parameters like pressure, temperature, level, flow etc. as required for the safe and efficient operation and maintenance as well as for operator and management information (including all computation) of equipment in the system under the scope of specification shall be provided on as required basis with in quoted lump sum price. The Contractor shall furnish all Instrumentation / Control equipment & accessories under this specification as per technical specification, ranges, makes & model as approved by the Employer during detailed engineering. |
| 1.04.00 | The necessary root valves, impulse piping, drain cocks, gauge-isoroing cocks, valve manifolds and all the other accessories required for mounting/erection of these local instruments shall be furnished, even if not specifically asked for, on as required basis. The contacts of equipment mounted instruments, sensors, switches etc. for external connection including spare contacts shall be wired out in flexible/rigid conduits, independently to suitably located common junction boxes. The proposal shall include the necessary cables, flexible conduits, junction boxes and accessories for the above purpose. Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg./sq.cm. |
| 1.05.00 | All instruments envisaged for sea water applications, shall be provided with wetted parts made of Monel/ Hastelloy C or any other material (if provenness experience of the proposed material for such applications is established by contractor). |
| 1.06.00 | For coastal areas, all instruments shall be provided with durable epoxy/ polyurethane coating for housings and all exposed surfaces of the instruments. |
| 1.07.00 | The instruments which are proposed to be used for PG test as indicated in the tender P&IDs shall meet the minimum requirements specified in ASME PTC or subsequent clauses in this chapter whichever is better. |

**2.03.00** **Ultrasonic Type level Transmitter**

| S.No. | Features | Essential/Minimum requirement |
|---|---|---|
| 1. | Type of Transmitter | Non-contact Microprocessor based 2 wire type (loop powered), HART protocol compatible Ultrasonic transmitter. |
| 2. | Output signal | 4-20 mA DC (Analog) along with superimposed digital signal (based on HART protocol). |
| 3. | Accuracy | +/- 0.5% of calibrated span or minimum 5mm. |
| 4. | Power supply | 24 V DC +/- 10%. |
| 5. | Temperature compensation | To be provided within transducer. |
| 6. | Housing | Weather proof as per IP-65, metallic housing with durable corrosion resistance coating. |
| 7. | Adjustment/calibration/ maintenance | Using hand held HART calibrator/ centralized PC based system (as applicable). . |
| 8. | Zero and Span adjustment | Continuous, tamper proof, remote as well as manual adjustability from instrument. It should be possible to calibrate the instrument without any level in the tank/sump etc. |

| | | |
|---|---|---|
| 9. | Sensor Material | Corrosion resistant material to suit individual application requirement. |
| 10. | False signal tolerance | Transmitter shall be capable of ignoring false echoes from internal tank/sumps obstructions such as pipes, heating coils or agitator blades. Also transmitter shall have adjustable damping circuitry. |
| 11. | Range | Range of transmitter shall be capable of covering the complete level span of tank taking care of blocking distance, frequency attenuation due to surface, obstructions, vapors etc. |
| 12. | Display | Integral digital display |
| 13. | Diagnostics | Loss of echo alarm etc. |
| 14. | Load Impedance | 500 ohms (minimum). |
| 15. | Electrical Connection | Plug and socket |
| 16. | Accessories | • All weather canopy shall be provided for protection from direct sunlight and direct rain for open locations.<br>• All mounting accessories required for erection and commissioning shall be provided.<br>• For hazardous area, explosion proof enclosure as described in NEC article 500 |

**Note:**

1) Contractor can also provide Radar type transmitter as per above specification in place of ultrasonic transmitter subject to approval by Employer during detailed Engineering. Sonic frequency based transmitters can also be provided under "ultrasonic transmitters" category for fly ash silo level.

2) Four wire type transmitters can also be provided for applications where 2- wire transmitter has some technical limitations, subject to employer's approval during detailed engineering stage. However, in such cases isolated 4-20 mA DC (analog) output shall be provided. Power supply required for such transmitters shall be 240V AC / 24V DC.

3) For applications where transmitter location is not accessible, the transmitter shall have separate sensor unit and electronic unit for such applications. It shall be possible to mount the electronic unit at accessible location.

3.02.00 **Resistance Temperature Detector ( RTD )**

| Sr. No. | Features | | Essential/Minimum Requirements |
|---|---|---|---|
| 1 | Type of RTD. | : | Four wire, Pt-100 (100 Ohms resistance at zero degree Centigrade). |
| 2 | No. of element | : | Duplex |
| 3 | Housing/Head | : | IP-65/Diecast Aluminium. Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable). Plug in connectors are to be provided for external signal cable connection. TE terminal head shall be spring loaded for positive contacts with the thermo well |
| 4 | Insulation and sheathing of RTD | : | Mineral (magnesium oxide) insulation and SS316 sheath, |
| 5 | Calibration and accuracy | : | As per As per IEC-751/ DIN-43760 Class-A for RTD |
| 6 | Accessories | : | Thermo well and associated fittings |
| 7 | Standard | : | IEC-751/ DIN-43760 for RTD and ASME PTC-19.3 for Thermo-well. |

**NOTES :**

1) The specifications for RTDs of winding/ bearings of motor/pump, can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However the type of RTD shall be Pt100.

2) The specifications of temp elements for air conditioning & ventilation system / process can be as per system manufacturer's standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice.

| | |
|---|---|
| **3.04.00** | **Thermo well** (for all process temp. elements)<br><br>(a) Shall be one piece solid bored type of 316 SS of step-less tapered design. (As per ASME PTC 19.3, 1974)<br><br>(b) For Mill classifier outlet long life solid sintered tungsten carbide material of high abrasion resistance shall be provided.<br><br>(c) For Air & Flue gas 316 SS protecting tube with welded cap. (However contractor shall provide better material for Flue gas service if required based on the specified boiler design parameters). |

14.00.00 NOT USED

15.00.00 PROCESS ACTUATED SWITCHES

| FEATURES | ESSENTIAL / MINIMUM REQUIREMENTS |
|---|---|

| | Pressure/ Draft Switches/ DP Switches | Temperature switches | Level switches |
|---|---|---|---|
| Sensing Element | Piston actuated for high pressure and diaphragm or bellows for low pr./ vacuum | Vapor pressure sensing, liquid filled bellow type with SS bulb and capillary (5 m minimum, to suit application) | Capacitance types, float type, conductivity type, RF type, Ultrasonic type as per suitability to the application. . |
| Material | 316 SS | Bulb 316 SS/ capillary 304 SS | 316 SS |
| End connection | ½ inch NPT (F) | ½ inch NPT (F) | Manufacturer standard |
| Over range/ proof pressure | 150% of maximum operating pr. | - | 150% of maximum operating pr. |
| Repeatability | +/- 0.5% of full range | | |
| No. of contacts | 2 No.+2NC. SPDT snap action dry contact | | |
| Rating of contacts | 60 V DC, 6 VA (or more if required by DDCMIS) | | |
| Elect. Connection | Plug in socket. | | |
| Set point adjustment | Provided over full range. | | |
| Dead band adjustment | Adjustable/ fixed as per requirement of application. | | |
| Enclosure | Weather and dust proof as per IP-55, metallic housing. | | |
| Accessories | Siphon, snubber, chemical seal, pulsation dampeners as required by process | Thermo well of 316 SS and packing glands | All mounting accessories |
| Mounting | Suitable for enclosure/ rack mounting or direct mounting | Suitable for rack mounting or direct mounting | - |
| Power Supply (wherever required) | As per Contractor's Standard practice. | | |

Notes :-

1) 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.

2) Pressure/ Diff pressure switches for very low press/ DP measurements can have sensor material other than SS316 in case of any technical limitation and the offered product is standard product of the manufacture for very low pressure applications.

3) Repeatability can be upto +/-1% of full range in case of switches with diaphragm seals or very low pressure/DP range.

4) The specifications of switches for air conditioning & ventilation system / process can be as per system manufacturer's standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice.

**16.00.00** **NOT USED**

**17.00.00** **SOLENOID VALVES**

Solenoid valves shall fulfil the following requirements:

a. Type 2/3/4 way SS 316/Forged Brass (depending on the application subject to Employer's approval during detailed Engg.)

b. Power supply : 24 V DC ± 10%.

c. Plug and socket electrical connection.

d. Insulation : Class 'H'

e. IP Class : IP65

**11.01.00** **Electronic Transmitter for Pressure, Differential Pressure and DP based Flow / Level measurements.**

| S No. | Features | Essential/Minimum Requirements |
|---|---|---|
| 1. | Type of Transmitter | FOUNDATION Fieldbus/PROFIBUS PA based output |