NTPC LIMITED

3X40 MW NTPC RAMMAM STAGE-III
HYDRO ELECTRIC PROJECT (HEP)

TECHNICAL SPECIFICATION

FOR

HVAC SYSTEM

SPECIFICATION NO.: - PE-TS-414-571-11000-A001 (REV00)
(MARCH-2021)

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

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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, supply / procurement, inspection and testing at vendor's / sub vendor's / manufacturer'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 and shipment till storage area and delivery from storage area to site, unloading, handling & on-site transportation, storage, preservation , security / safety at site , 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, operation & Maintenance of HVAC system (24x7) after commissioning till handing over and handover in flawless condition of the package to the end customer complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendment & agreements till placement of order for 3x40 MW NTPC RAMMAM STAGE-III HYDRO ELECTRIC PROJECT (HEP).

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 **HVAC SYSTEM.**

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

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

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

1.6 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under Vol-III of the specification **within 10 days of receipt of tender documents.** In absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of Purchaser / Customer shall prevail and shall be complied by the bidder without any commercial implication on account of the same. Further in case of any missing information in the specification not brought out by the prospective bidders as part of pre-bid clarification, the same shall be furnished by Purchaser/ Customer as and when brought to their notice either by the bidder or by purchaser/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.

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

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

1.9 In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, Section – C1 shall prevail over section – D, however more stringent requirement as per the interpretation of the owner shall apply.

Further, In case of any discrepancy in section 'C1' and section 'C2', Section-C2 shall prevail (customer specification).

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 refer relevant clause of GCC.

SECTION: I

SUB-SECTION: B

PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA

PART - A

SUB-SECTION-I

PROJECT INFORMATION

CONTENT

1.00.00 BACKGROUND

3 Nos. of vertical shaft generating units each of 40 MW coupled to 4-jet vertical axis Pelton Turbines, are required to be installed in the Rammam Stage - III Hydro Electric Project located in Darjeeling Dist. of West Bengal state. The project site can be accessed from Siliguri via Ghoom in Darjelling District of West Bengal.

2.00.00 GENERAL FEATURES OF THE PROJECT

2.01.00 **General**

Rammam Stage-III Hydro Electric Project is a run of the river scheme across the Rammam river between the confluence of Lodhama Khola with Rammam to Rammam with river Rangit. The scheme involves construction of Barrage on river Rammam approximately 240 m D/s of Rammam stage – II Power House with 3.5 m finished diameter, 8.2 Km. long horse shoe shaped HRT, 2.7 M diameter, 1.53 Km long pressure shaft/ penstock, 740 m long tailrace channel and surface power house. The installed capacity of the project is 120 MW (3x40 MW). Source of the water supply is Rammam river which is an important tributary of the river Rangit. The Rammam river originates in glacial area to the extreme west near the West Bengal and Nepal border, flows in a easterly direction for a considerable distance and joins the Rangit river near Naya Bazar. River Rangit in turn is a major tributary of the Teesta River. The Rammam river originates from Mane Bhanjan – Tongbu – Phalut ridge of the lower Himalayas which are continuation of Kanchan Jungha mountain ranges, at an elevation of about EL 3631 M and drains a catchment of about 247 KM^2 up to the Barrage site. There is considerable snow fed region in the catchment area of Rammam River in its upper reaches. A significant portion of the catchment area is covered with dense forest.

2.02.00 **Hydraulic and Civil features**

The Rammam Stage-III Hydro Electric project is located on Rammam River. It is developed as a run of river scheme by constructing a Barrage with 8.2 km long head race tunnel of horse shoe type having a diameter of 3.5 m to carry design discharge of 28 m3/s, one number restricted orifice type surge tank with 14.5 m diameter and 52.5 m height. One no. of 2.7 M diameter pressure shaft is considered to feed each unit turbine of 40 MW capacity that operate under a design head of 473 m.

The general layout of the scheme is indicated in the enclosed drawings: Drg.No. 5602-002-P-E-C-A-01-Geographical Location of the Project, Drg.No.5602-002-P-E-C-A-09 -General Project Layout and 5602-002-P-E-C-A-24 -Cross section of Power House through Water Conductor System.

3.00.00 SYSTEM DETAILS

3.01.00 The installed capacity of 120 MW would be provided by 3 Vertical Axis Pelton turbines driven generating units of 40 MW each. It is proposed to provide Inlet Valve of spherical type for each turbine, which would be accommodated in the powerhouse. The generation voltage of 11 kV would be stepped up to 132 kV through three single phase 17 MVA, 11/ 139/ √3 kV ODWF type step up transformers located near upstream wall of the power house for each unit. The 11

kV isolated phase bus ducts would connect the 11 kV generator terminals with 11 kV bushings of step up transformers. The 132 kV terminal of the transformers would be connected with 132 kV switchyard through 132 kV XLPE Cables. Power from the project will be evacuated through three Nos. 132 kV lines to be laid by WBSEB.

3.02.00 The power supply for unit auxiliaries is proposed to be obtained from three dry type 500KVA, 3 Phase, 11/0.433KV Unit Auxillary Transformers. Auxiliary power for station services would be supplied from 11 kV and would be step down through 2 Nos. of 1600 KVA, 11/0.433 kV step down dry type Station Service Transformers. For emergency supply, 2 Nos. of 750 KVA, 11 KV DG sets would also be installed which would be connected to Station Auxiliary Board. The Overall Electrical Single Line Diagram is shown in the enclosed drawing, Drg.No. 5602-003-P-E-E-A-101 "SLD for Overall Electrical System".

3.03.00 E.O.T. Crane

One no. E.O.T. Crane of 125/25/5 T capacity with main and auxiliary hooks are proposed to be installed in the power house for handling assembly and erection of generating units & associated equipment. The clearances, limits for hook approach and other dimensions of the crane shall be suitable for the proposed layout of this power station. One no EOT crane of 50/10/5T will be provided in the Valve House building for erection and handling of Butterfly valve.

4.00.00 CLIMATIC CONDITIONS

The project lies between EL 910m to 375 m. The area has moderate climatic conditions with no snow fall in the project area. Rainfall in the Project area is from June to August and in December, January. The Power House service bay floor is located at EL 412 m & the centre line of turbine runner has been set at EL 400 m. The climatic conditions are given below: -

i)	Maximum temperature in the project area	:	30 ° C
ii)	Minimum temperature in the project area	:	3 °C
iii)	Maximum Relative humidity	:	<95 %
iv)	Minimum Relative humidity	:	>35 %
v)	Average annual rainfall	:	2800 mm

5.00.00 SEISMIC FORCES

The Rammam stage III hydroelectric project is located at the margin of Zone-IV and Zone-V of the seismic zoning map of India. The equipment shall be designed to withstand seismic forces.

6.00.00 **PETROGRAPHIC REPORT OF RIVER SEDIMENT**

6.01.00 Grain size analysis of soil samples for Rammam Stage III project is given below:

Grain Size Analysis in Wt %

Clay %	Silt %	V.F. Sand %	F. Sand %	M. Sand %	Coarse Sand %	Total
(-)1.95 micron	(-)65.51 micron	(-)0.125 mm	(-)0.25 mm	(-)0.5 mm	(+)5mm	
0.20	8.0	60.34	25.23	4.98	1.25	100

6.02.00 **Petrographic Report on the Sediments**

a) Megascopic Observation

The samples are loose sediments and are brownish grey in colour. The samples range in size from coarse sand to very fine sand. The sand fraction is composed dominantly of mica flakes, quartz, feldspar and organic matter including wooden fragments.

b) Microscopic Examination

The mineral assemblages and organic matter with their relative volume percentages (as per visual estimate) of different size of sand fractions are furnished below:

Size fraction	Mineral Assemblages (with relative abundance based on visual estimate)
+ 500µm (Coarse Sand)	Quartz 40%, Biotite 30%, Muscovite 10%, Feldspar 10%, Lithic fragment (quartzite) 10%, Organic matter (with cellulose structure, few) and clay concretion (few)
+ 250µm (Medium Sand)	Biotite 40%, Quartz 20%, Feldspar 20%, Muscovite 10%, Garnet (5%) and Chlorite-Sillimanite – Lithic fragment (Granite, Quartz-Cholrite Schist) – Clay concretions Amorphous carbonate-Iron concretions (5%) – Organic matter (with cellulose structure, few)
+ 125µm (Fine Sand)	Biotite 70%, Muscovite 20% and Quartz- Feldspar-Garnet (10%)
+ 0.063mm (Very Fine Sand)	Quartz 60%. Biotite 20%, Feldspar 10%, Muscovite 5% and Amphibole-Chlorite (<5%)
Roundness	Both quartz and feldspar grains are generally sub rounded. But in coarse sand (+500 µm) the feldspar grains are subangular.

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	The Lithic fragments are well rounded.
Sphericity	Quartz grain show moderate to high sphericity but feldspar grains are of moderate sphericity only. The Lithic fragments show high sphericity.

7.00.00 TRANSPORTATION

7.01.00 **Location and Access**

The proposed Rammam Stage-III is located on the Rammam River in the state of West Bengal. The Rammam River forms the boundary with West Bengal and Sikkim. The diversion structure is just downstream at the confluence of Rammam with Lodhama Khola and the power house is near Barbatia village on right bank of the Rammam River. The project lies between Latitude 27°-6'-00"N to 27°-9'-00"N and Longitude 88°-8'-00"E to 88°-14'-00"E.

The project can be accessed from Siliguri via Ghoom in Darjelling District of West Bengal or from Jorthang in Sikkim by road. Bagdogra is the nearest airport and New Jalpaiguri is the nearest broad gauge railway station. The proposed project site is connected by all weather metalled road from Siliguri, the main city near by and connected to all parts of the country.

The proposed project site can be accessed through the following approach roads from Siliguri:

a) Approach roads to Barrage site;

i) Via Siliguri – Manebhanjan – Lodhama (about 140 Km).

ii) Via Siliguri – Kurseang – Bijanbari – Lodhama (about 130 Km).

b) Approach road to Power House site:

i) Via Siliguri – Melli – Jorthang (Naya bazaar) (about 120 km)

To have accessibility to various components of the project within the project area, a road network has been proposed with a single lane width as per BRO specifications.

7.02.00 **Transport Limitations**

The weights and dimension of the packages for transportation to site shall be limited to the following:-

a) Max. Weight of the package not to exceed 50 M.T.

b) Max. Size of the package not to exceed L = 8500 mm, W= 3000 mm, and H= 6000 mm.

The above information is tentative and it is the contractor's responsibility to verify the actual transport limitation.

8.00.00 **BIDDER TO INFORM HIMSELF**

The Bidder shall make independent/their own investigations about the conditions and circumstances affecting his tender estimates and about the possibility of executing the works as described. During the evaluation of tenders, it shall be presumed that the Bidder have inspected and examined the site and its surroundings and to have satisfied themselves about the form and nature of the site, the quantities and materials necessary for the completion of the work and the means of transport and access to site, the requirements of accommodation, general labor position at the site and have quoted their prices after taking into account, the risks, contingencies and other circumstances which may influence or affect the execution of the Contract.

Access to the site shall be allowed, to the prospective bidder(s) by prior appointment with the Employer.

Water quality of river Rammam in the project area is as follows:

Parameter	Unit	Value
Dissolved Oxygen	mg/1	8.6
BOD	mg/1	1.9
COD	mg/1	2.7
Electrical conductivity	µs/cm	0.013
Total Kjeldahl Nitrogen	mg/1	1.6
Temperature	°C	8.0
PH		7.8
TDS	mg/1	187
Sulphates	mg/1	10
Calcium	mg/1	19
Magnesium	mg/1	11
Copper	mg/1	<0.01
Chlorides	mg/1	67
Sodium	mg/1	5.7
Iron	mg/1	<0.1
Fluorides	mg/1	1.1
Mercury	mg/1	< 0.01
Lead	mg/1	< 0.1

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SECTION: I

SUB SECTION: C1

TECHNICAL SPECIFICATION

SECTION: I

SUB-SECTION: C 1

SPECIFIC TECHNICAL REQUIREMENT

1.0 FUNCTION

The purpose of the system is to provide HVAC (Air conditioning and ventilation) for different areas of 3x40 MW NTPC RAMMAM STAGE-III HYDRO ELECTRIC PROJECT under the scope of this tender. To achieve proper working conditions inside the power house complex, BFV house, Switchyard control building and Dam complex, HVAC system is provided to serve the following purpose:

i. To prevent temperature stratification
ii. To remove contaminated air
iii. To remove waste heat from equipment
iv. To provide outside fresh air necessary for human comfort
v. To evacuate smoke and remove heat

2.0 SYSTEM DESCRIPTION

Conditioned and dehumidified air shall be supplied to different zones of the powerhouse in accordance with heat generated in each zone. The power station shall be divided into two zones as below:

(A) Air Conditioning Zone
(B) Ventilation zone

2.1 AC SYSTEM ZONE CONSIST OF THE FOLLOWING AREAS.

2.1.1 Air-cooled Package type air conditioning plant shall be provided to cater to the air conditioning requirements of the following areas of power house.

2.1.1.1 Control Room, SCADA room, Shift engineer room & PLCC room
2.1.1.2 Conference room
2.1.1.3 Store and Library
2.1.1.4 Relay and protection room.

2.1.2 Split AC for control room of Control/switchgear building at Barrage area.
2.1.3 Split AC for office area for 11KV control building at 132KV switchyard.

2.2 VENTILATION SYSTEM ZONE CONSIST OF THE FOLLOWING AREAS

2.2.1. ONCE THROUGH TYPE VENTILATION SYSTEM

Once Through type ventilation system shall be provided for following areas:

Supply air from once through AHU shall be fed to various areas of power house as detailed below through insulated duct

2.2.1.1 MIV floor at EL 403.0M.
2.2.1.2 Turbine floor at EL 406.5M.
2.2.1.3 Generator Floor at EL 411M.
2.2.1.4 Machine floor at EL 416M.
2.2.1.5 Service Bay area EL 416M.

2.2.2 DRY TYPE MECHNICAL VENTILATION SYSTEM

Dry Mechanical type Ventilation System shall be provided for following areas:

2.2.2.1 Toilets, and Battery Room for power house.

2.2.2.2 MCC room for surge shaft / Valve House

2.2.2.3 MCC room for tail race building (Gates).

2.2.2.4 Butterfly Valve House.

2.2.2.5 Switchgear room, DG room, toilet for control / switchgear building at Barrage area.

2.2.2.6 Switchgear room of 11&33KV, DG room, store & toilet at 132KV switchyard.

2.3 REFERENCE DOCUMENT / DRAWINGS

2.3.1 The following drawings have been referred while designing the HVAC System:

2.3.1 5602-003-P-E-M-A-113: Schematic diagram for Ventilation system.

2.3.2 5602-906-H115-PVM-F-001: Station layout – Elevation

2.3.3 5602-906-H115-PVM-F-011: Station layout plan at EL.399.50M

2.3.4 5602-906-H115-PVM-F-003: Station layout plan at EL.401.50/403.00M

2.3.5 5602-906-H115-PVM-F-005: Station layout plan at EL.406.5M TURBINE FLOOR

2.3.6 5602-906-H115-PVM-F-008: Station layout plan at EL.411.00 GENERATOR FLOOR

2.3.7 5602-906-H115-PVM-F-009: Station layout plan at EL.416.00 MACHINE HALL

2.3.8 5602-906-H115-PVM-F-007: Layout of Powerhouse Longitudinal Section

2.3.9 5602-906-H115-PVM-F-006: Layout and cross section of B.F. VALVE HOUSE

2.3.10 5602-906-H115-PVM-F-107: Layout and Aux. Bldg (at 132 KVA Switchyard)

2.3.11 5602-906-H115-PVM-F-101: Layout of Equipment in Barrage control bldg.

2.3.12 5602-906-H115-PVM-F-106: Equipment Layout in Surge Shaft area.

2.3.13 5602-906-H115-PVM-F-105: Equipment Layout in TRT Portal

2.3.14 5602-906-H140-PVM-F-003: Diagram of control gear for cooling water system

2.4 Complete Structural work for erection of mechanical, electrical and C & I equipment, support, inserts for duct / fans / pipes / cable tray etc. is in bidder's scope. Following may please be noted.

1) Duct support structure outside and inside power house for routing supply / exhaust duct / cable trays etc. from AHU room shall be in bidder's scope. Necessary supports may be taken from nearest structure / walls / roofs / floors etc. by bidder subject to customer / BHEL acceptance during detail engineering.

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

3) Anchor fastener / HILTI fasteners shall be used by vendor for fixing duct/ pipes etc. wherever applicable.

4) Duct supporting and accessories material such that hangers, tie rods, nut, bolts, lock nut, washer, HILTI fastener, gasket, bracing, adhesive, sealant, rivets, angles, channels, bracket support etc. for completeness of duct installation in all aspects shall be in bidder scope.

Any other type of structural work for complete HVAC system is deemed to be in bidder's scope even though specifically not mentioned above.

3 DESIGN CRITERIA

3.1 SYSTEM DESIGN CRITERIA – AMBIENT CONDITIONS

3.1.1 The outside design conditions considered shall be under: -

	Summer	Monsoon	Winter
DBT (°C)	**37**	32	**8**
WBT (°C)	25.4	26	6.5

3.1.2 Mean maximum ambient temperature of air in summer: 33°C
3.1.3 Mean minimum ambient temperature of air in winter: 5°C
3.1.4 Mean maximum Relative humidity: 85%
3.1.5 Maximum river water temperature: 20 °C

3.2 SYSTEM DESIGN CRITERIA - AIR CONDITIONING SYSTEM

3.2.1 The inside design conditions to be maintained shall be as under: -

24°C ± 1^{0}C & RH 50% ± 5% for control room etc.

3.2.2 Fresh air requirement shall be minimum 1.0 air change per hour for control room areas or 16 CFM per person whichever is higher. For other areas like office, Fresh air shall be considered as per ISHRAE.

3.2.3 A design margin of 10% on total sensible and latent heat shall be considered while designing the AC Plant capacity for each area.

3.2.4 Necessary Heater and Humidifier shall be provided (if required).

3.2.5 The maximum air velocity through Air conditioning duct shall be 7.6 m/sec.

3.3 SYSTEM DESIGN CRITERIA - VENTILATION SYSTEM

3.3.1 Inside design temperature < 35°C & RH < 70%.

3.3.1 Ventilation provision for various location is envisaged as follows

S.No.	Name of premises	Type of Ventilation	ACPH
1.	Power House area	Ventilation by Once Through Water System with AHU and Mechanical exhaust from Wall mounted fans.	
a.	Lift & staircase area	Once Through water System through AHU	2
b.	Machine Hall	Once Through water System through AHU	2
c.	Service bay	Once Through water System through AHU	2
d.	Switchgear room in power house	Once Through water System through AHU	4
e.	Generator floor	Once Through water System through AHU	2
f.	Electrical workshop & Engineer's room	Once Through water System through AHU	4
g.	Turbine floor	Once Through water System through AHU	2
h.	Compressor room (Part of Power House)	**Fresh air supply**: Once Through Water System through AHU	4
i.	MIV Floor	Once Through water System through AHU	2
2.	Battery room / Battery charger room	Wall mounted exhaust fans (spark proof with flame proof motor) with ducting (if required) Fresh air supply through of Louvers	8
3.	Toilets & pantries for Power House and other areas	Exhaust by means of propeller type exhaust fan. Supply through door undercuts / door louvers	8
4.	Mechanical workshop	**Fresh air supply**: Once Through Water System through AHU **Exhaust Air:** by Through gravity dampers.	4
5.	Butterfly valve house	Fresh air supply through axial supply air fan. Exhaust by mean axial exhaust fan.	2
6.	DG set Room	Exhaust by means of wall mounted axial flow exhaust fans. Fresh air supply through of Louvers	10
7.	Switchgear room for outside power house	Fresh air supply through axial supply air fan. Exhaust by mean axial exhaust fan / gravity damper as per requirement.	4

3.3.2 Air quantities shall be calculated based on heat load basis based on heat dissipation values from the various equipment, other heat source in various areas and the air quantity calculated based on air changes per hour and adopting higher of the two values.

3.3.3 The maximum air velocity through ventilation duct shall be 12.5 m/sec.

3.4 CODES AND STANDARDS

The following standards, codes and technical documents are used for the design of HVAC system.

3.4.1 ASHRAE**/** ISHRAE Guide and data book, American Society of Heating, Refrigerating and Air Conditioning Engineers.
3.4.2 IS: 655/ IS 277 for Sheet Metal Air ducts.
3.4.3 IS: 4720, Indian Standard Code of Practice for Ventilation of Surface Hydel Power Stations.
3.4.4 IS: 3103- Code of practice for industrial ventilation
3.4.5 ANSI/ Standard 62- Ventilation for acceptable indoor air quality
3.4.6 IS 659- Safety code for Air-conditioning.

3.5 GENERAL PRINCIPLES

3.5.1 Cooled air shall be supplied generally at low points of the powerhouse and exhaust air shall be at high points.
3.5.2 Areas such as battery room, toilet and pantry which are exposed to harmful gases or odors shall be maintained at negative pressure and these harmful gases / odors shall be exhausted outside the power building with the help of separate exhaust air fans.
3.5.3 Lighting load considered shall be 2 Watts/sq. feet.
3.5.4 The Occupancy considered shall be 1 person in 25SQM or (actual) whichever is higher.
3.5.5 All the equipment for HVAC system shall be designed for continuous duty.
3.5.6 For winter Load calculations, only the lighting load shall be taken into account and equipment load shall be considered as Zero (0).
3.5.7 The heat dissipation values from various equipment / Occupants shall be taken into consideration while designing the HVAC system.

4. GENERAL DESCRIPTION OF VENTILATION AND AIR CONDITIONING SCHEME

4.1 VENTILATION SYSTEM

4.1.1 POWER HOUSE AREA

4.1.1.1 Once through type Ventilation system shall be provided for maintaining an air temperature of <35 degree in summer season & ≥18 degree in winter season with RH Less than 70%.
4.1.1.2 The supply air quantity requirement will be worked out based on heat load calculation from first principle as well as for maintaining minimum no. of air changes as per IS:4720 / as mentioned in table given above, under clause 3.3.1 (higher of the two). The higher value of the two shall be adopted for supplying air to various areas of power house.
4.1.1.3 In order to meet the above requirements, 3x50% Air Handling Units (AHU) shall be provided.
4.1.1.4 **E**ach AHU units of required capacity shall be placed inside AHU room at an elevation of **431.6M / 435.0M** floor. These units shall be in floor mounted horizontal design, comprising of fresh and return air dampers, Pre-filters & fine filters, cooling coil section / heating element and fan section having supply air centrifugal fan with driving/ installation accessories and shall supply the cooled air to the various areas of the power house building with the help of air conveyance ducting and grilles. The fresh air in these units shall be drawn from outside through fresh air intake louver / damper arrangement. During summer and monsoon seasons, there shall not be any return air intake. However, during winters, a part of air from Machine Hall shall be fed back to AHU room as return air and remaining

quantity of air (required only for human comfort) shall be taken as fresh air through Fresh Air Intake Louver provided in AHU room.

4.1.1.5 In summer, 60% of fresh air supplied to Power House area except Battery rooms & toilets, shall be exhausted with the help of exhaust fans. These fans shall be mounted at a higher level in Machine hall all through the equally distributed on upstream & downstream wall. These fans shall be complete with air inlet bird mesh, exhaust air cowl with gravity louver and bird mesh and supporting/ fixing frame.

4.1.1.6 For winter heating of power house strip heater along with control system of suitable capacity shall be considered.

4.1.1.7 The exhaust air from toilets and battery room in power house shall be evacuated by means of separate exhaust fans.

4.1.1.8 Automatic motorized dampers shall be provided at the common discharge duct of AHU's at power house. Fire rating of dampers shall be 90 minutes.
In order to avoid spreading of fire, the motorized damper with in-built controller having a provision of interfacing with the control panel of fire-fighting equipment of power house shall be considered.

4.1.1.9 For Exhaust of Stale air from Power House Complex a group of exhaust Air fans each of suitable capacity shall be provided on the wall of power house. in addition to these exhaust fans for stale air, additional fans for smoke exhaust shall be provided which shall be made operational automatically in case of detection of fire. These fans shall be placed on the two longitudinal sides of the Machine Hall and Service Bay near roof top. Provisions shall also be made for an automatic shutdown of the fresh air supply from AHU to the respective area in case of fire by using a signal of fire protection system. In such a case all exhaust fans shall work as a smoke exhaust fans. Due to these additional fans, draft will increase and smoke will be disposed outside the power house.

4.1.2 BUTTERFLY VALVE HOUSE AND SWITCHGEAR ROOM

4.1.2.1 Supply air shall be provided with the help of supply air axial fan.

4.1.2.2 In order to create positive pressure inside butterfly valve house, 60% of inducted fresh air supplied to valve house shall be exhausted with the help of exhaust air axial fans.

4.1.2.3 Pre & Fine filters, supply dampers, bird screen, grills, louvers wherever required for above units shall be provided.

4.1.3 CONTROL/SWITCHGEAR BUILDING AT BARRAGE AREA

4.1.3.1 Supply air shall be provided with the help of supply air axial fan for switchgear room. These fans shall be comprising of Pre & fine filters. In order to create positive pressure inside switchgear room, 60% of supply air shall be exhausted with the help of exhaust air axial fans.

4.1.3.2 Bird screen, grills, louvers wherever required for above units shall be provided.

4.1.3.3 Separate exhaust air axial fan shall be provided for DG room and toilets.

4.1.4 CONTROL / SWITCHGEAR BUILDING IN 132 KVA SWITCHYARD BUILDING

4.1.4.1 In 11KV & 33KV switchgear room, supply air shall be provided with the help of supply air fan with Pre & fine filters. This fan shall be of Tube Axial Flow type and shall be suitably placed on the wall of the room. These fans shall be provided with exhaust air gravity louver with bird mesh.

4.1.4.2 **S**eparate exhaust fan shall be provided for DG room, Store and toilets.

4.2 AIR-CONDITIONING SYSTEM

4.2.1 POWER HOUSE AREA

4.2.1.1 Air cooled package type air conditioners (PAC) shall be provided for power house as per details given below.

Sr. No.	Area to be Air-Conditioned	No. of PACs	Remarks
1.	Control Room, SCADA room, Shift engineer room & PLCC room	2 x 100 % / 4 x 50% *	
2.	Conference room	2 x 100% / 4 x 50% *	AC requirement is clubbed, being located on the same floor.
3.	Relay and protection room.		
4.	Store and Library	1 x 100%	Due to space constraint, we proposed split AC / ceiling suspended duct-able split AC or PAC.

'*' = Configuration of the PACs shall be decided based on Heat Load Calculations.

4.2.1.2 As per heat load calculation, the load / capacity of the air conditioning system for above areas shall be works out during detailed engineering stage.

4.2.1.3 Winter heating section shall consist the strip heater along with control system of suitable capacity.

4.2.1.4 For control of humidity, pan type humidifiers of suitable capacity shall be provided for above package air conditioners.

4.2.2 CONTROL / SWITCHGEAR BUILDING AT BARRAGE AREA

4.2.2.1 Split type air conditioners of suitable capacity shall be provided for air conditioning of control room of barrage area.

4.2.2.2 Winter heating section, the oil filled heaters along with control system of suitable capacity (2x100%) for control room of barrage area shall be provided.

4.2.3 CONTROL / SWITCHGEAR BUILDING IN 132 KVA SWITCHYARD BUILDING

4.2.3.1 Split type air conditioners of suitable capacity shall be provided for air conditioning of office area as applicable at switchyard area.

4.2.4 CONTROL ROOM FOR BFV HOUSE.

4.2.4.1 Split type air conditioners of suitable capacity shall be provided for air conditioning of control room of BFV house (if applicable).

5. LAYOUT CONSIDERATIONS:

5.1 AIR CONDITIONING SYSTEM

5.1.1 Air Cooled Package type AC shall be housed at various locations, as under:

Sr. No.	Area to be Air-Conditioned	Tentative Space Requirement for PAC	Location of PAC

1.	Control Room, SCADA room, Shift engineer room & PLCC room at EL 425.75.	8.5M x 5.5M	Above Control Room Area at EL 435.0M, Refer attached control block layout. Outdoor unit of PAC shall be located at roof of PAC/AHU room.
2.	Conference room at EL 420.80.	8.5M x 4.1M	Adjacent to Conference room and Relay & Protection room at EL 420.80. Outdoor unit of PAC shall be located at EL 416.0M outside power house.
3.	Relay and protection room at EL 420.80.		
4.	Store and Library		Location will be decided DDE. However, split AC / ceiling suspended duct-able split AC or PAC. adjacent to Store Room / library.

The locations and space requirement of the AC equipment given above may change during detail engineering.

5.1.2 Suitable provision (transducer, control cables etc) shall be kept for transmission of relative humidity and temperature data from AC system of relay room to the control room.

5.2 VENTILATION SYSTEM

5.2.1 3 nos AHU (2W+1SB) in AHU Room at auxiliary floor EL. 431.6M / 435.00M level or as decided during detailed engineering.

6. EQUIPMENTS TO BE PROVIDED

6.1 Required numbers Air Cooled Package type air conditioners with R-134a / R-410A / R-407C or any other environment friendly latest refrigerant complete with all accessories as described hereinafter.

6.2 3x50% Air Handling Units (AHU) of suitable capacity for Ventilation system.

6.3 1 (one) Pan type humidifier with tank and header in common discharge plenum shall be provided for Package AC room. A makeup water line with float valve shall be provided for Pan Humidifier tank. Pan humidifier requirement for AHU room (if applicable) shall also be provided for Ventilation system.

6.4 1 lot strip type duct heaters.

6.5 Lot – Pre-filters having efficiency of 90% down to 10-micron particle size (inside the pre-filter section of the AHUs

Pressure drop:

Initial pressure drop: Not to exceed 5.0 mm WC at rated flow

Final pressure drop: Up to 7.5 mm WC

6.6 Lot - Fine filters having efficiency of 99% down to 5-micron particle size (shall be provided for individual AHUs). Differential pressure sensor with alarm to be provided across filter sets refer P&ID.

Pressure drop:

Initial pressure drop: Not to exceed 10.0 mm WC at rated flow

Final pressure drop: Up to 25 mm WC

6.7 Fresh air arrangement complete with louvers, filters shall be provided for AHU room.

6.8 Lot- Refrigerant piping with insulation interconnecting PAC and fittings such as elbows, tees, reducers, flanges etc.

6.9 Lot-Drain water piping out of MS pipes conforming to IS-1239, Part I, heavy grade and galvanized as per IS:4736, from various equipment like Package AC etc. up to the nearest drain point.

6.10 The supply air duct shall be provided with motor operated fire damper at locations where duct pass through walls & floors for ease of isolation, maintenance and as well as for emergency operation. The operation of these automatic dampers shall be interlocked with the fire alarm system. Fire dampers shall be of rating 90 minutes.

6.11 Lot – GSS Ducting (as per IS-277) with 275 g/sq.m. of zinc coating sheet metal work, complete with volume control dampers, extruded aluminium supply air (with VCD) and return air grills, hangers, supports, flexible connections, including thermal insulation on complete supply air duct & return air duct (as applicable for air conditioning system) and Ventilation duct, wherever they are exposed to outside the building.

6.12 **ACOUSTIC INSULATION**

6.12.1 Lot- Acoustic insulation 25 mm thick of fibre glass with 48kg/m3 of first 5 M of ducting after AHUs & PAC but limited to plenum.

7. AC EQUIPMENT

7.1 Air Cooled type (DX system) Package AC
Each air cooled type package unit shall comprise of the following as per Manufacturer standard:

a. Scroll / Reciprocating Compressors (Semi-Hermetic / Hermetic) with R-134a/R-407c/R-410a refrigerant, motors complete with suction and discharge shut off valves, oil pumps, high

pressure cut out, low pressure cut out, oil pressure cut out, built-in automatic capacity control etc.

b. One (1) No. fan and fin type air cooled condenser Vapour inlet and liquid outlet connection for refrigerant, drain connection etc. One (1) No evaporator coil and fan having direct expansion type copper tubes and aluminium fins. The evaporator fan shall be DIDW forward curved centrifugal fan.

c. Lot-MS (Mild Steel) heavy class seamless refrigerant piping, valves and fittings, inter-connecting compressor, condenser and chiller.

d. Lot-MS (Mild Steel) structural frame work with anti-vibration pads.

e. Initial fill of refrigerant and compressor lube oil

f. Lot- insulation of suction line and evaporator

g. Lot-Controls with microprocessor based control panel mounted on the Package AC.

h. Fine filter in common plenum

i. Electric strip heater in common plenum

j. Fresh air arrangement complete with louvers, filters fan and motor shall be provided for each Package AC Unit Rooms

k. For other details please refer to clauses no 6.02.01 and other relevant clauses of Customer technical specification section C2-A.

7.2 SHEET METAL WORK

a. Lot – GSS (Galvanised Steel Sheet) supply and return air Ducting (as per IS-277) with 275 g/sq.m. Of zinc coating complete with vanes, damper, hangers / supports etc.

b. Lot- Supply air diffusers / grilles (Frame and Louvres of Diffuser/Grilles shall be of extruded aluminium of 1.2 mm thick section, duly powder coated) with volume control dampers. Return air Diffusers will have no Volume Control Damper.

c. Rectangular ducts of size upto 750mm and above shall be supported by 15mm M.S. rods and 50 x 50 x 3 mm M.S. angles while ducts below 750mm shall be supported by 10 mm M.S. rods and 40 x 40 x 3mm M.S. angles. The M.S. rods and angles shall be given a coat of primer paint. The spacing of duct supports shall not be more than 2500 mm. Arrangement like drilling and placing anchor fasteners for duct support, auxiliary or special steel members, hooks coach screws and all other supporting material required shall be provided. wherever the ducts are thermally insulated the M.S. angles and supports shall not be in direct contact with ducts.

d. For other details please refer to clauses no 6.03.00 and other relevant clauses of Customer technical specification section C2-A.

7.3. SPLIT AIR CONDITIONER

Split type air conditioners (air cooled) shall be provided to cater to the air conditioning requirements for auxiliary / local control room etc. For these areas multiple working split ACs shall be provided. Local isolator / MCB shall be provided with split units.

Hand operated remote and other accessories as specified. Local Distribution Boards containing Switch / MCB shall be provided for Split Air Conditioners. Each split unit shall also be provided with suitable rating stabilizer. 100 % stand by split AC units shall be provided.

Split AC shall conform to latest available highest BEE rating.

8.0 VENTILATION EQUIPMENT:

8.1 AIR HANDLING UNIT (DOUBLE SKIN TYPE)

Each air handling unit shall comprise of the following: -

a. Double skin panels (inside and outside) shall be fabricated using **minimum 0.63 mm (24 G)** galvanized steel, with 25 mm thick polyurethane insulation of minimum **38 kg/m3** density in between, GSS channels shall be used as reinforcing to give structural strength. 16G MS Structure of Sectionalized construction, insulated SS drain pan, and all accessories as specified are to be provided.
b. Filter section shall be separate.
c. Fan-motor set on a common base frame with all drive accessories shall be provided in the fan section and fan section shall be provided with access door
d. Fan section complete with forward / backward curved multi-bladed centrifugal fan mounted on a shaft with adjustable motor base.
e. One No. adequately sized TEFC sq. cage induction motor suitable for 415 V, 3 phase, 50 Hz AC supply with drive package comprising fan pulley, motor pulley, V-belt and belt guard.
f. Coil section (integral with filter section) with suitably sized circulation water coil made of as per manufacturer standard and aluminium fins along with valves for isolation.
g. Flat filter sections complete with 50 mm thick dry panel type filter having efficiency 90% down to 10 micron.
h. Drain piping from the AHUs up to nearest drain point.
i. Lot – Controls comprising:
j. 150 mm dia dial type temperature gauges one each at suction & discharge side of the coil of AHU.
k. 150 mm dia dial type pressure gauges one each at suction & discharge side of the coil of AHU.
l. Lot – vibration isolation (Neoprene rubber cushy foot / neoprene serrated rubber pad type with isolation efficiency not less than 85 %.)
m. Lot- supply water pipeline for AHUs of ventilation system.
n. For other details please refer to clauses no 6.01.00, 6.01.11, 6.01.16.01, 6.01.16.02 and other relevant clauses of Customer technical specification section C2-A.

8.2 CIRCULATION WATER PUMP SETS

Each water circulating pump set shall comprise of the following: -

i. One No. for taking water from upstream/ sump to AHU's, Horizontal split casing type centrifugal pump of adequate capacity to match the system requirement.

ii. One No. adequately sized TEFC sq. cage induction motor suitable for 415 V, 3 phase, 50 Hz AC supply.

iii. One set of base plate, coupling guard, anti-vibration pads, foundation bolts etc.

iv. Valves, Instruments other fittings etc along with chilled water pumps.

v. One No. Duplex Filter at inlet complete with all accessories, drain arrangement, etc.

vi. 150 mm dia dial type pressure gauges one each at suction & discharge side of the pump set.

vii. 150 mm dia dial type temperature gauges at suction side of each of the pump set.

viii. Gate valves, one each at suction and discharge side of the pump set.

ix. One No. non-return (check) valve at discharge side of pump set.

x. One No. Pressure Switch at discharge side of pump set.

xi. Drain Piping from pump to nearest drain.

xii. Mechanical seals and all accessories as specified shall be provided.

xiii. MOC of Pump

- Pump Casing — Cast steel (ASTM A216 WCB)
- Pump Shaft — Stainless steel (AISI 420 or better)
- Impeller — High grade duplex stainless steel
- Pump Bearings — Anti friction
- Impeller wear rings — Stainless Steel
- Casing wear rings — Stainless Steel
- Shaft sleeve — Stainless Steel Gr. 410 H
- Base Plate — MS Plate to IS 2062
- Stuffing box seal — Gland Packing / Mechanical seal (C vs SiC & C vs TC) to suit silty water
- Companion Flange — IS 2062 Gr.B
- Insulation class F (temp rise limited to b)

8.3 AUTOMATIC BACKWASH SELF CLEANING FILTER (ABSF) & CYCLONE SEPARATOR

(I) Filters element shall be of SS-316 or superior for ABSF.

(II) Internals shall be of SS-316 or superior for Cyclone separator.

8.4 WALL MOUNTED AXIAL FLOW FAN/ TUBE AXIAL FAN / PROPELLER FANS

Each wall mounted axial flow fan shall be complete with

(i) Fan impeller with aerofoil section of cast aluminium alloy & casing/short duct as required.

(ii) Electric drive motor with coupling if any, including motor brackets.

(iii) Inlet cone and grouting framework, if any.

(iv) Rain protection cowl with bird-screen adjustable damper, vibration isolators, back draft dampers etc. shall be provided.

(v) Axial fans will be of propeller type, for fans with 5 mm of wc fan static pressure and Tube Axial type for fans with static pressure above 5 mm of wc.

(vi) Each Axial fan comprises of fan, fan motor, inlet and outlet cone (for Tube axial), Louvered shutter (exhaust fans), bird screen and supporting arrangement.

(vii) For other details please refer relevant clauses of Customer technical specification section C2-A.

1	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
2	Axial flow supply fans with 20 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	10,000 CMH	1.5 KW	800mmx800mm
b.	7,500 CMH	1.1 KW	700mmx700mm
c.	6,000 CMH	1.1 KW	600mmx600mm

d.	4,000 CMH	0.75 KW	600mmx600mm
3	Axial flow exhaust fans (Bifurcated type) with 15 mmwc static pressure.		
a.	Capacity	Motor rating	Wall opening
b.	15,000 CMH	2.2 KW	900mmx900mm
c.	10,000 CMH	1.5 KW	800mmx800mm
d.	7,500 CMH	1.1 KW	700mmx700mm
e.	4,000 CMH	0.75 KW	600mmx600mm
f.	2,000 CMH	0.55 KW	500mmx500mm
4	Axial flow exhaust fans with 10 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	15,000 CMH	1.1 KW	900mmx900mm
b.	10,000 CMH	0.75 KW	800mmx800mm
c.	7,500 CMH	0.55 KW	700mmx700mm
d.	6,000 CMH	0.55 KW	600mmx600mm
e.	4,000 CMH	0.55 KW	600mmx600mm
f.	2,000 CMH	0.37 KW	500mmx500mm
5	Exhaust fan (propeller type) with 5 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	1000 CMH	100 W	300 mm circular

8.5 SHEET METAL WORK

(i) Same as clause no. 7.2 (Sheet metal work for AC system).

9. INSULATION FOR HVAC SYSTEM

Insulation shall be provided as under:

S.No	Surface	Insulation Material	Insulation Form	Thickness (mm)	Finish
i)	AC Duct	resin bonded fiber glass, (25 Kg/m3 density)	Roll / Slab	25	24 gauge Al cladding
ii	Ventilation duct (running outside the building) (if required)	resin bonded fiber glass, (25 Kg/m3 density)	Roll / Slab	25	Covered with 500 Gauge Polythene sheet, chicken wire mesh, 12mm thick sand cement plaster and an overall cladding of 24 G GI sheet.
iii)	Acoustic insulation of first 5M of ducting after AHUs but limited to plenum	Fibreglass (48 Kg density)	Roll / Slab	25	Perforated Al sheet
iv)	Refrigerant Piping	Al foil faced Nitrile rubber / Eqvt	Roll / Slab	39	Al cladding

For other details please refer to clauses no 6.03.06 and other relevant clauses of Customer technical specification section C2-A.

10. CONTROL PHILOSPHY

Control system for AC & Ventilation **system shall be controlled through main "Power House SCADA"** and following equipment shall be controlled through SCADA.

- Air Handling Units
- Package Air Conditioners and associated instrument.
- Smoke Exhaust fans
- Motorized Butterfly Valves for AHU stand-by selection
- Heater and Humidifier
- Motorized Fire Damper
- Any other drive/instrument required for system completion during detailed engineering

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

Detailed control philosophy shall be discussed and approved during detailed engineering stage.

For other details please refer to relevant clauses of Customer technical specification section C2-A.

11. POWER SUPPLY ARRANGEMENT

The power supply (rated voltage, frequency, phase) of the equipments will be 415V +/- 10%, 3ph, 50 Hz +/- 5% or 240V+/- 10%, 1ph, 50 Hz +/- 5% as the case may be.

12. ACCEPTANCE TEST

a. **Air conditioning system:** Room condition test shall consist of taking the reading of dry bulb and wet bulb temp at different locations points to be mutually decided at site in the areas which are air-conditioned by the respective system/plant. Room condition test shall be done after stabilization of the system. The dry and wet bulb temp shall be measured by sling psychrometer which will have accuracy of +/-0.5% with aleast count of 0.5 degC. This will be carried out for 24 hrs continuously and readings will be taken every two hours. Standby equipment should be changed over during these 24 hours. This test shall be carried out during summer during month April to June when the dry bulb temp is generally high and during. The format for recording the readings shall be defined in PG / Demonstration test procedure during detailed engineering stage. Relative humidity shall be determined from psychometric chart

b. **Ventilation system:** Temperature test at the out let of AHU and at different floors at mutually agreed locations. The dry bulb temp shall be measured by sling psychrometer which will have accuracy of +/-0.5% with a least count of 0.5 deg C. This will be carried out for 24 hrs continuously and readings will be taken every two hours. Standby equipment should be changed over during these 24 hours. This test shall be carried out during summer between months April to June. The format for recording the readings shall be defined in PG / Demonstration test procedure during detailed engineering stage.

c. All shop testing and test at site as specified shall be carried out.

d. The Noise level of the AC system shall not be exceeded 55dB (A) in rooms as in the Control Rooms, Offices & Reception Room.

e. The Noise level of the rotating derive shall not be exceed 85dB (A) at 1.5m from source.

Acceptance Test to be covered separately and should cover followings;

1. Performance Testing (Air Quantity at various floors)
2. Air Balancing
3. Leakage
4. Noise level
5. Vibration level
6. Fire Dampers working
7. Interlocking with SCADA
8. Motor Current
9. Temperature/Humidity at various location of different floors
10. All equipment (fans, blowers, motors, Compressors, Pumps, heater etc.) checking

For other details please refer to clauses no 7.00.00 and other relevant clauses of Customer technical specification section C2-A.

13.0 GENERAL

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

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

3) All drawings and documents shall be computer based.

4) All commissioning spares & consumables for trouble free operation shall be provided by Vendor.

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

6) Indicative list of makes is enclosed elsewhere in the specifications; however, these equipments / items shall be subject to Customer & BHEL approval during detail engineering Stage.

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

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

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

10) Only calibrated instruments shall be used by HVAC supplier for testing of various equipment.

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

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

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

14) 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%.

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

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

- Design dry bulb temperature and relative humidity of conditioned air, Vibration and noise level etc.
- All calibrated instruments to be used for the tests at manufacturer's works/site shall be arranged by the bidder.

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

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

19) Bidder should suitably group the signals coming from various instruments etc. & the same shall terminate in local JB, from Local JB common cable to PLC / panel / MCC shall be selected. Any Electrical / C&I items and accessories like junction box, glands etc. shall be included by vendor in his scope.

20) 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.

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

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

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

24) 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.

25) HVAC plant supplier to furnish drawings/ documents as per the dwg. / documents distribution as per project requirement.

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

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

28) The bidder shall furnish complete tech. Particulars in data sheet and schedules as specified elsewhere in the specification during detailed engineering.

29) The bidder shall arrange to provide training on complete HVAC system including operation & Maintenance for Employer Personnel.

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

31) Construction of openings in brick-walls, as required, for routing the ventilation, Air conditioning ducts and installation of axial fans, shall be in bidder's scope of works. Floor openings, as available at site, for duct routing can be used by bidder during erection of duct.

32) Further, sealing of duct opening, grouting of foundation / foundation bolts including special type of grouting like GPX2 etc. are in the scope of HVAC system supplier.

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

14.0 EXCLUSIONS

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

a) Construction of HVAC plant room, air handling unit room, foundations for HVAC equipments.

b) False ceiling, drop ceiling.

c) Provision of drain traps / points,

d) Fire water tank.

15.0 Codes and Standards

Design, manufacture, inspection and testing of the equipment covered by the specification shall conform to the latest edition of the standards and codes of HVAC system.

SECTION: I

SUB-SECTION: C2-A

CUSTOMER SPECIFICATION

(TECHNICAL REQUIREMENT)

PART - A

SUB-SECTION-III

SCOPE OF SUPPLY & SERVICES

RAMMAM STAGE-III HYDRO ELECTRIC PROJECT (3 X 40 MW) ELECTRO MECHANICAL WORKS EPC CONTRACT PACKAGE BIDDING DOC NO.: CS-5602-003-9	TECHNICAL SPECIFICATION SECTION-VI

1.00.00 SCOPE OF SUPPLY AND SERVICES

1.01.00 The scope of work for the equipment and accessories to be furnished in accordance with this specification shall include design, manufacture, engineering, inspection and testing at Bidders works, Insurance, packing, forwarding to site, unloading, erection, pre-commissioning, testing and commissioning, and performance testing of the equipment / system and works indicated in this Sub-section - III of Part - A of the technical specification. Any items or works though not specifically mentioned in this specification but needed to complete the equipment & systems to meet the Intent of the Specification shall also be furnished, unless specifically mentioned under "Exclusions" in Sub-section -IV of Part -A of the Technical Specifications.

1.02.00 Scope of supply of the Bidder includes mandatory spares, start-up and commissioning spares and recommended spares if ordered by Employer. The general requirements in respect of various types of spares are given in Sub-Section-VI of Section-VI, Part - A. The detailed list of mandatory spares is given in Part - F of Section-VI.

1.03.00 The detailed scope of work of the Bidder is detailed out in this Part-A of the technical specification Section-VI and is elaborated below:

Sub - Section

III A	-	Mechanical equipment and systems
III B	-	Electrical equipments and systems
III C	-	Control & Instrumentation systems

1.04.00 The scope of the Bidder includes all shop tests, model test, type tests, site tests, routine tests, etc., fulfillment of complete quality assurance & inspection requirements and related activities for all the equipment & systems covered under the scope of work of Bidder as per the stipulations of Technical Specifications.

1.05.00 **Paints**

The Bidder's scope of work includes supply of paints and painting of all equipments and structures as per the Employer's standard colour coding scheme. The quality and finish of paints shall be as per standards of BIS or of approved equivalent. The painting requirements & colour coding scheme are specified in Section-VI of the Technical Specification.

1.06.00 **Pre-commissioning and Commissioning Activities**

The Bidder's scope shall include all pre-commissioning and commissioning activities, materials and services as detailed in clause no. 30.00.00 of Part-D of Technical Specifications (Erection Conditions of Contract) including supply of all consumables, temporary equipments and pipings, instruments, labour/ skilled manpowers etc. The

	scope includes complete requirement of flushing oils including fresh oil refilling during the pre-commissioning & commissioning activities and subsequent initial operation.
1.07.00	**Consumables, Oils & Lubricants** All the first fill including the necessary quantity for flushing & for the first charge of greases, oil, lubricants, servo fluids and essential chemicals etc. which will be required to put the equipments covered under the scope of specifications, into successful commissioning/ initial operation and to establish completion of facilities shall be furnished by the Bidder, unless specifically excluded under the Exclusions in these specifications and documents.
1.08.00	**Guarantee Tests** The guarantee tests for various equipment and systems shall be carried out as specified under Sub-section-V, Part-A of Technical Specification. All special equipment, tools and tackles instruments, measuring devices required for the successful conductance of Guarantee Tests shall be provided by the Bidder, free of cost. All costs associated with the tests shall be included in bid price.
1.09.00	**Spares** The scope of work includes supply of mandatory spares, commissioning spares, consumable spares and others as specified under conditions of contract. The list of mandatory spares is brought out at Part-F, Section-VI.
1.10.00	**Special Tools & Tackles and Test/ Measuring Equipments** One set of all special tools and tackles including testing, calibrating and measuring instruments required for erection, assembly, disassembly and maintenance of all equipments/ systems covered under the scope of the Bidder shall be supplied by the Bidder as per clause no. 17.00.00 of Part-C and as specified elsewhere in Part-A / Part-B of Technical Specifications. These shall not be used for erection/ commissioning purposes and shall be in an unused and new condition, when they are handed over to the Employer. A list of all such special tools and tackles shall be submitted along with the offer.
1.11.00	The scope of the Bidder includes complete design and engineering, technical co-ordination (including participation and arranging technical co-ordination meetings), finalization of drawings/ documents, submission of engineering drawing / documents and processing of their approvals by the Employer as per clause no. 7.00.00, 8.00.00 & 9.00.00 of Part-C and other relevant clauses given elsewhere in the Technical Specifications.
1.12.00	Further, the scope shall also include submission, in proper shape & format, of all types of manuals, handbooks & documents in requisite numbers to the Employer at different phases of the project as per the requirement of Employer.

1.13.00	Bidder shall furnish all relevant data required by the Employer, at interface points within 45 days of notification of award.
1.14.00	**Noise Level** The noise level to be maintained by all the equipment & systems supplied & erected by the Bidder shall be as per clause no. 23.00.00 of General Technical Requirements, Section-VI, Part-C. Further noise level for motors shall be as specified in motor specification.
1.15.00	Bidder shall provide all necessary training to Employer's personnel as specified in Part-C, Section-VI, and as specified elsewhere in technical specification.
1.16.00	The Project construction works involve works to be carried out by other Bidders in addition to the works in the scope of EM Bidder. The Bidder shall, through co-ordination with the other Bidders, ensure the continuity and the coherence between his supply and that of the other Bidders. An overview of the equipment and facilities to be supplied at various locations by different Bidders are elaborated in Annexure to Sub-section-III.
1.17.00	As per Clause no. 1.09.00, sub-section-III B, Part-A, all Power & Control cables for the plant and equipment are included in the scope of the Bidder and as per Clause 1.01.00 (vi) & (vii), sub-section-IIIC of Part-A, Power, Control & Instrumentation Cables and fibre optic cables are included in the scope of the Bidder. Bidder may note that regarding cabling between switch yard and various offsite areas, the quantities (as indicated in Annexure-I to the sub-section-IIIB) of following type of cables shall be deemed to be included within the scope of the Bidder. • 33KV cables, • 11KV Aerial bunched cables, • LT power cables, • Control cables, • Instrumentation cables & • Fibre optic cables Bidder shall indicate unit rates and total cost for the above cables in the relevant schedule of BPS and the same shall be considered for evaluation of the Bids also. In case of variation in quantities of above cables during execution, the contract price adjustment on account of the same shall be based on the unit rates as agreed in the contract and the actual quantities supplied/ installed.

	Other than the above cables, all cables required as per system/ equipment in the Bidder's scope/ Employer's requirement as specified, shall be deemed to have been included within the bid price quoted by the Bidder and no extra cost on account of the same shall be considered during execution of the contract.
1.18.00	**General**
1. 18.01	All Fixtures, inserts, embedded parts, steel embedments including fixing lugs and welding between them, foundation plates, nuts, bolts etc., for fixing all the equipments, piping on civil works shall be in Bidder's scope. All structures which would be required by the Bidder for supporting the piping shall be in Bidder's scope.
1.18.02	Operating platforms for various inaccessible valves and equipment etc. shall be in Bidder's scope.

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PART - A

SUB-SECTION-IIIA

SCOPE OF SUPPLY & SERVICES (MECHANICAL)

RAMMAM STAGE-III HYDRO ELECTRIC PROJECT (3 X 40 MW) ELECTRO MECHANICAL WORKS EPC CONTRACT PACKAGE BIDDING DOC NO.: CS-5602-003-9	TECHNICAL SPECIFICATION SECTION-VI

CLAUSE NO.	SCOPE OF SUPPLY AND SERVICES (MECHANICAL)
1.05.00	**Ventilation and Air Conditioning System**
1.05.01	Complete Ventilation system consisting of fans, air filtration units, AHU's, supply air and exhaust fans, louvers, filters, ducting, diffusers, piping, instrumentations for the following areas:
1.05.01.01	Power station including power house, auxiliary block, buildings in switchyard, etc.
1.05.01.02	Butterfly valve house.
1.05.01.03	Control / Switchgear building in barrage area.
1.05.02	Split AC/ Package air conditioners for the control room and other rooms as specified in detailed specification in power house complete with associated accessories.
1.05.03	~~Window air conditioners~~ for control room of Control / Switchgear building in barrage area. Split AC
1.06.00	**Fire Detection, Safety and Fire Protection System**
	Complete fire detection, safety and fire protection system (including instrumentation & control) comprising of:
1.06.01	Fire Alarm and Detection System
	Microprocessor based main fire alarm panel and its repeater alarm panels, smoke detectors, manual call points, Audio devices, supervisory signal transmission facility from control panels for smoke detection systems and water based fire protection system, all cabling for various smoke/fire/heat detection systems, linear heat sensing detection system, and water based fire protection system, spares and tools etc. complete as described in the detailed specification (Part-B, Section-VI).
1.06.02	Water Based Fire Protection System
	Complete design, supply and installation of water supply system comprising of Vertical turbine pumps, strainers, piping alongwith valves & fittings, accessories etc. for various water spray and fire hydrant systems for powerhouse, transformer yard and switchyard.
	Testing of the complete system for alarm, trouble and supervisory functions upon completion of installation including coordinating and conducting the Demonstration and Acceptance Tests.
1.06.03	Electrically actuated automatic inert gas clean agent fire extinguishing system complete with clean agent cylinders, manifolds, directional valves, pipes, discharge nozzles bracket supports, hangers and such other fittings as necessary for the complete installation of the system.
1.06.05	CO_2 Fire Protection System for Generators.
1.06.06	Portable fire extinguishers of types as described in detailed specification.

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PART-B

SUB-SECTION- M5

HEATING VENTILATION AND AIR CONDITIONING SYSTEM

RAMMAM STAGE-III HYDRO ELECTRIC PROJECT (3 X 40 MW) ELECTRO MECHANICAL WORKS EPC CONTRACT PACKAGE BIDDING DOC NO.: CS-5602-003-9	TECHNICAL SPECIFICATION SECTION-VI

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1.00.00 DESIGN CRITERIA

1.01.00 The Heating, ventilation and air conditioning system shall be designed to provide specified environmental condition for equipment and/or personnel during all modes of plant operation. Filtering, cooling, heating, humidification/dehumidification of the supply air and its distribution shall be done to maintain the specified condition within the specified limits as indicated below:

a) **Ventilation System**

The system shall be designed to normally attain the following conditions throughout the year.

Temperature	--	<35 ° C
Relative humidity	--	< 70 %

Refer Clarification & Amendment Enclosed Below

b) **Air Conditioning System**

Required air conditions throughout the year in the premises to be air conditioned are as below:

DBT: 24 ° C ± 1 ° C

RH: 50 ± 5%

1.02.00 The following conditions of temperature shall be considered for designing the Air-conditioning & Ventilation system:

1)	Max. Temperature of air in summer	40 ° C
2)	Min temperature of air in winter	1 ° C
3)	Max RH	100%

Refer Clarification & Amendment Enclosed Below

1.03.00 In order to achieve the above-mentioned environmental conditions, the total air circulation rate within the Power house and other areas, shall be calculated based on air change required and heat load.

1.04.00 The air change required and occupancy for various areas which are ventilated/air conditioned are given in Annexure-I. Contractor shall estimate the heat load as per requirement.

1.05.00 Lighting load shall be minimum 2 Watts/sq. feet or more as per final lighting provided for each area.

1.06.00 All the equipments of Ventilation and Air Conditioning system shall be designed for continuous duty.

1.07.00 For winter heat load calculations, only the lighting load shall be taken into account and equipment load shall be considered as zero.

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1.08.00	The air distribution system shall be sized to have a constant frictional drop along its length and velocity through air conditioning ducts shall not exceed 7.6 m/sec and through ventilation duct shall not exceed 12.5 m/sec.
1.09.00	In case of fans and blowers continuous Motor rating shall be at least ten percent (10%) above the maximum load demand of the Fan, compressors, blower at the design duty point.
1.10.00	Wherever belt drives are used the belts shall be sized for 150% of the rated power and there shall be minimum of two belts per drive.
1.11.00	Noise level within the air conditioned space shall be restricted to 35-45 NC level with suitable acoustic attenuation/ duct silencers/ acoustic insulation, etc.
1.12.00	For calculating friction loss in piping system: WILLIAM & HAZEN formula shall be used with C value as 100
1.13.00	Air distribution for ventilation system and air-conditioning system shall be designed in such a way that there will be no dead pockets any where and sufficient air flow as indicated above is obtained along with full length of the room/hall.
1.14.00	ABBREVIATIONS Abbreviations used in this specification are as below:

AHU	:	Air Handling Unit
CMH	:	Cubic Meter per Hour
CW	:	Cooling Water
DBT	:	Dry Bulb Temperature
EAF	:	Exhaust Air Fan
FAD	:	Fresh Air Duct
FD	:	Fire Damper
PID	:	Proportional Integral & Differential
RAD	:	Return Air Duct
RH	:	Relative Humidity
SAD	:	Supply Air Duct

CONSTRAINTS

Various equipment of Ventilation and Air Conditioning Scheme, piping layout, fresh air, supply air and return air ducting will have to be accommodated / installed in the

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available space taking care of the sizes of columns / beams, trenches, room etc. as well as the layout of other equipment in the power house.

If any of the civil works wherein equipment, piping, ducting, etc. of ventilation and Air Conditioning Plant is to be installed is not ready, the work of erection shall be carried out as per the progress of the civil works.

2.00.00 GENERAL DESCRIPTION OF VENTILATION AND AIR CONDITIONING SCHEME FOR POWER STATION

2.01.00 **Drawings**

The proposed schematic for the ventilation and air conditioning system in various floors of the Power House are shown in the relevant tender drawings enclosed under Part-E, Section-VI of Technical Specification.

2.02.00 **Ventilation System of Power House**

2.02.00 The system shall comprise all necessary supply and exhaust air fans, bird screen, air filters, AHU , Cooling Coils, water piping and valves, grills, louvers, motor/manually operated valves, fire dampers, all galvanized metal sheet ducts, acoustic & thermal insulations where required and complete support and steel frame work for air ducting system in various floors/areas ,flexible duct and all airtight type door wherever required for the AHU and Fresh air Blower Rooms.

2.02.00 During normal operating period, all the working equipment shall run on normal power supply. However, in case of complete black-out condition, DG sets are required to cater the load of the following ventilation and air-conditioning equipments:

a) Packaged Air conditioners for Control Room and SCADA room.

b) One (1) no. AHU at powerhouse.

c) Minimum 50% of total qty of each capacity of exhaust fans.

2.02.03 Total air quantity required for the ventilation system of the power house shall be calculated and submitted by Contractor along with bid.. The total ventilation air quantity shall also include air required for lift shafts and lift machine rooms.

2.03.00 **Ventilation System Air**
One (1) sets of AHU (comprising of 3 identical units in which 2 units working and 1 unit as standby) shall be provided to achieve the total flow rate.

2.04.00 **Fresh Supply Air**

The principal function of the plant is to supply fresh air to machine hall and to various other floors in the power house.

Each AHU shall supply treated air (cooled in AHU by cold water from Over head water storage tank) through ducts to the various areas as indicated in tender drawings .Supply air shall be circulated in the power house through two headers

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running along the full length oh the power house at the various floor levels to achieve even distribution of air. The duct routing shall be finalised during detail engineering based on actual requirements.

Pre-filter and fine filter shall be provided for each unit of AHU.

2.05.00 **Exhaust Air**

i) It is planned to evacuate air equivalent to 60% of the fresh air intake from the powerhouse. Adequate number of exhaust fans shall be mounted along the wall of the power house for evacuation of air.

ii) The exhaust air from toilets and battery rooms in powerhouse shall be evacuated by means of separate exhaust fans. A separate exhaust air GI duct, as applicable, shall be provided for the same.

iii) For DG set rooms, exhaust fans shall be provided with requisite no. of air-changes as per the relevant standard.

2.06.00 Automatic motorized operated fire damper shall be provided at Common discharge air ducts of AHUs at Power house to avoid spread of fire/ smoke.

The operation of the automatic dampers shall be interlocked with the fire alarm system and shall also be possible to operate manually from the remote control panel. Required electrical contacts shall be provided in control panel of AHU by the Contractor for further wiring up to Fire alarm panels.

The fire dampers shall have fire rating of minimum 90 minutes. Closure of fire dampers shall raise an alarm in the system.

3.00.00 AIR CONDITIONING SYSTEM IN POWER HOUSE AREA

3.01.00 The following areas shall be air conditioned by packaged air conditioners:

Sl. no.	Areas to be Air-Conditioned	Nos of packaged air conditioners
1	Control Room, SCADA room, Shift engineer room & PLCC Room	2 x 100%
2	Conference Room	2 x 50 %
3	Store and Library	1 x 100%
4	Relay and protection room	2 x 100%

3.02.00 Final capacity of Packaged Air-Conditioners shall be subject to approval during detailed engineering.

3.03.00	Suitable provision (transducer, control cables etc.) shall be kept for transmission of relative humidity and temperature data etc., from A.C. system of relay room to the Control room.
3.04.00	Layout The Contractor shall furnish recommended layout & scheme of equipments, main ducts, branch ducts, exhaust fans etc. for ventilation and air conditioning system in his bid.
4.00.00	**GENERAL DESCRIPTION OF VENTILATION SCHEME FOR BUTTERFLY VALVE HOUSE**
4.01.00	Ventilation system shall be provided for butterfly valve house. The system shall comprise all necessary supply air fans, exhaust fan, bird screen, pre-filter and fine filters, grills, louvers wherever required shall be provided for the ventilation system.
4.02.00	Exhaust Air In order to create positive pressure inside the butterfly valve house for proper ventilation, it is planned to evacuate 60% of the inducted fresh air from the butterfly valve house.
5.00.00	**GENERAL DESCRIPTION OF VENTILATION AND AIR CONDITIONING SCHEME FOR CONTROL/SWITCHGEAR BUILDING AT BARRAGE AREA**
5.01.00	Ventilation system shall be provided for the Switchgear room of the control/switchgear building of the barrage. The temperature inside control/switchgear room shall be maintained below 35^0C. The system shall comprise all necessary supply air fans, bird screen, pre-filter and fine filters, grills, louvers wherever required shall be provided for the ventilation system. Separate exhaust fans shall be provided for DG room and toilets.
5.02.00	The air conditioning system comprising of 2 x 100% ~~window air conditioners~~ Split AC shall be provided for the control room of the control/switchgear building at Barrage Area. Oil filled room heaters of adequate capacity (2X100%) shall be provided to take care of heat load during winters. The Contractor shall assess the cooling and heating load capacity of ~~window air conditioners~~ as per relevant standard under the design conditions stated above. Split AC

Refer Clarification & Amendment Enclosed Below

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6.00.00	**DESCRIPTION OF EQUIPMENTS FOR VENTILATION AND AIR CONDITIONING SYSTEM**
6.01.00	**VENTILATION SYSTEM**
6.01.01	**Fans** The design, material, construction, manufacture, inspection, testing and performance of fans shall comply with the latest edition of IS.
6.01.02	**Fan Housing** The casing shall be of GI /Mild steel spray galvanized with minimum thickness of 3 mm. The casing shall be of welded construction, fabricated with heavy gauge material. It shall be rigidly reinforced and supported by structural angles and seams shall be permanently sealed air tight. Casing drain with valve shall be provided, if required. The materials of construction shall be specified by the Contractor.
6.01.03	**Impeller** The impeller blade shall be Forward/ backward curved blade. The impeller shall have die formed blades welded to a rim and back plate. Inlet shall be spun to have a smooth contour. If required intermediate stiffening rings will be provided. Shaft sleeves shall be furnished. The impeller, pulley and shaft sleeves shall be secured to the shaft by keys and nuts. The impeller shall be statically and dynamically balanced.
6.01.04	**Bearings** The bearings shall be of Self aligning type, permanently lubricated, heavy duty with a design life of 10,000 operating hours and roller type supported adequately. They shall be easily accessible and lubricated properly.
6.01.05	**Fan Motor Drive** For main blower fans multiple V-belt type drive shall be used. Each drive shall consist of a cast iron fan pulley, cast iron motor pulley, endless rubber and fibre 'V' belt of suitable thickness. Pulleys shall be accurately proportioned so that the fan will be driven at the correct speed groove for the proper number of V-belts, statically and dynamically balanced and bored, fitted and keyed to their respective shafts. The other fans where direct drives are employed with flexible coupling, the same shall be ruggedly constructed and adequate for its application. It shall be carefully fitted and secured to the fan and motor shaft. A removable metal guard of substantial construction shall be provided for each flexible coupling. The guard shall adequately protect the operator and others from contacts with the coupling. Suitable drive guard shall be fitted to fans. These guards shall be designed to allow adequate ventilation and to permit the measurement of shaft speed without its removal.

6.01.06	Inlet Guard shall be spun to have a smooth contour. Inlet screen shall be made up of galvanized wire mesh of 25 square mm.
6.01.07	Base plate with necessary number of steel spring vibration isolators shall be provided.
6.01.08	All the accessories of the fans as required for its satisfactory operation shall be provided.
6.01.09	The fans shall be provided with anti vibration pads to ensure noise level (<80 db). The fan shall be designed for optimum performance at a given duty. However, it shall be suitable for working reasonably over a range of pressure and volume of air handled. The fan shall be capable of generating static pressures suitable for site conditions and to deliver the designed quantity of air at the remotest point in the duct network if applicable. The static pressure shall be sufficient to also take into account the losses involved at the suction side including for air filters & cooling coils heat exchanger.
6.01.10	Each fan shall be provided with heavy steel wire mesh inlet guards to prevent accidental contact with the rotating blades. The fans shall be provided with adjustable 'V' belts.
6.01. 11	Air Handling Unit (AHU)
6.01.11.01	Each AHU shall consist of casing, fan impeller section, cooling coil section, damper section, steel frame with vibration isolators (of minimum damping efficiency of 85%) for the complete AHU, Pre-filter at the suction of each individual AHU and isolation dampers at the suction and discharge of each AHU.
6.01.11.02	The casing of AHUs shall be of double skin construction. Double skin sandwich panels (inside and outside) shall be fabricated using minimum 0.63 mm (24g) galvanized steel sheet, with 25mm thick polyurethane foam insulation of minimum 38 Kg/Cum density in between. Suitable reinforcements shall be provided to give structural strength to prevent any deformation/buckling.
6.01.11.03	Cooling Coil Cooling coil shall be of seamless copper tubes with aluminum fins and shall be provided with suitable drains and vents connections. The cooling Coil shall be of standard make and mounted in such a way that each element is replaceable. i) Finned Tube Type Cooling Coil having large surface area shall be made from 18 gauge copper seamless tubes and plate type continuous Aluminium fins 28 gauge, 7 fins per inch. The headers shall also be of seamless copper pipes. The frames shall be made from 10 gauge MS sheet and sand blasted before applying finish paint. ii) After inserting the fins over the tubes, the tubes shall be mechanically expanded from inside throughout their length so as to ensure firm contact between the tubes and fin collars for efficient heat transfer.

iii) Each section of the will be hydraulically tested at 5kg/cm^2 pressure and test certificate will be issued.

iv) Water inlet and out connections shall be of flanged type and flanges shall be as per relevant Indian Standards.

6.01.12 Critical speed

First critical speed of rotating assembly shall be at least 25% above the operating speed.

6.01.13 Strip Heaters

The strip heaters, along with control systems, of suitable capacity and numbers shall be suitably located, so as to maximize its efficiency of heating.

6.01.14 Induction Motors

Please refer separate sub-section for motors.

6.01.15 Pan Humidifier with tank and header in common discharge plenum shall be provided. A make up water line with float valve shall be provided for Pan Humidifier tank.

6.01.16 Air Filters

6.01.16.01 Pre Filters

1) Filter medium :

i) Filter media shall consist of suitable fibrous material (e.g. non-woven material of polyster / polyethylene) sandwiched between protective mesh of HDPE and supporting mesh of GI.

However, filter media shall be V fold galvanized wire mesh inter-spaced with a flat layer of galvanized wire mesh in case of metallic type.

ii) Casing shall be GI sheet (minimum 18 gauge thick) or Aluminium alloy of (minimum 16 gauge). Suitable aluminum spacers to be provided to ensure for uniform distribution of air flow.

iii) Casing shall be provided with neoprene sponge rubber sealing on fitting face.

iv) Capable of being cleaned by water flushing.

v) Density of filter medium shall increase in the direction of air flow in case of metallic pre-filter.

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2) Efficiency :

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

3) Minimum thickness : 50 mm for Fabric type.

4) Face Velocity : Not more than 2.5 m/sec.

5) Pressure drop : Initial pressure drop - Not to exceed 5.0 mm WC at rated flow. Final pressure drop - Upto 7.5 mm WC.

6.01.16.02 Fine Filters (Microvee type)

1) Construction : By pleating a continuous sheet of filter medium into closely spaced pleats separated by aluminum spacers.

2) Frame : Aluminium alloy of (minimum 16 gauge conforming to IS:737) with handles.

3) Other requirements : a) A neoprene sponge rubber sealing shall be provided on fitting face of the filter frame.

b) Capable of being cleaned by air or water flushing

4) Efficiency : Average arrestance of 80-90% when tested in accordance with BS:6540/ASHRAE–52-76.

5) Minimum thickness : 150 mm or 300 mm.

6) Face Velocity : Not more than 1.2 m/sec for 150 mm and not more than 2.4 m/sec. for 300 mm.

7) Pressure drop : Initial pressure drop - Not to exceed 10 mm WC at rated flow; Final pressure drop-Up to 25 mm WC.

6.02.00 **AIR CONDITIONING SYSTEM**

6.02.01 **Package Air Conditioning System** Refer Clarification & Amendment Enclosed Below

The package air conditioning plant shall be of a reputed manufacturer, standard product which has been proved reliable and satisfactory in the service intended. The Contractor shall assess the cooling and heating load capacity of air conditioning plant as per relevant standard under the design conditions stated above. Detailed design calculations for the air conditioning system shall be furnished by contractor during detail engineering.

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The offered plant shall be complete with compressor, condenser, fan, electric motors, starters, wiring, control panel, valves, cooling coils, heating shell, humidifier, filters, dampers, air ducts insulation, piping, fittings and other parts which are essential for air conditioning piping and fittings.

6.02.02 **Refrigerant Compressor** Refer Amendment Enclosed Below

a) The design, manufacture and performance of refrigerant compressor and refrigerant shall comply with the latest edition of Indian/International standards.

b) The compressor of suitable capacity at the required suction, discharge & temperatures shall be offered. The compressor shall be rugged and of heavy construction so arranged that parts are readily accessible for maintenance and repair. The refrigerant used shall be non-inflammable, non toxic and non explosive and shall have pressure and temperature characteristics suitable for the application. The compressor shall be able to withstand hydrostatic, volumetric and refrigerant leak tests etc. to be carried out at the manufacturer's works in accordance with the applicable codes.

c) The compressor shall be mounted on a suitable base together with the motor and drive. Necessary vibration dampers shall be provided to reduce the transmission of vibration to the structure.

6.02.03 **Cooling Coils** Refer Amendment Enclosed Below

a) The design, manufacture and performance of refrigerant coolers shall conform to the latest edition of the Indian standards or its equivalent.

b) The cooling coil shall be of approved make and provided with sufficient no. of rows to produce specified cooling when passing the specified amount of air based upon the design of air conditioning system. The cooling coils shall be copper tube for a larger surface area with steel fins for providing low air velocity and better cooling effect. The capacity of the cooling coils shall be of suitable rating as per the manufacturer design of air conditioning system being offered.

6.02.04 **Water Cooled Refrigerant Condenser** Refer Clarification & Amendment Enclosed Below

a) The design, manufacture and performance of water cooled refrigerant condenser shall comply with all currently applicable codes and to the latest editions of the Indian standards or its equivalent.

b) The condenser shall be of steel shell and copper tube type with copper fins with sufficient number of rows for cooling the refrigerant to the designed temperature. The condenser shall have a capacity to store full charge of refrigerant. Test pressure shall be 1.5 times the design pressure in case of hydraulic testing, and 1.25 times the design pressure in case of pneumatic testing.

c) The condenser may be designed based on once through water at the temperature (inlet) as given in the design data.

6.02.05 **Humidifier**

The unit shall control the humidity of the air automatically. Condensed water from the cooling coil shall be collected in galvanized sheet steel pan and shall be drained out with the help of suitable piping.

6.02.06 **Control Panels**

Requirements specified in HT/LT Switchgear Sub-Section shall be applicable.

6.03.00 **AIR DISTRIBUTION SYSTEM EQUIPMENT**

The design and manufacture of Air Distribution System shall comply with all currently applicable Indian/British/ ASHRAE standards, regulations and safety codes in the locality where the equipment will be installed.

6.03.01 **Material Requirements**

a) The rolled steel sheet before galvanizing shall be properly annealed or normalized so as to allow fabrication of ducts without developing cracks and zinc coating on the steel shall not be less than 275 gms/m^2 as per latest edition of IS:277 .

b) The Aluminium sheets shall be of grade SIC or NS3 and shall be suitable for duct fabrication work as per latest edition of IS: 737.

6.03.02 **Construction Features**

The thickness of steel sheets, type of bracings and other construction and fabrication details shall be in accordance with the latest version of IS: 655.

6.03.03 **Duct Supports**

Unless otherwise shown in the drawing, rectangular ducts of size upto 750mm and above shall be supported by 15mm M.S. rods and 50 x 50 x 3 mm M.S. angles while ducts below 750mm shall be supported by 10 mm M.S. rods and 40 x 40 x 3mm M.S. angles. The M.S. rods and angles shall be given a coat of primer paint. The spacing of duct supports shall not be more than 2500 mm. Arrangement likes drilling and placing anchor fasteners for duct support, auxiliary or special steel members, hooks coach screws and all other supporting material required shall be included in the scope of supply of the tenderer. Wherever the ducts are thermally insulated the M.S. angles and supports shall not be in direct contact with ducts.

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6.03.04 **Flexible Connections**

Where the sheet metal duct(s) connects to the intake or discharge of fan units, a closely woven, double layer asbestos/canvas flexible connection of at-least 150 mm width shall be provided to prevent the noise due to fan vibration being transmitted to sheet metal duct. The material shall be attached to angle iron frame on equipment and to similar frames on duct or casing by means of a steel band or collar fitting near the end of the flexible connection and bolted fittings near the end of the flexible connection's angle iron frame so as to clamp securely between the band and the angle frame.

6.03.05 **Transformation and Breaches**

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

6.03.06 **Duct Insulation for air conditioning system**

i) The insulation for ducts shall be provided conforming to the latest edition of the Indian standards or any other equivalent standard in practice.

ii) The insulating material as well as protective coverings shall be new and unused, non corrosive, vermin proof, and shall be guaranteed to withstand continuously and without deterioration the maximum/minimum temperature to which they may be subjected to.

iii) The insulation material for air conditioning system for the supply air ducting, return air ducting shall be resin bonded fiber glass, density not less than 25 Kg/m^3. Insulation thickness for ducts shall not be less than 25mm. The insulation shall be covered by 24 gauge aluminium plenum with help of self tapping screws with at least 50 mm overlapping at joints.

6.03.07 **Caulking and Drain**

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

6.03.08 **Access Doors**

Access doors shall be provided in the duct work, as applicable, as well as on casing on 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. All doors shall be set so as to flush with any insulation.

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6.03.09 **Splitters and Dampers**

(i) Splitters and dampers shall be placed at all suitable points for proportional volume control of the system. Splitters and dampers shall be made of 16 gauge GS Sheet of quadrant type with suitable locking device mounted outside of duct in an accessible location.

(ii) Fire dampers made up of 16 gauge GSS and shall be of air tight type to be able to block the flow of air in case of fire. The fire dampers shall be motorized with programmable logic controller having a provision of interfacing with the control panels of fire fighting equipment of power house. The status indications i.e. close/open may be provided. Fire dampers shall have fire rating of minimum 90 minutes.

6.03.10 **Vanes**

Unless otherwise shown in the drawing, all elbows shall be such that the throat radius is 75% of the duct width. In case the throat radius is smaller, suitable single thickness vanes of approved details shall be provided.

6.03.11 **Diffusers & Grills**

a) The type and the quantity of diffusers and grills required shall be worked out by the contractor and detailed calculations shall have to be submitted for approval by the Employer. The contractor shall ensure that the diffusers/grilles offered are of requisite capacity, throw and terminal velocity. The air pressure drop and the noise level shall be within the limits specified in the relevant standards. The Contractor shall propose suitable location of diffusers and grilles for smooth distribution of air

b) The diffuser/grilles shall be fabricated out of extruded aluminium section with powder coating. Supply air and Return air exhaust diffusers/grilles shall be provided with volume control dampers of the opposed blade type. Supply air grilles shall be of double deflection type while the return air/exhaust grilles shall be of single deflection type.

c) Suitable vanes shall be provided in the duct collars to have a uniform/proper air distribution. Baffles wherever required shall be provided.

6.03.12 **Painting**

Wherever specified ducts shall be painted or lined with suitable anti-corrosive paints/lining to prevent corrosion of steel metal.

6.03.13 **Acoustic Lining**

Wherever it is essential, the ducts shall be acoustically lined from inside.

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6.03.14 **Thermal Insulation for Air conditioning ducts**

Thermal insulation shall be provided wherever required. The Contractor shall indicate clearly the areas where thermal insulation is proposed to be provided and the same shall be subject to the approval of Employer.

6.03.15 **Inspection and Testing**

The ducts, branches, elbows, etc. shall be inspected and the joints and connections are to be checked before they are assembled in position. After assembly the system shall be checked for tightness, vibration and noise.

6.03.16 **Balancing**

a) The air distribution system shall be tested/balanced by the contractor so that the requisite temperature and air flow are maintained throughout the space to be air conditioned/ventilated.

b) All instruments required for testing/balancing the air distribution system shall be provided by Contractor.

7.00.00 INSPECTION & TESTING

7.01.00 **Testing At Manufacturer's Works**

The tests to be conducted at manufacturer's works are specified in relevant QA chapter elsewhere in the specification.

7.02.00 **Tests At Site**

i) Before final acceptance of the work completed by the contractor, all equipment and ducting shall be tested by the contractor in the presence of the employer or his authorized representatives. Such tests shall be carried out to the satisfaction of the purchaser that each item of the system has been properly and accurately installed in accordance with the equipment plans and specification.

The following tests shall be carried out for air duct work.

a) Verification of material test certificate.

b) The ducts, branches, elbows, tee points etc. shall be inspected and the joints and connections shall be checked before they are assembled in position.

c) After assembly, the system shall be checked for tightness, vibration and noise due to turbulence.

ii) All fans, blowers, motors and other equipment shall be checked for correct alignment, lubrication of bearings and direction of rotation.

iii) Entire system shall be tested under operating conditions for performance and leakage after completion of work.

iv) Equipment that fails to test requirements shall be corrected and tested again until satisfactory results are obtained.

v) All facilities, instruments, equipments and man power required to carry out the tests shall be arranged by the contractor.

8.00.00 CODES & STANDARDS

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 Contractor of this responsibility.

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.

Air Changes per Hour

Annexure I

Sl. No.	Name of premises	Minimum Air changes per hour	Occupancy
1.	Lift & staircase area	2	
2.	Battery room/Battery charger room	8	
3.	Machine Hall	2	10
4.	Service bay	2	
5.	Switchgear room	4	
6.	Generator floor	2	4
7.	Electrical workshop & Engineer's room	4	2
8.	Turbine floor	2	4
9.	Mechanical workshop & compressor room	4	3
10.	MIV Floor	2	4
11.	Butterfly valve house	2	

Note: The total ventilation quantity shall also include air requirement for lift shaft.

NTPC reply on HVAC Clarification

Sl.No.	REFERENCE	Clarification Sought by Agency	NTPC Reply
		System. **Bidder's Comment:** Please confirm whether the largest risk is to be considered or total risk for designing inert gas clean agent system.	
139.	Package VI, Part B, Sub section M5, Clause No. 1.01.00 & Clause No. 1.02.00 page 2 of 17.	**Specification Requirement:** a) Ventilation system The system shall be designed to normally attain the following conditions throughout the year: - Temperature < 35 deg C - Relative Humidity - < 70 % **Bidder's comment:** The referred temperature<35 DegC &RH<70% in power house cannot be achieved without cooling of air.But the same is not specified in the Technical Specification. Please confirm whether cooling of air is required for ventilation areas or not.If yes please furnish the technical specification for Chillers.	Please refer to Sl. No. B.36 of Amendment No. 1 to Technical Specification Section-VI Chiller is not envisaged. Ventilation shall be achieved by supply & exhaust air fans.
140.	Package VI, Part B, Sub section M5, Clause No. 1.02.00; Page 3 of 17	(a)The following conditions of temperature shall be considered for designing the Air conditioning & Ventilation system : 1) Max. Temperature of air in summer - 40 deg C 2) Min. Temperature of air in Winter - 1 deg C 3) Max. RH - 100 % Also it is indicated climatic condition against Clause no. 4.00.00 of Package, Section VI, Part A, Sub section I as,	

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Sl.No.	REFERENCE	Clarification Sought by Agency	NTPC Reply
		Max. temp. in project area - 30 Deg C Min. temp. in project area - 3 deg C **Bidder's comment:** There is discrepancy in climatic condition given in these clauses. Please review & confirm climatic condition. Normally, mean max temperature shall be considered for designing ventilation and air conditioning system. Please confirm the mean max. temperature of the project area. **Specification Requirement:**	Please refer to Sl. No. B.36 of Amendment No. 1 to Technical Specification Section-VI
	Package VI, Part B, Sub section M5, Clause No. 5.00.00;	Ventilation system shall be provided for the Switchgear room of the control/switchgear building of the barrage. The temperature inside control/switchgear room shall be maintained below 35 0C. The system shall comprise all necessary supply air fans, bird screen, pre-filter and fine filters, grills, louvers wherever required shall be provided for the ventilation system. **Bidder's comment:** The referred temperature < 35 Deg. C in control/switchgear room can not be achieved without cooling of air. But the same is not specified in the technical specification. Please confirm whether cooling of air is required for ventilation	Please also refer to Sl. No. B.37 of Amendment No. 1 to Technical Specification Section-VI

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NTPC reply on HVAC Clarification

Sl.No.	REFERENCE	Clarification Sought by Agency	NTPC Reply
		areas or not. If yes, please furnish the technical specification for Chillers. Also furnish us the layout drawings of the control/switchgear building of the barrage area.	Chiller is not envisaged. Ventilation shall be achieved by supply & exhaust air fans. Layout drawings of control/switchgear building shall be finalized during detailed engineering.
141.	Package VI, Part B, Sub section M5, Clause No. 6.02.01; Page 10 of 17	It is indicated water cooled Package Air conditioning system for various areas. **Bidder's comment:** We propose air cooled packaged air conditioners are also acceptable. Please confirm.	Please refer to Sl. No. B.40 of Amendmeht No. 1 to Technical Specification Section-VI
142.	Technical Spec. Section VI, Part QA, Sub-Section- QM Clause 3.04.00	**Specification requirement:** NDT for casting is required as per CCH-70-3 **Bidder's comment:** NDT on casting in line with corresponding ASME code is also acceptable, please confirm	100% UT, MPI and DPT shall be carried out on hub and bucket castings as per CCH-70-3 class-2 or any equivalent/higher international standards.
143.	Technical Spec. Section VI, Part QA, Sub-Section- QM, Appendix-3 Page 13 of 32	**Specification requirement:** For turbine, shaft and runner assembly inspection is required to check run out. **Bidder's comment:** We propose run out check of shaft and runner individually at shop, and assembly check will be done at site.	Acceptable.
144.	Technical Spec. Section VI, Part QA, Sub-Section- QM,Page 21 of 32	**Specification requirement:** Discharge head/ Column Pipes/Distance piece requires RT(for cooling water system pumps) **Bidder's comment:** We propose to do UT instead of RT on mentioned parts at vendor shop.	Acceptable.

Sl. No.	BID DOCUMENT REFERENCE	EXISTING PROVISION	AMENDED PROVISION
B.36	Sub section M5, Clause No. 1.02.00, Page 2 of 17	The following conditions of temperature shall be considered for designing the Air Conditioning and Ventilation System: 1) Max. Temp. of air in Summer – 40 deg. C 2)Min. Temp. of air in winter – 1 deg C 3) Max. RH – 100%	The following conditions of temperature shall be considered for designing the Air Conditioning and Ventilation System: 1) Mean Max. Temp. of air in Summer– 33 deg. C 2) Mean Min. Temp. of air in winter – 5 deg C 3) Mean Max. RH – 85%
B.37	Sub section M5, Clause No. 5.01.00, Para-2, Line-1-3 page No. 6 of 17.	The system shall comprise all necessary supply air fans, bird screen, pre-filter and fine filters, grills, louvers wherever required shall be provided for the ventilation system.	The system shall comprise all necessary supply air fans, bird screen, filters, exhaust air fans, grills and louvers as per requirement.
B.38	Sub section M5, Clause No. 6.02.02 page No. 11 of 17	Refrigerant Compressor	Deleted.
B.39	Sub section M5, Clause No. 6.02.03, page No. 11 of 17	Cooling Coils	Deleted.
B.40	Sub section M5, Clause No. 6.02.04, page No. 11 of 17	Water cooled Refrigerant Condenser	Replace Clause 6.02.04 as given in Attachment-II to Amendment 1 to technical specification section VI "Air cooled type (DX system) Package Air Conditioning System"
B.41	Sub section M5, Clause No. 6.02.01, Para-2, Line-1 page No. 11 of 17	The offered plant shall be complete with compressor, condenser, fan, electric	The offered plant shall be complete with compressor, condenser(air cooled type - DX system), fan, electric
B.42	MECHANICAL WORKSHOP AND ELECTRICAL	• Resistance: 0.001m ohms to 1Mohms	• Resistance: 0.001ohms to 100Mohms

6.02.04 Air cooled type (DX system) Package Air Conditioning System

Condensing unit

Type	:	Air cooled screw / scroll type
Vibration isolators	:	Steel spring/ Neoprene rubber cushy foot type with isolation efficiency not less than 85%.

Compressor

Type	:	The Compressor shall be screw /scroll, serviceable, either hermatic type or semi-hermetic type with load, unload and automatic capacity control (minimum 3 steps).
Type of drive	:	Motor driven, direct or through V-belt.
Refrigerant	:	The refrigerant shall be R-22/R-123/R-134a/ R-410A or any other environment friendly refrigerant.
Accessories	:	High/Low pressure cutouts, oil pressure switches, relief valves, pressure gauges at each stage, lube oil and control oil pressure gauges, suction & discharge stop valves, Muffler, Crank case heaters, oil filters, magnetic oil separators, temperature indicators for lube oil/heaters, oil level indicators, safety thermostat for crank case heater, vibration isolators, etc.
Motor Rating	:	10% more than the power required by the compressor at 40 deg C design ambient temperature.
Capacity	:	Minimum capacity shall be suitable for the identified/selected at evaporating temperature and condensing temperature and shall be indicated.

II-633

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PART-G

SUB-SECTION- M5

HEATING, VENTILATION AND AIR CONDITIONING SYSTEM

RAMMAM STAGE-III HYDRO ELECTRIC PROJECT (3 X 40 MW) ELECTRO MECHANICAL WORKS EPC CONTRACT PACKAGE BIDDING DOC NO.: CS-5602-003-9	TECHNICAL DATA SHEETS

TO BE FILLED & SUBMITTED BY THE BIDDER AFTER AWARD OF CONTRACT

CLAUSE NO.	HEATING, VENTILATION AND AIR CONDITIONING SYSTEM (M5)	एनटीपीसी NTPC लिमिटेड Hydro

Bidder's Name: .....

1.00.00 TECHNICAL PARTICULARS

(TO BE FILLED IN BY THE TENDERER)

1. BLOWERS FOR VENTILATION SYSTEM

a) Type of Blower

b) Name of manufacturer

c) Model Number

d) Number of stages

e) Capacity (M^3/hr) ---(^{0}C) and pressure in (mm of w g)

f) Total Pressure (differential) (mm of w g)

g) Impeller diameter

h) Speed (rpm)

i) Class of construction

j) Volumetric efficiency (%)

k) Design Static Pressure (mm of w g)

l) Seal system

m) Bearing type

n) Hydrostatic test pressure (Kg/cm2)

o) Outlet velocity

p) Shaft Horse Power

q) Recommended motor h. p.

r) Weight of

i) Blower

ii) Motor

2041

Bidder's Name: .....

iii) Base

iv) Belt drive

s) General arrangement drawing enclosed (Yes/No)

t) Foundation & drawing enclosed (Yes/No)

u) Operating and maintenance manual enclosed (Yes/No)

v) Design calculation supplied (Yes/No)

w) Any other details

2. INDUCTION MOTORS

a) Application/Designation

b) Name of Manufacturer

c) Applicable standards

d) Rated

i) Output (KW)

ii) Speed (RPM)

e) Type of duty

f) Duty designation

g) Supply condition

i) Rated voltage (Volts)

ii) No. of phases

iii) Frequency (Hz)

h) Allowable variation in

i) Voltage (%)

ii) Frequency (%)

2242

Bidder's Name: .....

	iii) Combined (%)	
	i) Permissible unbalance in supply voltage (%)	
	j) Current	
	i) Full Load (Amps)	
	ii) Starting (%) (FL)	
	k) Full load efficiency (%)	
	l) Full load power factor	
	m) Method of starting	
	n) Torque	
	i) Starting	
	ii) Maximum	
	o) Type of insulation	
	p) Ref. ambient temp. (^{0}C)	
	q) Temperature rise (^{0}C)	
	r) Type of enclosure	
	s) Suitable for Indoor operation (Yes/No)	
	t) Type and no of terminals brought out	
	u) Normal winding connection (Star/Delta)	
	v) Shaft orientation	
	w) Dimensional drawing enclosed (Yes/No)	
	x) Foundation drawing enciosed (Yes/No)	
	y) Type of protection adopted	
	Z) Any other details	

2043

Bidder's Name: .....

3. HEAT EXCHANGER

a) Name of Manufacturer

b) Model No

c) Type offered

d) Number of units

e) Unit size (L x W x H) mm

f) Outlet Cooling water temperature (^{0}C)

g) Air velocity through the heat exchanger

h) Heat Exchanger efficiency

i) Friction drop of air at rated capacity (pressure drop)

j) Overall size of each unit

k) Any other details

4. FILTERS

a) Name of Manufacturer

b) Model No.

c) Filter media

d) Whether cleanable (Yes/No)

e) Number of units in m^3 /hr air

f) Rating of each Unit (CFM)

g) Size of wire & wire mesh

h) Unit size (L x W x H)mm

i) Air velocity through filter

j) Actual pressure drop in clean condition (mm w g)

2044

Bidder's Name: .....

k) Actual pressure drop in saturated condition (mm w g)

l) Filter efficiency

m) Method of test

n) Overall size of each unit

o) Any other details

5. EXHAUST FAN/SUPPLY AIR FAN

a) Type of fan

b) Name of manufacturer

c) Model Number

d) Size, mm

e) Capacity (M^3/hr)

f) Impeller diameter

g) Speed (rpm)

h) Fan efficiency

i) Bearing type

j) Net power requirement

k) Motor HP

l) Motor Insulation

m) Total weight

n) Type of guard

o) Mounting details

p) Overall dimension

q) Performance curve enclosed (Yes/No)

2.45

Bidder's Name: .....

r) Design calculation supplied (Yes/No)

s) Any other details

6 DUCTING

a) Type of material

b) Thickness

c) Main duct dimension

d) Distribution duct dimension

e) Branch duct dimension

f) Type of grills

g) Size of grills

h) Total number of grills

7. PACKAGE AIR CONDITIONING EQUIPMENT

a) Make of Unit

b) Rated capacity

c) Electric power consumption at rated capacity.

d) Overall dimension of unit (L x B x H)

e) Total weight of unit

f) General arrangement drawing enclosed (Yes/No)

g) Foundation & drawing enclosed (Yes/No)

h) Operating and maintenance manual enclosed (Yes/No)

i) Noise level DB(A)

2248

Bidder's Name: .....

i Filter Section

a) Name of Manufacturer

b) Model No.

c) Type offered

d) Size (L x W x H)mm

e) Rating CFM

f) Number

g) Serial number

h) Efficiency

i) Method of test

j) Actual pressure drop in clean condition (mm w g)

k) Actual pressure drop in saturated condition (mm w g)

l) Filter media

m) Whether cleanable (Yes/No)

ii Fan Module

a) Type of fan

b) Name of manufacturer

c) Model Number

d) Number of stages

e) Capacity (M^3/hr)

f) Total Pressure(differential) (mm of w g)

g) Impeller diameter

h) Speed (rpm)

2047

Bidder's Name: .....

i) Class of construction

j) Volumetric efficiency (%)

k) Design Static Pressure (w.g H2O)

l) Seal system

m) Cooling water requirement M^3/hr. at--- C and Pressure in Kg/cm^2

n) Bearing type

o) Hydrostatic test pressure(Kg/cm2)

p) Outlet velocity

q) Shaft Horse Power

r) Motor HP

s) Motor Insulation

t) Other details of Motor

iii. Refrigerant Compressor

a) Manufacturer's name

b) Model Number

c) No. of stages

d) Refrigerant

e) Type of cooling

f) Suction temperature (°C)

g) Condensing Temperature (°C)

h) Operating speed (RPM)

i) Capacity at operating conditions

2248

Bidder's Name: .....

j) Capacity and BHP

k) BHP at operating conditions

l) Capacity control (Manual/Auto)

m) Drive type

n) Drive belt Guard

o) Motor HP

p) Motor Insulation

q) Other details of Motor

r) Any other data

iv. Cooling Coils

a) Type

b) Number offered

c) Make

d) Capacity

e) Heat transfer area (M^2)

f) Air inlet and outlet temperature (oC)

g) Air velocity(ft/min)

h) Pressure drop (mm.wg)

i) Refrigerant evaporating temperature (oC)

j) Insulation material

k) Insulation thickness

l) Thickness of shell

m) Thickness of tube

2449

Bidder's Name: .....

n) Material of shell

o) Material of tube

p) Test pressures

i) Shell side Kg/Cm^2

ii) Tube side Kg/Cm^2

q) Number of refrigerant circuits

v. Refrigerant Condensers

a) Make and type

b) Shell material

c) Shell thickness

d) Tube material

e) No. of tubes

f) Fin's type

g) No. of fins per inch

h) Water inside pressure Kg/Cm2

i) Circulating water quantity

j) Water inlet temperature oC

k) Water outlet temperature oC

l) Water velocity in tubes (ft./Min)/M/Min

m) Total heat transfer area

n) Any other data supplied

2.50

Bidder's Name: .....

vi. Humidifier

a) Make

b) Type

c) Material of construction

d) Water pressure (Kg/Cm2)

e) Any other information supplied

9. METAL AIR DUCTS

a) Manufacturer's name

b) Material of construction

c) Thickness of sheet

d) Type of construction

e) Supporting frame detail attached (Yes/No)

f) Thickness of insulation for Air conditioning ducts (mm)

g) Thermal conductivity of Insulation material

h) Material of insulation

i) Density of insulation

j) Static Pressure drop mm wg H20/unit length

k) Max. velocity of air in the duct

l) Details of fixing ducts to walls/ceiling

10. DAMPERS

a) Type

b) Motor operated (Fire dampers) (Yes/No)

2.51

Bidder's Name: .....

c) Name of manufacturer

d) Make of Motors

11. GRILLES/DIFFUSERS

a) Name of Manufacturer

b) Capacity CFM

c) Terminal velocity(FT/Min.)

d) Jet velocity (Ft/Min)

e) Dimensions

i) If rectangular (LxW)

f) Material

g) Throw (H/Min)

h) Volume control damper provided (Yes/No)

12. CONTROL PANEL

a) Switchgear designation

b) Single front or double front

c) Modular construction (Yes/No)

d) Fully drawout/semidrawout/fixed

e) Total dimensions (LxWxH)

f) Bus bar continuous rating under site conditions

g) Sheet steel

A. Cold rolled / Hot rolled

B. Thickness

2252

Bidder's Name: .....

i) Frame

ii) Door

iii) Rear cover

iv) Side and top cover

v) Panel partitions

h) Bus Bars

i) Material of busbar

ii) Cross-Sectional Area (mm2)

iii) Continuous current rating under site conditions

iv) Type of busbar insulation if insulated

v) Clearance between phases

vi) Clearance between phase and earth

vii) Short time rating (One sec.) (KA)

viii) Momentary rating (Peak (KA)

i) Circuit breakers

i) Name of Manufacturer

ii) Type, designation

iii) Circuit breaker type (air break or MCCB)

iv) Rated voltage duty

v) Rated current

vi) Rated symmetrical breaking current at rated voltage (indicate P.F)

vii) Rated short time withstand rating (indicate time)

viii) Limits of voltage for satisfactory operation of the following devices as % of normal voltage

2053

Bidder's Name: .....

I. Operating mechanism %

II. Closing coil %

III. Trip Coil %

j) Power for closing at

i) Normal voltage W

ii) 80% normal voltage W

k) Power required for tripping at

i) Normal voltage W

ii) 50% normal voltage W

13. WINDOW AIR CONDITIONERS

a) Make of Unit

b) Rated capacity

c) Electric power consumption at rated capacity.

d) Overall dimension of unit (L x B x H)

e) Total weight of unit

f) General arrangement drawing enclosed (Yes/No)

g) Operating and maintenance manual enclosed (Yes/No)

h) Noise level DB(A)

i Filter Section

a) Name of Manufacturer

b) Model No.

c) Type offered

d) Size (L x W x H)mm

2254

Bidder's Name: .....

	ii	**Fan**
	a)	Type of fan
	b)	Name of manufacturer
	c)	Model Number
	d)	Number of stages
	e)	Capacity (M^3/hr)
	f)	Total Pressure(differential) (mm of w g)
	g)	Impeller diameter
	h)	Speed (rpm)
	i)	Bearing type
	j)	Shaft Horse Power
	k)	Motor HP
	l)	Motor Insulation
	m)	Other details of Motor
	iii.	Details of Compressor
	a)	Manufacturer's name
	b)	Model Number
	c)	No. of stages
	d)	Refrigerant
	e)	Motor HP
	f)	Motor Insulation
	g)	Other details of Motor
	h)	Any other data

2055

Bidder's Name: .....

iv. Cooling Coils

a) Type

b) Number offered

c) Make

d) Capacity

e) Any other data

v. Refrigerant Condensers

a) Make and type

b) Any other data

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PART - A

SUB-SECTION-VI

SPARES

CLAUSE NO.	SPARES	एनटीपीसी NTPC Hydro
1.00.00	The Bidder shall include in his scope of supply all the necessary Mandatory spares, Start-up and commissioning spares and Recommended spares and indicate these in the relevant schedules of the Bid Forms & Price Schedules. The general requirements pertaining to the supply of these spares are given below:	
1.01.00	**MANDATORY SPARES**	
	a) The list of mandatory spares considered essential by the Employer is indicated in Part-F, Section-VI. The bidder shall indicate the prices for each and every item (except for items not applicable to the bidders design) in the 'Schedule of Mandatory Spares' whether or not he considers it necessary for the Employer to have such spares. If the bidder fails to comply with the above or fails to quote the price of any spare item, the cost of such spares shall be deemed to be included in the contract price. The bidder shall furnish the population per unit of each item in the Bid Forms & Price Schedules. Whenever the quantity is mentioned in "sets" the bidder has to give the item details and prices of each item.	
	b) Whenever the quantity is indicated as a percentage, it shall mean percentage of total population of that item in the station (project), unless specified otherwise, and the fraction will be rounded off to the next higher whole number. Wherever the requirement has been specified as a 'set' it will include the total requirement of the item for a unit, module or the station as specified. Where it is not specified, a 'set' would mean the requirement for the single equipment / system as the case may be. Also one set for the particular equipment. e.g. 'set' of bearings for a pump would include the total number of bearings in a pump. Also the 'set' would include all components required to replace the item; for example, a set of bearings shall include all hardware normally required while replacing the bearings.	
	c) The Employer reserves the right to buy any or all the mandatory spare parts.	
	d) The prices of mandatory spares indicated by the Bidder in the Bid Proposal sheets shall be used for bid evaluation purposes.	
	e) All mandatory spares shall be delivered at site as per schedule given in Section VII. However, spares shall not be dispatched before dispatch of corresponding main equipments.	
	f) Wherever quantity is specified both as a percentage and a value, the Bidder has to supply the higher quantity until & unless specified otherwise.	
1.02.00	**RECOMMENDED SPARES**	
	a) In addition to the spare parts mentioned above, the Contractor shall also provide a list of recommended spares for 3 years of normal operation of the plant and indicate the list and total prices in relevant schedule of the Bid Forms & Price Schedules. This list shall take into consideration the mandatory spares specified in this Part – F, Section-VI, and should be independent of the list of the mandatory spares. The Employer reserves the right to buy any or all of the recommended spares. The recommended	

spares shall be delivered at project site at least two months before the scheduled date of initial operation of first unit. However, the spares shall not be dispatched before the dispatch of the main equipment.

b) Prices of recommended spares will not be used for evaluation of the bids. The price of these spares will remain valid up to 6 months after placement of Notification of Award for the main equipment. However, the Contractor shall be liable to provide necessary justification for the quoted prices for these spares as desired by the Employer.

1.03.00 **START-UP & COMMISSIONING SPARES**

a) Start-up & commissioning spares are those spares which may be required during the start-up and commissioning of the equipments/systems. All spares used till the Plant is handed over to the Employer shall come under this category. The Contractor shall provide for an adequate stock of such start up and commissioning spares to be brought by him to the site for the plant erection and commissioning. They must be available at site before the equipments are energized. The unused spares, if any, should be removed from there only after the issue of Taking Over certificate. All start up spares which remain unused at the time shall remain the property of the Contractor.

1.04.00 The Bidder shall include in his scope of supply all the necessary Mandatory spares, Start-up and commissioning spares and Recommended spares and indicate these in the relevant schedules of the Bid Forms & Price Schedules. The general requirements pertaining to the supply of these spares is given below:

2.00.00 The Contractor shall indicate the service expectancy period for the spare parts (both mandatory and recommended) under normal operating conditions before replacement is necessary.

3.00.00 All spares supplied under this contract shall be strictly inter-changeable with the parts for which they are intended for replacements. The spares shall be treated and packed for long storage under the climatic conditions prevailing at the site e.g. small items shall be packed in sealed transparent plastic with desiccator packs as necessary.

4.00.00 All the spares (both recommended and mandatory) shall be manufactured along with the main equipment components as a continuous operation as per same specification and quality plan.

5.00.00 The Contractor will provide Employer with cross-sectional drawings, catalogues, assembly drawings and other relevant documents so as to enable the Employer to identify and finalize order for recommended spares.

6.00.00 Each spare part shall be clearly marked or labeled on the outside of the packing with its description. When more than one spare part is packed in a single case, a general description of the content shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purposes of identification.

CLAUSE NO.	SPARES	एनटीपीसी NTPC हाइड्रो hydro
7.00.00	All cases, containers or other packages are to be opened for such examination as may be considered necessary by the Employer.	
8.00.00	The Contractor will provide the Employer with all the addresses and particulars of his sub-Contractors while placing the order on vendors for items/ components/equipments covered under the Contract and will further ensure with his vendors that the Employer, if so desires, will have the right to place order for spares directly on them on mutually agreed terms based on offers of such vendors.	
9.00.00	The Contractor shall warrant that all spares supplied will be new and in accordance with the Contract Documents and will be free from defects in design, material and workmanship.	
10.00.00	In addition to the recommended spares listed by the Contractor, if the Employer further identifies certain particular items of spares, the Contractor shall submit the prices and delivery quotation for such spares within 30 days of receipt of such request with a validity period of 6 months for consideration by the Employer and placement of order for additional spares if the Employer so desires.	
11.00.00	The Contractor shall guarantee the long term availability of spares to the Employer for the full life of the equipment covered under the Contract. The Contractor shall guarantee that before going out of production of spare parts of the equipment covered under the Contract, he shall give the Employer at least 2 years advance notice so that the latter may order his bulk requirement of spares, if he so desires. The same provision will also be applicable to Sub-contractors. Further, in case of discontinuance of manufacture of any spares by the Contractor and/or his Sub-Contractors, Contractor will provide the Employer, two years in advance, with full manufacturing drawings, material specifications and technical information including information on alternative equivalent makes required by the Employer for the purpose of manufacture/procurement of such items.	

Clause No.	Item	Quantity
4.16.03	Cylinder valve with safety pressure relief device	1 no. of each size/type
4.16.04	Gas cylinder	2 nos. of each size/type
4.16.05	Flexible hoses (if applicable)	2 nos. of each size/type
4.16.06	Solenoid coils gas for release system	2 nos. of each size/type
4.16.07	Pressure gauges	5 nos.
4.16.08	Temperature gauges	2 nos.
4.16.09	Level Indicator	2 nos.
4.16.10	Pressure Switches	5 nos.
4.16.11	Flow Switches	2 nos.
4.16.12	Limit Switches for isolation valves	20 nos.
5.00.00	**VENTILATION SYSTEM**	
5.01.00	Supply air fan assembly **(for each model and capacity)**	
5.01.01	Supply air fan	1 No.
5.01.02	V-belts for blower	4 Sets
5.01.03	Blower bearings	1 Set
5.01.04	Motor	1 No.
5.02.00	Exhaust Air Fan Assembly (for each model and capacity)	10%
5.03.00	Local indicators like temperature gauges, pressure gauges, differential pressure gauges etc.	10% or 2 Nos. of each make, model and type whichever is more

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CLAUSE NO.	LIST OF MANDATORY SPARES (ELECTRICAL)	
Clause No.	**Item**	**Quantity**
7.00.00	**LT/HT SWITCHGEAR (33 KV,11 kV & 415 V SWITCHGEAR)**	
7.01.00	Circuit breaker (triple pole)/ MCCB/Isolator/Switch	1 No. for each type and rating
7.02.00	Current transformer	1 No. of each type and rating
7.03.00	Potential Transformer	1 No. of each type and rating
7.04.00.	TNC control switch for circuit breaker control	2 Nos. of each type and rating
7.05.00	HRC fuses links	6 Nos. of each type and rating
7.06.00	Ammeter selector switches	2 Nos. of each type and rating
7.07.00	Local/Remote selector switches	2 Nos. of each type and rating
7.08.00	Voltmeter selector switches	3 Nos. of each type and rating
7.09.00	Shunt trip coil	2 Nos. of each type and rating
7.10.00	Closing coil	2 Nos. of each type and rating
7.11.00	Push button for trip circuit healthy test	2 Nos. of each type and rating
7.12.00	KWh meter, 3 phase, 3 wire(Microprocessor based Trivector)	1 No. of each type and rating
7.13.00	Alarm bell	1 No. of each type and rating
7.14.00	Relays (including Anti pumping relay, Aux. relay, Lockout relays/times	2 Nos. of each type and rating

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CLAUSE NO.	LIST OF MANDATORY SPARES (ELECTRICAL)	
Clause No.	**Item**	**Quantity**
7.15.00	Discrepancy control switch for C.B. control	2 Nos. of each type and rating
7.16.00	ACB driving motor	2 Nos. of each type and rating
7.17.00	ACB driving mechanism	2 Nos. of each type & rating

LIST OF MANDATORY SPARES (ELECTRICAL)

Clause No.	Item	Quantity
11.00.00	**HT CABLE, LT POWER CABLE , CONTROL CABLE & AERIAL BUNCH CABLE**	
11.01.00	Each and every type of cable	10% of installed quantity
12.00.00	**CABLING EARTHING & LIGHTNING PROTECTION**	
12.01.00	Termination of each type and rating	5% of installed qty. (min. one No)
12.02.00	Jointing kit of each type and rating	5% of installed qty. (minimum one No)
13.00.00		
13.01.00		
13.02.00		
13.03.00		
13.04.00		
13.05.00		
14.00.00		
14.01.00		
14.02.00		
14.03.00		
14.04.00		
14.05.00		

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Clause No.	Item	Quantity
2.00.00	**MEASURING INSTRUMENTS**	
1	Electronic Transmitters	
(i)	Transmitters of all type, range and model no. (for the measurement of Pressure, differential pressure flow,	10 % of each type and model or 2Nos.

Clause No.	Item	Quantity
	level, etc.)	whichever is more
(ii)	Electronic cards / PCB's for each type and model of transmitters.	10 % of each type and model or 2Nos. whichever is more
2	Temperature elements	
(i)	a) RTD's b) Any other temperature sensor	10 % of each type and model or 2Nos. whichever is more
(ii)	Temperature Transmitters	10% of each type and model or 2Nos. whichever is more
3	Electrical Metering Instruments: Electrical meters including voltmeter (analog), motor current ammeter, semaphore indicator, frequency meter (analog), synchroscope	1 no. of each type and model.
4	Vibration Monitoring System	
(i)	Sensors	10% or 2 Nos. whichever is more
(ii)	Power Supply Module Cards	10% or 2 Nos. whichever is more
(iii)	Driver / Interface Cards & all other electronic cards.	10% or 2 Nos. whichever is more

Clause No.	Item	Quantity
4.00.00	**PROCESS CONNECTION PIPING**	
(i)	Valves of all types	10%
(ii)	2 way, 3way, 5way valve manifolds	10% of each type, class, size and model or 2 whichever is more
(iii)	Fittings	10% of each type or model.
5.00.00	**INSTRUMENTATION CABLE, INTERNAL WIRING**	
(i)	Pre fabricated cable of each type (other than SCADA application)	10% of installed quantity
(ii)	Other cables (including core cables)	5 % of each type, pair and size of actual installed quantity

Clause No.	Item	Quantity
6.00.00	CONTROL DESK & CONTROL PANEL	
(i)	Replacement lamps/ LED's for each type of lamps/ LED	100%
(ii)	MCBs	10% of each type and rating.
(iii)	Fuses	100% of each type and rating.
(iv)	Blank tiles	10% of total no. of tiles

Clause No.	Item	Quantity
12.00.00	**WATER LEVEL MEASUREMENTS**	
(i)	Sensor for level overshoot detection	10% of each type, model and rating or 2 nos. whichever is more.
(ii)	Electronic cards/ Relays/ fuses/ connectors/ Power supply modules / power packs / special cable (as applicable)	10% of each type, model and rating or 2 nos. whichever is more.

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SECTION: I

SUB-SECTION: C2-B

CUSTOMER SPECIFICATION

(PROJECT SPECIFIC GENERAL REQUIREMENTS)

PART - C

GENERAL TECHNICAL REQUIREMENTS

RAMMAM STAGE-III HYDRO ELECTRIC PROJECT (3 X 40 MW) ELECTRO MECHANICAL WORKS EPC CONTRACT PACKAGE BIDDING DOC NO.: CS-5602-003-9	TECHNICAL SPECIFICATION SECTION-VI

CONTENTS

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 specifications and 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 Contractor'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 Contractors may note that this is a turnkey contract. Each of the plant shall be engineered and designed in accordance with the specification requirement. All engineering and associated services are required to ensure a completely engineered plant shall be 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 personal, as required by applicable codes, though they may not have been specifically detailed in the respective specifications, unless included in the list of exclusions.

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

5.00.00	**CODES & STANDARDS**
5.01.00	In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment / plant / system, all equipment parts, systems and works covered under this specification shall comply with all currently applicable statutory regulations and safety codes of the Republic of India as well as of the locality where they will be installed, including the following : a) Bureau of Indian Standards (BIS) b) Indian Electricity Act c) Indian Electricity Rules d) Indian Explosives Act e) Indian Factories Act and State Factories Act f) Indian Boiler Regulations (IBR) g) Regulations of the Central Pollution Control Board, India h) Regulations of the Ministry of Environment & Forest (MoEF), Government of India
	i) Pollution Control Regulations of Department of Environment, Government of India j) State Pollution Control Board. k) Rules for Electrical installation by Tariff Advisory Committee. l) Any other statutory codes / standards / regulations, as may be applicable.
5.02.00	Unless covered otherwise by Indian codes & standards and in case nothing to the contrary is specifically mentioned elsewhere in the specifications, the latest editions (as applicable as on date of bid opening), of the codes and standards given below shall also apply : a) Japanese Industrial Standards (JIS) b) American National Standards Institute (ANSI) c) American Society of Testing and Materials (ASTM) d) American Society of Mechanical Engineers (ASME) e) American Petroleum Institute (API) f) Standards of the Hydraulic Institute , U.S.A.

	g)	International Organisation for Standardisation (ISO)
	h)	Tubular Exchanger Manufacturer's Association (TEMA)
	i)	American Welding Society (AWS)
	j)	National Electrical Manufacturers Association (NEMA)
	k)	National Fire Protection Association (NFPA)
	l)	International Electro-Technical Commission (IEC)
	m)	Expansion Joint Manufacturers Association (EJMA)
	n)	Heat Exchange Institute (HEI)
	o)	International Telecommunication Union (ITU)
	p)	Euronorms (ITU)
	q)	Association Francaise de Normalisation (AFNOR)
	r)	Deutsche Industries Normen (DIN)
	s)	Verein Deutscher Elektriker (VDE)
	t)	Verein Deutscher ingenieure (VDI)
	u)	British Standards (BS)
	v)	American Iron and Steel Institute (AISI)
	w)	Institute of Electrical Engineer (IEE)
	x)	Institute of Electrical and Electronic Engineers (IEEE)
	y)	American Society of Heating, Refrigerating and Air-Conditioning Engineers
	z)	Consultative committee for International Telegraphy or Telephony (CCITT)
	aa)	Groupe d'e' tuede, Cahier des Charges Hydrauliques (CCH)
5.03.00	Other International/ National standards such as DIN, VDI, BS, etc. shall also be accepted for only material codes and manufacturing standards, subject to the Employer's approval, for which the Contractor shall furnish, along with the offer, adequate information to justify that these standards are equivalent or superior to the standards mentioned above. In all such cases the Contractor shall furnish specifically the variations and deviations from the standards mentioned under 5.01.00 and 5.02.00 together with the complete word to word translation of the standard that is normally not published in English.	

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5.04.00	As regards highly standardized equipments such as Hydro Turbine and Generator, National /International standards such as JIS, DIN, VDI, ISO, SEL, SEW, VDE, IEC & VDI shall also be considered as far as applicable for Design, Manufacturing and Testing of the respective equipment. In addition, these standards shall be referred for the design of machine foundations, wherever specifically mentioned in the specifications. However, for those of the above equipment not covered by these National / International standards, established and proven standards of manufacturers shall also be considered.
5.05.00	In the event of any conflict between the codes and standards referred to in the above clauses and the requirement of this specification, the requirement of Technical Specification shall govern.
5.06.00	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.
5.07.00	A detailed list of standards apart from those mentioned in the respective detailed specifications in other parts of Section-VI to which all equipment/systems/civil works should conform is given in the Annexure-I to this section.
6.00.00	**EQUIPMENT FUNCTIONAL GUARANTEE**
6.01.00	The functional guarantees of the equipment under the scope of the Contract are given in Section-VI Part - A of Technical Specifications. These guarantees shall supplement the general functional guarantee provisions covered under Defect liabilities Section-IV, 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 Contractor shall specifically state the design features incorporated to achieve high degree of reliability/ availability and ease of maintenance. The Contractor shall also furnish details of availability records in the reference plants stated in his experience list.

Contractor 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 shall be specified in terms of running hours, clearly defining the spare parts and man-hour requirement for each stage.

Lifting devices i.e. hoists and chain pulley jacks ,etc. shall be provided by the 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 Contractors may note that this is a turnkey contract. 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 and power systems, control & instrumentation as per the scope defined in various sections of the Technical-Specifications.

The Contractor shall furnish engineering data in accordance with the schedule of information as specified in Technical Data Sheets and Technical Specification.

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

8.03.00 **Engineering Information Submission Schedule**

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

i) Information that shall be submitted for the approval to the Employer before proceeding further, and

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ii) Information that would be submitted for Employer's information only.

The Engineering Information Schedule shall be updated month wise.

The schedule should allow adequate time for proper review and incorporation of changes/ modifications, if any, to meet the contract without affecting the equipment delivery schedule and overall project schedule. The early submission of drawings and data is as important as the manufacture and delivery of equipment and hardware and this shall be duly considered while determining the overall performance and progress. The review of these data by the Employer will cover only general conformance of the data to the specifications and documents interfaces with the equipment provided under specifications. This review by the Employer may not indicate a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the Project Manager shall not be construed by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

All engineering data submitted by the Contractor after final process including review and approval by the Employer shall form part of the Contract Documents and the entire works covered under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the Employer in writing.

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

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.

ii) Sizing criteria of all the systems, sub-systems/ equipments/ structures/ equipment foundations along with all calculations justifying and identifying the sizing and the design margins.

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

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

v) 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 Contractor's scope.

vi) Basic layouts and cross sections of the main plant building (various floor elevations) and other areas including interface-areas included in the scope of the Contractor.

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

The successful Contractor shall furnish within three (3) weeks from the date of Notification of Award, a list of contents of the Plant Definition Manual (PDMs), which shall then be mutually discussed & finalised with the Employer.

B) **Detailed Engineering Documents**

i) General layout plan of the station.

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

iii) Flow diagrams, Process & Instrumentation Diagrams

iv) Piping composite layout drawings.

v) Purchase specifications/ technical data sheets for all bought out and manufactured items. Contractor shall use the Employer's specifications as a base for placement of orders on their sub vendors.

vi) Detailed design calculations for components, system, piping etc., wherever applicable including sizing calculations for all auxiliaries.

vii) Transient & hydraulic analysis of piping and system wherever applicable.

viii) Comprehensive list of all terminal points which interface with Employer's facilities giving details of location, end connection details, forces, moments etc.

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

x) Protection system diagrams and relay settings.

xi) Cables schedules and interconnection diagrams.

xii) Cable routing plan.

xiii) 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.

xiv) Alarm and annunciation/ Sequence of Event (SOE) list and alarms & trip set points.

xv) Sequence and protection interlock schemes.

xvi) Type test reports, insulation co-ordination study report and power system stability study report.

xvii) Control system configuration diagrams and card circuit diagrams and maintenance details.

xviii) Detailed software manuals & source software listing.

xix) Detailed flow chart for digital control system.

xx) Mimic diagram layout.

xxi) Model study reports wherever applicable.

xxii) Functional & guarantee test procedures and test reports.

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

xxiv) For equipment foundation, seperate composit general arrangement drawings for equipment foundation shall be furnished by the Contractor including the location of pockets/bolts/inserts/embedments/pedestals and extent of grouting, point of application of loads etc.

The Contractor's while submitting the above documents/ drawings for approval/ reference as the case may be, shall mark on each copy of submission the reference letter along with the date vide which the submissions are made.

8.04.00 **Engineering 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-II of Part-C. The soft copies to be supplied shall be either in CDs, DVD or through direct transfer via E-mail, etc. The drawings submitted for approval could be in the image form.

(b) All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail to indicate 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.

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(c) Each drawing submitted by the Contractor (including those of sub vendors) 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 and 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 drawings shall be in English. All the dimensions should be in metric units.

(d) The drawings submitted by the Contractor (or their sub vendor's) 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 Contractor 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.

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

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

(e) 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.

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

(g) 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 equipments / 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 Specifications.

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(h) 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

(i) Drawing 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. 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.

(j) 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.

8.05.00 **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 finalisation and approval of the Employer the Instruction Manuals shall be submitted as indicated in Annexure-II. 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) Procedure for initial checking after erection.

i) Procedure for testing and acceptance norms.

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

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

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

B) **Operation & Maintenance Manuals**

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

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

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

iv) The manuals shall include the following

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

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

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

v) Detailed specifications for all the consumables including lubricant oils, greases, chemicals etc. required for the complete plant.

vi) On completion of erection, a complete list of bearings/equipment giving their location, and identification marks etc. shall also be furnished to the Employer.

8.06.00 **Plant Handbook and Project Completion Report**

8.06.01 **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

i) Design and performance data.

ii) Process & Instrumentation diagrams.

iii) Single line diagrams.

iv) Sequence & Protection Interlock Schemes.

v) Alarm and trip values.

vi) Performance Curves.

vii) General layout plan and layout of main plant building and auxiliary buildings

viii) 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.

8.06.02 **Project Completion Report**

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

8.07.00 **Engineering Progress and Exception Report**

8.07.01 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.
8.07.02	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.
8.08.00	**Clearance of Employers' Drawings:**
	During detailed Engineering contractor will check the interface of relevant structural general arrangement drawings, foundation drawings, RCC drawings and architectural plan/elevation drawings furnished by the Employer for various areas and forward his consolidated observations/comments within three (3) weeks from the date of forwarding the drawings by the Employer.
9.00.00	**TECHNICAL CO-ORDINATION MEETING**
9.01.00	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.
9.02.00	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.
9.02.01	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.
9.02.02	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.
9.03.00	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.
10.00.00	**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.

11.00.00 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 shall 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.

12.00.00 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.

13.00.00 LUBRICANTS, SERVO FLUIDS AND CHEMICALS

13.01.00 The Contractor's scope includes all the first fill including the necessary quantity for the flushing of oils, lubricants, servo fluids, gases essential chemicals etc. Consumption of all these consumables during the initial operation and final filling after the initial operation shall also be included in the scope of the Contractor. Contractor shall also supply necessary quantity for the first change of consumables such as oils, lubricants, servo fluids, gases, essential chemical etc. This additional quantity shall be supplied in separate Containers.

13.02.00 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 along with lubrication requirements.

14.00.00 LUBRICATION

14.01.00 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.

15.00.00 MATERIAL OF CONSTRUCTION

15.01.00 All materials used for the construction of the equipment shall be new and shall be in

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accordance with the requirements of this specification. Materials utilised for various components shall be those which have established themselves for use in such applications.

16.00.00 RATING PLATES, NAME PLATES & LABELS

16.01.00 Each main and auxiliary item of plant 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.

16.02.00 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.

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

16.04.00 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.

16.05.00 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

17.00.00 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 Contractor along with the offer.

The price of each tool / tackle shall be deemed to have been included in the total bid price. These tools and tackles shall be separately packed and sent to site. The 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. In case these tools and tackles are used by the Contractor during erection, commissioning or initial operation the same shall be refurbished repaired/replaced as required to the satisfaction of the Employer before handing over to the Employer. All the tools and tackles shall be of reputed make acceptable to the Employer.

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18.00.00	**WELDING**
18.01.00	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.
19.00.00	**COLOUR CODE FOR ALL EQUIPMENTS/ PIPINGS/ PIPE SERVICES**
19.01.00	All equipment/ piping/ pipe services are to be painted by the Contractor in accordance with colour and coding scheme given in Annexure-III enclosed.
19.02.00	**Surface Treatment and Coatings** Please refer Annexure-IV of this sub-section.
20.00.00	**PROTECTION**
20.01.00	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.
21.00.00	**QUALITY ASSURANCE PROGRAMME**
20.01.00	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 IS/ISO-9001. A quality assurance programme of the contractor shall generally cover the following: i) His organisation structure for the management and implementation of the proposed quality assurance programme ii) Quality System Manual iii) Design Control System iv) Documentation and Data Control System v) Qualification data for Contractor's key Personnel.

vi) 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.

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

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

ix) Inspection and test procedure both for manufacture and field activities.

x) Control of calibration and testing of measuring testing equipments.

xi) System for Quality Audits.

xii) System for identification and appraisal of inspection status.

xiii) System for authorising release of manufactured product to the Employer.

xiv) System for handling, storage and delivery.

xv) System for maintenance of records, and

xvi) 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.

21.02.00 GENERAL REQUIREMENTS - QUALITY ASSURANCE

21.02.01 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. 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 Contractor and will be submitted to Employer for approval. Schedule of finalisation of such quality plans will be finalised before award.

21.02.02 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 e.g. floppy or E-mail in addition to hard copy, for review and approval. After approval the same shall be submitted in compiled form on CD ROM.
21.02.03	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.
21.02.04	The Contractor shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans alongwith 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 alongwith technical justification for approval and dispositioning.
21.02.05	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).
21.02.06	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.

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21.02.07	The contractor shall submit to the Employer Field Welding Schedule for field welding activities. 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.
21.02.08	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.
21.02.09	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.
21.02.10	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.
21.02.11	Any other statutory requirements as applicable for the equipments/systems shall also be complied with.
21.02.12	Unless otherwise proven and specifically agreed with the Employer, welding of dissimilar materials and high alloy materials shall be carried out at shop only.
21.02.13	No welding shall be carried out on cast iron components for repair.
21.02.14	All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.
21.02.15	All non-destructive examination shall be performed in accordance with written procedures as per International Standards. The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination). NDT shall be recorded in a report which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job. All plates of thickness 40mm and above & all bar stock/Forging 40mm and above dia shall be ultrasonically tested. For pressure parts, plate of thickness equal to or above 25mm shall be ultrasonically tested.

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21.02.16	The Contractor shall list out all major items/ equipments/ 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 finalized 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 report on sub-contractor details submission / approval shall be furnished. Such vendor approval shall not relieve the contractor from any obligation, duty or responsibility under the contract.
21.02.17	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. Within three weeks of the release of the purchase orders/contracts for such bought out items/components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the Employer on the monthly basis by the Contractor along with a report of the Purchase Order placed so far for the contract.
21.02.18	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.
21.02.19	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/equipments 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.
21.02.20	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.
21.02.21	For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.
21.02.22	Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Employer/ authorised representative.
21.03.00	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.
21.03.01	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.

21.03.02 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.

21.04.00 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.

21.04.01 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.

21.04.02 Typical contents of QA Documentation is as below:-

i) Quality Plan

ii) Material mill test reports on components as specified by the specification and approved Quality Plans.

iii) Manufacturer / works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.

iv) 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.

v) Heat Treatment Certificate/Record (Time- temperature Chart)

vi) All the accepted Non-conformance Reports (Major/Minor) / deviation, including complete technical details / repair procedure.

vii) CHP / Inspection reports duly signed by the Inspector of the Employer and Contractor for the agreed Customer Hold Points.

viii) Certificate of Conformance (COC) wherever applicable.

ix) MDCC

21.04.03 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.

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

i) 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.

ii) 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.

iii) If a decision is made despatch, whereas all outstanding actions cannot be readily cleared for the release of the quality document by that time, the supplier shall immediately, upon shipment of the equipment, send a copy of the quality document Review Status signed by the Supplier Representative to the Inspector and notify of the committed date for the completion of all outstanding actions & submission. The Inspector shall stamp the quality document for applicable section when it is effectively completed. The submission of QA documentation package shall not be later than 3 weeks after the despatch of equipment.

21.05.00 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 deliveries, the complete quality document to the Employer shall be issued not later than 3 weeks after the date of the last delivery of equipment.

21.06.00 PROJECT MANAGER'S SUPERVISION

21.06.01 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.

21.06.02 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:

i) Interpretation of all the terms and conditions of these documents and specifications.

ii) Review and interpretation of all the Contractor's drawing, engineering data, etc.

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iii) 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.

v) Inspect, accept or reject any equipment, material and work under the contract.

vi) Issue certificate of acceptance and/or progressive payment and final payment certificates

vii) Review and suggest modifications and improvement in completion schedules from time to time, and

viii) Supervise Quality Assurance Programme implementation at all stages of the works.

21.09.00 INSPECTION, TESTING AND INSPECTION CERTIFICATES

21.09.01 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.

21.09.02 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.

21.09.03 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, 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.

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21.09.04	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.
21.09.05	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.
21.09.06	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.
21.09.07	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.
21.09.08	To facilitate advance planning of inspection in addition to giving inspection notice as above, 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.
21.09.09	All inspection, measuring and test equipments 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 the Employer. Wherever asked specifically, the contractor shall re-calibrate the measuring/test equipments in the presence of Project Manager / Inspector.

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21.10.00 **ASSOCIATED DOCUMENTS:**

21.10.01 Manufacturing Quality Plan Format No.: QS-01-QAI-P-09/F1-R1

21.10.02 Field Quality Plan Format No.: QS-01-QAI-P-09/F2-R1

22.00.00 **SAFETY ASPECTS DURING CONSTRUCTION AND ERECTION**

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

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

ii) Single core electrical cables shall not be used. Only 3 Core cable for single phase supply and 4 Core for 3 phase supply shall be used.

iii) 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.

23.00.00 **NOISE LEVEL AND VIBRATION**

For noise level please refer Annexure-VII of this part.

For vibration please refer Annexure –VIII of this part.

24.00.00 **PRE-COMMISSIONING AND COMMISSIONING FACILITIES**

24.01.00 (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 Clause No. 30.00.00 of 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) The time consumed in the inspection and checking of the units shall be considered as a part of the erection and installation period.

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d) 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 Employer.

e) 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.

f) Contractor shall furnish the commissioning organisation chart for review & acceptance of employer at least eighteen months prior to the schedule date of synchronization. The chart should contain:

(i) Bio-data including experience of the commissioning engineer.

24.02.00 **Initial Operation**

a) Subsequent to 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.

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

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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.

*Shall be appropriately adjusted for any generation loss attributable to the Employer.

24.03.00 **Guarantee Tests**

a) The final test as to prove the Guarantees shall be conducted at Site by the Contractor in presence of the Employer. The contractor's Commissioning, start-up and initial operation shall make the unit ready to conduct such test.

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

c) For performance/ demonstration tests instrumentations of accuracy class, subject to the approval of the Employer shall be used. The numbers and location of the instruments shall be as per the specified test codes.

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 in Part A and Part B of Section-VI.

24.04.00 **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.

25.00.00 TRAINING OF EMPLOYER'S PERSONNEL

In addition to the requirements given in Section General Condition of contract (GCC), Section-IV regarding training of Employer's personnel, the following shall also apply.

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25.02.00 **General**

The Contractor shall provide suitable instructors, training material and facilities (instruments, apparatus, simulators, documents, drawings, protective clothing, rooms, office supplies, etc.) for the Personnel made available by the Employer for training.

One month before the training start, the Employer will send the list of the trainees and any comments on the training program proposed by the Contractor. This program shall be adapted to the design and nature of the Works, and the needs of trainees. Trainees shall be suitably trained in the various aspects of design, manufacture, installation/erection, operation and maintenance, relevant to the training, of works similar to the Works

The Contractor shall supervise and provide direction to, and be liable for the acts or omissions, other than negligent or wilful misconduct of such personnel, of the Employer's trainees.

The Contractor shall provide the training described hereafter in accordance with any further specific requirements stated in the Employer's Requirements.

The Contractor shall assist the Employer in obtaining any visas and other formalities for entering or leaving the territory on which the training is being provided.

The Contractor shall bear responsibility for ensuring the safety of the trainees during their stay in the country of the training. On their part, the trainees shall comply with the laws, regulations and customs of the country in which training is being held.

In the event of illness or accident, the Contractor shall take all steps to provide the trainees with the appropriate medical care.

25.03.00 **Training of Employer's Personnel**

The Contractor shall provide training to Employer's personnel to meet operational and maintenance requirements of various Systems/equipments supplied under this package. This shall include trainee in the areas as enclosed at Annexure-V & VI.

The scope of service under training of Employer's engineers shall include a training module covering the following:

a) **Training During Engineering/ Manufacturing Phase**

This shall cover all disciplines viz, Mechanical, Electrical, C&I & QA etc. and shall include all the related areas like Design familiarisation, training on product design features and product design software 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. The training in areas of Operation and Maintenance shall take place preferably during end of manufacture/ tests.

b) Training During the Erection / Installation / Site Work

Independently from the supervision and inspection functions of the Employer's Representative, the Contractor shall authorise the Employer's Personnel to follow the erection / installation / site work at his site.

The Employer's Start-up Personnel shall take no part in the equipment erection and/or installation operations, which shall be exclusively carried out by the Contractor and under his entire responsibility.

This on site training shall cover each phase of erection / installation / site work and shall be of sufficient duration.

The Contractor shall supply the information or measurements concerning the erection requested by the Employer's Representative or/and by the Employer's personnel.

c) Training during the Tests on Completion phase, Operation & Maintenance

The scope of service under training of Customer's engineers shall necessarily include, training of upto twelve (12) Employer's personnel for the power plant in the areas of Operation & Maintenance. The Contractor shall provide on the-job training in the operation and maintenance of the Works to the Employer's Operating Personnel. Such training shall start at least 30 days prior to commencement of Tests on Completion and continue until Taking Over. Its scope and quality shall be such so that the operation and maintenance phase of the project can be carried out to ensure sustained guaranteed performance of the equal availability of the units as offered. The training should provide the trainees with comprehensive understanding of all operational and maintenance aspects of the Works. Such training shall also include safety and environmental protection aspects applicable to the Works.

25.04.00 Exact details, extent of training and the training schedule shall be finalised based on the Contractor's proposal.

In all the above cases, whenever the training of Employer's personnel is arranged at the works of the manufacturers, it shall be noted that the lodging and boarding of the Employer's personnel shall be Contractor's scope. The Contractor shall make all necessary arrangements towards the same.

26.00.00 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

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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.

27.00.00 ELECTRICAL ENCLOSURE

27.01.00 All electrical equipments and devices, including insulation, heating and ventilation devices shall be designed for ambient temperature of 40 degree C and a maximum relative humidity of ~~100%~~ 95%.

28.00.00 JUNCTION BOXES

The junction boxes shall be made of minimum 2 mm thick sheet steel. Gland plates shall be removable type and made of 3 mm thick sheet steel. The boxes shall be provided with detachable cover or hinged door with captive screws. Top of the box shall be arranged to slope towards the rear of the box. The box shall be hot dip galvanised and shall be provided with suitable neoprene gaskets to achieve requisite degree of protection. Adequate spacing shall be provided to terminate the external cables. The boxes shall be suitable for mounting on various types of steel structures. The terminal blocks provided shall be of 1100 V grade, rated for 10 A for control cables. Suitable numbering for terminal blocks shall be done. In case of junction box for power cable, the box shall be rated for maximum current carrying capacity. Terminal blocks shall be of one piece, Klippon RSF-1 or ELMEX CSLT-1 type with insulating barriers.

29.00.00 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.

29.01.00 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:

1.	Temperature	-	Degree centigrade (deg. C)
2.	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.
3.	Draught	-	Millimetres of water column (mm wc).

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	4.	Vacuum	-	Millimeters of mercury gauge (mm Hg) or water column (mm Wcl).
	5.	Flow (Liquid)	-	LPS/LPM/LPH
	6.	Flow base	-	760 mm Hg. 15 deg.C
	7.	Density	-	Grams per cubic centimetre.

29.02.00 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 plan-in connection at rear.

29.03.00 Instruments for sensing, transmission and measuring system shall be of electronic type with signal transmission in current mode of 4-20 mA DC. For interrogation of potential free contacts, 48 V DC power supply shall be employed.

29.04.00 For sequence interlocks and equipment/ unit protection, independent and separate direct acting switches shall be provided. Indicating type process switches shall not be acceptable. Wherever blind switches are provided, separate gauges for local indication shall be provided to facilitate easy operation/ maintenance.

29.05.00 The contacts of switch devices (process switches, limit switches) etc., unless higher rating is required for specific application, shall be rated continuously for 5A at 240 V AC, 50 Hz (breaking inductive circuits) and 0.5 A at 220V DC. Each switching element including the contacts from limit and torque switches of valve actuators shall be provided with two electrically independent single pole double throw (SPDT) snap acting contacts. All spare contracts of the switch devices shall be wired to the nearest junction box/ terminal box.

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

29.07.00 All equipment/ systems located in the field shall be suitable for continuous operation without loss of function, departure from specifications or damage, at the ambient temperature of 40 deg. C and relative humidity of 95%.

29.08.00 All equipment/ systems located in air conditioned area as specified else where shall also be designed and constructed to operate for short periods of plant operation when air-conditioning equipment malfunctions (without loss of function, departure from specifications requirements or damage) at the maximum ambient temperature of40 deg C and relative humidity of 95% RH.

30.00.00 PROTECTION CLASS OF CABINETS / PANELS, ENCLOSURES ETC.

a) All panels desks cabinets & enclosures furnished shall at least comply with the requirements of protection classes as indicated below:

1. In-door air -conditioned (A.C.) areas - IP22

2. In-door Non A.C. areas:

   (a) Ventilated enclosures - IP42

   (b) Non- Ventilated - IP54

3. Out-door - IP55

b) Distribution boxes, junction boxes, cold junction compensation boxes, terminal boxes and all other field mounted equipment to be furnished as per this specification shall have weather protection conforming to IP 55.

c) The design of panels. Cabinets, enclosures and packaging density of components mounted therein shall be such that the temperature rise does not exceed 10 deg C above the ambient under the worst conditions. The Contractor shall furnish during detailed engineering the necessary design calculation for Employer's review.

d) Enclosures for peripheral equipments like printers, etc. shall take care of noise and shall ensure minimum possible noise disturbance to the working personnel.

30.01.00 Permanently fastened, stainless steel, name plate stamped with the Employer's tag number and other necessary details shall be furnished on all gauges, control valves, flow devices, switch devices, temperature elements, solenoid valves, and all other devices, panels, cabinets, enclosures, console inserts etc. after Employer's approval.

31.00.00 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. The equipment shall be protected against ESD as per IEC-801- 2. Radio frequency interference (RFI) and electro magnetic interference (EMI) protection against hardware damage and control system mal operations/errors shall be provided for all systems.

32.00.00 SURGE PROTECTION FOR SOLID STATE EQUIPMENT

All solid state systems /equipment shall be able to withstand the electrical noise and surge as encountered in actual service conditions and inherent in a power plant and shall meet the requirements of surge protection as defined in ANSI C37.90.1-1989 on its suitable equivalent class of IEC 254-4. Details of the features incorporated and relevant tests carried out, the test certificates, etc. shall be submitted by the Contractor.

33.00.00 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.

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.

33.01.00 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.

i) Temperature test pockets with stub and thermowell

ii) Pressure test pockets

34.00.00 SYSTEM DOCUMENTATION

The Contractor 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 "Technical Data Sheets" Part of specifications. In addition to this, system documentation for DDCMIS shall include as a minimum to that specified under Sub-section C&I, Part -B, Section-VI Technical Specification.

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

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

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34.02.00	**Electronic Module/Component Details** The Contractor shall have to furnish all technical details in respect of each and every electronic card/module as employed on the various solid state as well as microprocessor based systems and equipment including conventional instruments and peripheral.

ANNEXURE-I

LIST OF STANDARDS

Abbreviations have been used for denoting International and National Standardanisation Organizations.

The Names and Address of reputed Organisations is given below.

ASA	American Standards Association American National Standards Institute 1340 Broadway, New York, Y. N. 10018. U.S.A.
ASTM	American Society to Testing and Materials 1916, Race Street, Philadelphia, Pennsylvania-19103, U.S.A.
BS	British Standards, British Standards Institution, 101, Pentonvile Road, London N 19 ND. U.K.
CEE	Commission on rule for the approval of Electric Equipment (Netherland), Netherlands Normalisate - Institute, Polkwege, Rijswijk (ZH)-2016, Netherland
DIN	Deutscher Normenausschuss Beuth Verlag GmbH Ausilieferung Burggra Fenstrape, 4-7 10009 Berlin 30, Germany.
IEC	International Electrotechnical Commission Bureqa Central De la Commission Electrotechnique Internationale, 1, Rue De Veremba Geneve Switzerland
IS	Indian Standards, Manak Bhavan, 9 Bahadur Shah Safar Marg, New Delhi-1.
ISO	International Organization for Standardization Danizh Board for Standardization DANSK STANDARDESRING SRAAT AUREHOEGVEJ-12 DK 2900 JELLEPRUP, DENMARK.

JIS	Japanese Standards Institution Japanese Standards Association, 124 Asasaka 4 Chome, Tokya 107, Japan.	
SAA	Standards Association of Australia Marks Committee, SAA, P.O. Box 458, North-Sydney, Australia.	
VDE	German Standards VDE. Verlag GmbH, 1000 Berlin 12 Bissmarc-Ketrabe 33, Germany.	

LIST OF CODES

Indian Standards	**Title**	**International and Internationally recognised standard**
EOT CRANES		
IS-1383 & (Part 1,2,3,4 & 5)	-	Cranes Classification
IS - 3177/ BS : 466	-	Code of Practice for Electric overhead travelling cranes and gantry cranes other than steel work crane.
IS - 807/ BS : 2573	-	Code of practice for design, manufacture, erection and testing (Structural portion) of cranes and hoists.
IS - 5749/ BS : 3017	-	Forged Ramshorn hooks.
IS - 2266/ BS : 302	-	Specifications for steel wire ropes for general engineering purposes.
IS – 6938	-	Code of Practice for design of rope drum and chain hoists for hydraulic gates.
IS - 325/BS : 2960	-	Three phase induction motors.
IS - 13947 (Part 4/sec 1)	-	Contactors and motor starters - Electromechanical contactors & motor starter.
IS – 3815	-	Point hooks with shanks for general engineering purpose.
IS – 1030	-	Carbon steel castings for general engineering purposes.

IS – 1875	-	Carbon steel billets, bloom, slabs and bars for forgings.
IS – 210	-	Grey Iron castings.
IS - 4460 (Part 1,2,3)	-	Gears - spur & helical gears - calculation of load capacity.

FIRE DETECTION, SAFETY AND FIRE PROTECTION SYSTEM

Overall scope of the work

NFPA 851	:	Recommended practice for fire protection for hydroelectric generating plants.
NFPA 72	:	National Fire Alarm Code
NFPA 72 E	:	National Fire Alarm Code
NFPA 70	:	National Electrical Code
NFPA 101	:	Life Safety Code
IS 1646	:	Code of practice for Fire safety for buildings (General): Electrical installation
IS 5571	:	Guide for Selection of Electrical equipment in hazardous areas

Fire Alarm & Detection System

IS 2189	:	Selection, Installation and maintenance of automatic fire detection and fire alarm system - Code of Practice
IS 11360	:	Specification for smoke detectors for use in Automatic electric fire alarm system.

IS 2175 : Heat sensitive fire detectors for use in automatic fire alarm system.

IS 2148 : Electrical apparatus for explosive gas atmospheres-flameproof enclosures "d".

IS 694 : PVC insulated cables for working voltages upto and including 1100 volts – Specification.

IS 4237 : General requirement for switchgear & control gear.

Water Based Fire Protection System.

NPFA 13 : Installation of sprinkler systems

NFPA 14 : Installation of standpipe and hose systems

NFPA 15 : Water spray fixed system

NFPA 25 : Fire Pumps & Controllers

TAC doc. : Recommendation for fire protection of transformers

IS 3034: 1993 : Fire safety of industrial buildings: Electrical generating & distributing stations - Code of practice.

IS 10221 : Code of Practice for Coating and Wrapping of underground mild steel pipelines.

IS 952 : Specification for Fog nozzles for fire brigade use

IS-8034 : Specification for submersible pump sets.

IS 3844 : Code of practice for installation & maintenance of internal fire hydrants hose reels on premises.

IS 780 : Sluice valves for water work purposes

IS 5312	:	Swing check type reflux (non return) valve for water works purposes- Specification.
IS 903	:	Fire hose delivery couplings, branch pipes, nozzles and spanner – Specification.
IS 9972	:	Specification for Automatic sprinkler heads for Fire protection system.
IS 7760	:	Specification for steel glass front cabinets.
IS 901	:	Specification for couplings double male and double Female instantaneous pattern for fire fighting.
IS 5290	:	Landing valves – Specification.
IS 4927	:	Unlined flax canvas hose for fire Fighting – Specification.
IS 884	:	Specification for first aid hose reel for fire fighting.

Portable Fire Extinguishers

NFPA 10	:	Portable fire extinguishers
IS 2190	:	Selection, Installation & Maintenance of first aid fire extinguishers - Code of practice.
IS 2171	:	Portable Fire Extinguishers, dry powder (cartridge type) - Specification
IS 2878	:	Fire extinguisher, Carbon dioxide type (portable and trolley mounted) – Specification.
IS 933	:	Specification for Portable Fire extinguisher Foam Type.
IS 13849	:	Portable fire extinguisher Dry powder Type (Stored Pressure)- Specification

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IS 940 : Portable fire extinguisher, water type (gas cartridge) - Specification

NFPA 2001 : Standard on clean agent fire extinguishing system

VENTILATION AND AIR CONDITIONING SYSTEM

Standard	Title
IS 4720	Code of practice for ventilation of surface hydel power station
IS 3103	Code of practice of ventilation for industrial ventilation
IS 4894	Centrifugal fans
IS 2312	Propeller type AC ventilating fans
IS : 7613	Air filters
DIN-2425	Pumps and motors
BS 2831	Methods of test for air filters used in air conditioning and general ventilation
BS 3928	Sodium flame test for air filters other than for air supply to I.C Engines and Compressors.
IS 655	Metal Air Ducts
IS 277	Specification for Galvanised Steel Sheets
IS 737	Specification for Wrought Aluminium or Aluminium Alloys Sheet and Strip
IS : 3624	Pressure & vacuum gauges
IS 659	Safety code for Air conditioning
IS 5111	Measurement of testing refrigerant compressor
IS 3069	Glossary of terms, symbols and units relating to thermal insulation material
IS 4671	Expanded polystyrene for thermal insulation purpose
ARI Standard	Sound level measurement

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575-87	
ASTM B-88	Refrigerant piping
IS : 702	Hot Bitumen Insulation
IS : 1042	Code for flow measurement
ASHRAE15-1994	Safety code for Mechanical Refrigeration
IS : 661	Code of practice for insulation
IS : 14164	Mode of Measurement of insulation

ELECTRIC PASSENGER LIFT

IS-4289	Flexible cables for lifts and other flexible connections.
IS-14665, Part-1,2,3&4	Electric Traction lift.

GENERAL

IS:800	Code of practice for use of structural steel in general building construction	BS 449:1969 BS 5950 ASA A57, 1-1952
IS:807	Code of practice for design, manufacture, erection and testing (Structural portion) of cranes and hoists	Draft Revision of A.S. NO. CS.2 SAA Crane and Hoist code Doc:No. BU/4 Rev 6588 (Issued by Standards Association of Australia). DIN 120:1936 (Sheet 1) DIN 120:1936 (Sheet 2) 327 part-I, 1951 BS 466 part-II, 1960 BS 644:1960 BS 1757:1951 BS 2573:part-I:1960
IS:875	Code of practice for design loads (other than earthquake) for buildings and structures	National Building code of Canada (1953)-Part-IV

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	Leading standards	Design section 4.1 (issued by Canadian Standard) DIN-1055-1955 (Issued by ASA)
IS:1239 Part-I	Mild steel tubes	(ISO/R 65-1957) (ISO/R-64-1958) (ISO/R-65-1958) (BS 1387 : 1957)
IS:1239 Part-II	Mild steel tubulars and other wrought steel pipe fittings	BS 1387 : 1967 BS 1387 :1967 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 performance of constant speed IC Engines for general Purpose	
IS:1893	Criteria for earthquake resistant design of structures	
IS1978-1971	Line Pipe	API Standards 5L April 1969.
IS:2254-1970	Dimensions of vertical shaft motor for pumps	IEC Pub 72-1 part I NEMA Pub MG 1 1954
IS:2312	Propellant type Ventilation fans	
IS:3346	Method for the determination of thermal conductivity of thermal insulation materials (two slab guarded hot plate method)	DIN 52612 (Deutscher Normenausschuss) ASTM C 163-1964 (American Society of Testing and materials)

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		ASTM C 167-1974 ASTM C 177-1963
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 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	
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:5456	Code of practice for testing of positive displacement type air compressors and exhauster (For Test Tolerance Only)	

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	IS:5749	Forged ramshorn hooks	Entwurf DIN 15402 Blett 1 Entwurf DIN 15402 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	
	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 BS:848 (Part-1,2)	Central station AHU/Application of Central Station AHU 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.

Properties, Storage and Handling of Common Building Materials

IS: 808	Rolled steel Beam channel and angle sections.
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: 2062	Specification for steel for general structural purposes.
IS: 8500	Medium and high strength structural steel.

Sheeting Works

IS:277	Galvanised steel sheets (plain or corrugated).
IS: 459	Unreinforced corrugated and semi-corrugated asbestos cement sheets.

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	IS: 513	Cold-rolled carbon steel sheets.
	IS: 730	Specification for fixing accessories for corrugated sheet roofing.
	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	
	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.
	IS: 6649	High Tensile friction grip washers.

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	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 ISI (Part 1 to 7)	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.
	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.

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	IS : 3658	Code of practice for Liquid penetrant Flaw Detection.
	IS : 5334	Code of practice for Magnetic Particle Flaw Detection of Welds.
	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 : 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.

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	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.
	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.
	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.
	Painting and Allied Works	
	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.
	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.
	ISO : 8501-1	Sand blasting.
	ISO:8601-1	Surface preparation of steel or ferrous equipment.
	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.
	Miscellaneous	
	IS:802 (Relevant parts)	Code of practice for use of structural steel in 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	Criteria 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 Publication	Design and construction of buried thin-wall pipes.

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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 measurement 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) Electronic 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 controlling instrument - ANSI C 39.5 - 1974.
3. Compatibility 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.

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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.

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

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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 socket weld 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 through 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 unto 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.

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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

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ANNEXURE-II

NUMBER OF COPIES OF DRAWING AND DOCUMENTS

Sl. No.	DESCRIPTION	NO. OF PRINTS	NO. OF CD-ROMs/Soft Copies	NO. OF MANUALS (SETS)
1.	PLANT DEFINITION MANUAL	-	3 CD-ROMs	10
2.	Drawings "FOR APPROVAL"	6	1 CD-ROM or Soft Copies by E-Mail	-
3.	Drawings "FOR INFORMATION"	4	1 CD-ROM or Soft Copies by E-Mail	-
4.	Drawings "FINAL DRAWING"	10	3 CD-ROMs	-
5.	Drawings "AS BUILT"	10	3 CD-ROMs	-
6.	DATA SHEETS, DESIGN CALCULATIONS, PURCHASE SPECIFICATIONS, etc. and Other type of documents.			
	i) For Approval	4	3 CD-ROMs/Soft Copies by E-Mail	-
	ii) FINAL	10	3 CD-ROMs	-
	iii) Analysis reports of equipments / structures components / systems employing software packages as detailed in the specifications			
	a) Input	4	3CD-ROMs	-
	b) Output	4	3CD-ROMs	-
	c) Drawings / Sketches	4	3CD-ROMs	-

Sl. No.	DESCRIPTION	NO. OF PRINTS	NO. OF CD-ROMs/Soft Copies	NO. OF MANUALS (SETS)
7.	Erection manual "DRAFT"	-	1 CD-ROM or Soft Copies by E-Mail	4
8.	Erection manual "FINAL"	-	3CD-ROMs	10
9.	Operation & Maintenance manual "DRAFT"	1	1 CD-ROM or Soft Copies by E-Mail	4
10.	Operation & Maintenance manual "FINAL"	-	3CD-ROMs	10
11.	Plant Hand Book "DRAFT"	1	1 CD-ROM or Soft Copies by E-Mail	4
12.	Plant Hand Book "FINAL"	3	3 CD-ROMs	10
13.	Commissioning and Performance Procedure manual "DRAFT"	1	3 CD-ROMs/Soft Copies by E-Mail	4
14.	Commissioning and Performance Procedure manual "FINAL"	1	3 CD-ROMs	10
15.	Performance and Functional Guarantees test report	8	3 CD-ROMs	
16.	Progress Reports	8	3 CD-ROMs/Soft Copies by E-Mail	
17.	Project completion report	15	3 CD-ROMs	-
18.	QA programme including Organisation for implementation and QA system manual (with revision servicing)	15	3 CD-ROMs	-
19.	Vendor details in respect of proposed vendors, including Contractor's evaluation report.	1	-	-

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Sl. No.	DESCRIPTION	NO. OF PRINTS	NO. OF CD-ROMs/Soft Copies	NO. OF MANUALS (SETS)
20.	Manufacturing QP's, Field QPs, Field welding schedules and their reference documents like test procedures, WPS, POR etc.			
	i) For review / comment	3	-	-
	ii) For final approval	4	1 CD-ROM	
21.	Welding Manual, Heat Treatment Manuals, Storage & preservation manuals			
	i) Draft	-	-	4 sets
	ii) Final	-	2 CD-ROMs	4 sets
22.	Monthly Vendor Approval and QP approval status	2	1 CD-ROM or Soft Copies by E-Mail	
23.	QA Documentation package for items / equipment manufactured and despatched to site.	2	2 CD-ROMs	
24.	QA Documentation Package for field activities on equipment / system at site.	2	2 CD-ROMs	

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ANNEXURE-III

1.00 **EQUIPMENTS**

		GROUND COLOUR		IDENTIFICATION TAG/BAND			
Sl. No.	***Equipment***	***Colour***	***RAL***	***Colour***	***ISC No.***	***Equi-valent RAL No.***	***Remarks***
	TG SET						
1.	Turbine	Blue	5012	White		9010	Legend in black letters
2.	Main generator	Blue	5012	White		9010	Legend in black letters
3.	**Pumps**						
	Lube oil	Grey	9002	White		9010	Legend in black letters
4.	Valves, gates, filters	Grey	9002	White		9010	Legend in black letters
5.	Turbine Oil System	Grey	9002	White		9010	Legend in black letters
6.	Hand rails	Blue	5012				Wherever required otherwise SS or GI
7.	Pipe supports	Black	9011				
8.	Gratings (non-galvanised)	Black	9011				
9.	Air ducts	Grey	9002	White		9010	Legend in

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		GROUND COLOUR		IDENTIFICATION TAG/BAND			
Sl. No.	***Equipment***	***Colour***	***RAL***	***Colour***	***ISC No.***	***Equi-valent RAL No.***	***Remarks***
							black letters.
10.	FANS	Grey	9002	White		9010	Legend in Black Letters.
11.	Structural steel work fabricated at site	Grey	9002				
	HP AND LP COMPRESSED AIR SYSTEM						
12.	Compressors with inter and after coolers	Blue	5012	White		9010	Identifying legends to be used.
13.	Heater/Drivers	Grey	9002	White		9010	-
14.	Air receivers	Blue	5012	White		9010	Legend in black letters
	MISCELLANEOUS EQUIPMENTS						
15.	Cranes	Golden Yellow	1004	White		9010	
	- Mono Rails & chain pulley systems	Golden Yellow	1004				
16.	Hooks	Signal Red	3001				
17.	Tanks	Grey	9002	white			Legend in Black letters

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		GROUND COLOUR		IDENTIFICATION TAG/BAND			
Sl. No.	***Equipment***	***Colour***	***RAL***	***Colour***	***ISC No.***	***Equi-valent RAL No.***	***Remarks***
18.	Doors industrial type	Blue	5012				
19.	Hydraulic power unit	Golden Yellow	1004	Signal Red	537	3001	
20.	Fencing	Black					
21.	Lighting poles	Aluminium					
	ELECTRICAL COMPONENTS						
22.	**MAIN GENERATOR**						
	- Lub oil system - Seal Oil System	Grey	9002	White		9010	Legend in Black Letters
	- Stator Water Sys.	Grey	9002	White		9010	Legend in Black Letters
23.	**DIESEL GENERATOR SET**						
	- Diesel Engine	Grey	9002	White		9010	
	- Generator	Grey	9002	White		9010	
24.	**L.T. TRANSFORMERS**						
	- Indoor	Blue	5012				Legend in Black Letters

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		GROUND COLOUR		IDENTIFICATION TAG/BAND			
Sl. No.	***Equipment***	***Colour***	***RAL***	***Colour***	***ISC No.***	***Equi-valent RAL No.***	***Remarks***
	- Outdoor	Blue	5012				Legend in Black Letters
25.	33 KV class transformers	Blue	5012	Signal Red	537	3001	
26	Generator bus duct	Blue	5012	Signal Red	537	3001	
27.	Battery charger	Grey	9002	White		9010	
28.	Mimic flow diagram						
	220 KV	Purple Violet	4007	White		9010	
	33.0 KV	Olive Green	6003	White		9010	
	11.0 KV	Zink Gleb	1018	White		9010	
	415 V	Lehm Braun	8003	White		9010	
	220V DC	Tief Orange	2011				
	Gen Fld.	Tiefschwartz	9005				
29.	**MOTORS**						
	- Indoor	Blue	5012				
	- Outdoor	Blue	5012				

		GROUND COLOUR		IDENTIFICATION TAG/BAND			
Sl. No.	***Equipment***	***Colour***	***RAL***	***Colour***	***ISC No.***	***Equi-valent RAL No.***	***Remarks***
30.	**LT SWITCHGEAR (INDOOR)**						
	- LT Switchgear Exterior	Grey & Blue	9002 5012				Front & Rear Panels in Grey (RAL 9002). End Panels sides in Blue (RAL 5012)
	- MCC	Grey & Blue	9002 5012				Front & Rear Panels in Grey (RAL 9002). End Panels sides in Blue (RAL 5012)
	- D.C. Distributio n board	Grey & Blue	9002 5012				Front & Rear Panels in Grey (RAL 9002). End Panels sides in Blue (RAL 5012)
	L.T. busduct outside of enclosures	Blue	5012				

		GROUND COLOUR		IDENTIFICATION TAG/BAND			
Sl. No.	***Equipment***	***Colour***	***RAL***	***Colour***	***ISC No.***	***Equi-valent RAL No.***	***Remarks***
31.	**33 KV SWGR cubicle**	Grey & Blue	9002 5012				Front & Rear Panels in Grey (RAL 9002). End Panels sides in Blue (RAL 5012)
	- CR Panels	Grey	9002				
	- Surge protection cubicle	Grey	9002				
32.	DDCMIS/PLC system cabinets, computer system cabinets, Termination, Marshalling, Relay Panels etc.	Blue & Grey	5012& 9002				Front & Rear Panels in Grey (RAL 9002). End Panels sides in Blue (RAL 5012)
33.	All locally mounted C&I systems panel/ cabinets	Blue & Grey	5012& 9002				Front & Rear Panels in Grey (RAL 9002). End Panels sides in Blue (RAL 5012)
34	Junction boxes	Grey	9002				
35	LIE/LIR	Grey	9002				

		GROUND COLOUR		IDENTIFICATION TAG/BAND			
Sl. No.	***Equipment***	***Colour***	***RAL***	***Colour***	***ISC No.***	***Equi-valent RAL No.***	***Remarks***
36	Remote I/O cabinets	Grey	9002				
37	Intercom	Equipment					
	- Hand sets unit	Grey	9002				
	- Hand sets plant	Grey	9002				
38	- Metal containers/ cable junction boxes	Grey	9002	White		9010	-
39.	**LIGHTING EQUIPMENT/PANELS**						
	- Exterior	Grey	9002				
40.	**INSULATING OIL TREATMENT PLANT**						
	- Tanks and the equipment	Grey	9002	White		9010	Legend in Black Letters
41.	**IDENTIFICATIONS PLATES**						
	Mechanical equipment's and piping						
	- Background	White	9010				
	- Border	Black	9011				
	- Lettering	Black	9011				

Note: 1) For mechanical equipments ground colour indicated against each equipment shall be followed in case equipment is not insulated/cladded.

2) However if enclosure is provided for the mechanical equipments, then the indicated ground colour for mechanical equipment shall be followed

2.00 PIPELINES

		Ground Colour		*Identification Tag/ Band Colour*				
S. No.	***Medium***	***Colour***	***RAL***	***COLOUR***	***ISC No***	***RAL #***	***Legend***	***Remarks***
1.	**WATER**							
a.	Untreated or Raw/ service	Grey	9002	Sea Green	217		RW/SW	
b.	Treated	Grey	9002	Sea Green	217		PW	
2.	**AIR**							
a.	Instrument	Grey	9002	Sky blue	101		IA	
b.	Service/ Plant	Grey	9002	Sky blue	101		PA	
3.	**OILS**							
a.	High speed diesel	Grey	9002	Light brown *	410		HSD	* Hazard Mark
b.	Lubricating oil	Grey	9002	Light brown	410		LO	* Hazard Mark
c.	Hydraulic	Grey	9002	Light	410		HYD.O	

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		Ground Colour		Identification Tag/ Band Colour				
S. No.	Medium	Colour	RAL	COLOUR	ISC No	RAL #	Legend	Remarks
	power			brown				
d.	Control fluid	Grey	9002	Light brown	410		CR.O	
e.	Transformer oil	Grey	9002	Light brown	410		TR.O	
4.	**FIRE INSTAL-LATIONS**	Fire Red	536 (ISC) 3001 (RAL)	White		9010	FIRE	Legend in Red Letters over White Background

Note : 1. Ground colour indicated against each piping shall be followed in case piping is not insulated /cladded.

2 For any equipment not covered above, colour codification shall be furnished by employer during detail engineering.

ANNEXURE-IV

SURFACE TREATMENT AND COATINGS

Object: The present specifications apply to equipment and spare part surface coating. They define surface coating, the types of recommended coating, and the associated guarantees. In any case, the Contractor shall submit to the Employer his coating schemes.

1.00.00 CORROSION PROTECTION

The Contractor shall take all necessary favorable measures to protect equipment from all abnormal corrosion and, taking into account project specific risks.

In particular, the Contractor shall choose the materials most suited to this project and shall submit a modification request to the Employer when the materials indicated in the specifications are considered unable to guarantee its behaviour against corrosion.

1.01.00 Equipment in Contact with Reservoir Water.

For all equipment on the water conveyance circuit (trashracks, valves, pipes, pump turbines instruments), the use of uncoated carbon steel is prohibited, even where corrosion allowance is planned. If he considers it necessary, the Contractor may apply stainless steel cladding to some carbon steel parts, or manufacture these parts in solid stainless steel.

If maintenance is unsure because of peculiar equipment arrangement, or if the equipment cannot easily be shutdown, the Contractor may submit to the Employer, alternative corrosion protection methods, so that vulnerable surfaces can be protected effectively.

1.01.01 Outdoor Exposed Equipment.

Among these equipment can be distinguished: those figuring as the subject of a particular specification, and for which the nature of materials and corrosion protection is clearly defined, those which, unlike the above, are not functional in nature and so are not subject to the same attention regarding problems of corrosion: parapets, gratings, lighting poles, etc. Even this second category of equipment shall be subject to particular attention with regard to choice of materials and corrosion protection.

In general, attention shall be paid to taking constructive measures or acquiring standard equipment, whatever the function, to avoid any water build-up. Such constructive measures are, for example: for constructive using structural sections (dam gates, stop logs), that all horizontal sheet metal sections have drainage holes at regular intervals, for auxiliary structures, embedding holes shall be completely filled with concrete, taking care to avoid any break in corrosion protection where concrete is exposed to the air.

2.00.0	GENERAL
	The Contractor shall provide a complete and reliable surface treatment of the equipment furnished for corrosion protection.
	Surface protection shall comprise:
	A surface preparation phase with mechanical cleaning, grit blasting or chemical cleaning, a surface treatment phase with either metallizing and application of one or two priming coats suited to the type of metal surface, or application of priming coat, an application phase with several coatings of products, including final colored coat.
	Surface protection shall be performed either in the Contractor's shops or on site with the necessary precautions taken.
	Finishing touch-ups shall be performed on site upon completion of erection.
3.00.00	**SURFACE PREPARATION.**
	All surfaces to be coated shall first be mechanically or chemically cleaned.
3.01.00	MECHANICAL CLEANING.
	Surfaces shall be mechanically cleaned using one of the following methods:
	shot-blasting or grit blasting, scraping, stripping, mechanical brushing.
3.01.01	SHOT-BLASTING OR GRIT BLASTING.
	If mineral abrasives are used, they shall be selected in compliance with the prevailing regulations concerning workers' safety.
	The required care levels of surface states after cleaning are defined by the illustrations in standard ISO 8501, or equivalent. The required care shall be as follows:
	♦ preparation of steel surfaces to be imbedded set in concrete = Level 1,
	♦ preparation of steel surfaces to receive definitive protection = Level 2.5,
	♦ preparation of steel surfaces to receive metallized protection = Level 3.
	The roughness of the cleaned surfaces shall be Ra = 12.5 µm, except for surfaces that shall be metallized later, for which the roughness shall be Ra = 6.3 µm.

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3.01.02 SCRAPING, STRIPPING, MECHANICAL BRUSHING.

This type of cleaning shall concern:

- Parts to be set in concrete, which shall not be coated.

These parts shall be brushed immediately prior to concreting.

- Repair of defective surface coating. In this case, cleaning by scraping, stripping or brushing shall only be performed if shot-blasting or grit blasting is impossible.

The required care shall be as follows:

- St 2 for surfaces which shall subsequently receive a definitive coating.
- St 1 for surfaces to be set in concrete with no surface protection.

After cleaning, all surfaces shall be thoroughly dusted.

3.01.03 SURFACE PROTECTION REPAIR

Before surface protection is repaired, the old protection shall be partially or entirely removed. A new defects liability period shall start as soon as the zone in question has been repaired.

The old coating shall be completely removed by shot-blasting or grit blasting, in compliance with the specifications in 3.01.01.

If this process is impossible, the old coating shall be removed by scraping, stripping or mechanical brushing, in compliance with the specifications in 3.01.02.

4.00.00 CHEMICAL CLEANING

All traces of pollution shall be removed with solvents (degreasing, neutralisation).

The surfaces shall then be rinsed and dried (with special cleaning paper).

The Contractor shall submit, for the Employer's approval, a list with the characteristics of the solvents that he intends to use.

5.00.00 SURFACE TREATMENT

Immediately after surface preparation, the Contractor shall employ one of the following three surface treatment processes:

6.00.00 METALIZING

Metalizing shall be performed within 2 hours after preparation.

The chemical composition of the metal used shall be: 85 % Zinc - 15 % Aluminum. The thickness shall be 120 µm.

Application shall be by spray gun in compliance with ISO standard R 2053.

After metalizing, pores shall be plugged by applying a wash primer, or, if the equipment is intended for immersion, by applying a thin coat of zinc epoxy (max. 20 µm).

7.00.00 HOT GALVANIZING

This coating performed by quenching shall have the following characteristics:

- minimum unit mass : 5g/dm²,
- average thickness : 70 µm

This process shall be used when metalizing cannot be performed under satisfactory conditions.

8.00.00 PRIMING COAT APPLICATION

This coating shall have the following characteristics:

- product : zinc epoxy coat,
- thickness : minimum 40 µm.

9.00.00 APPLICATION OF THE PROTECTION

The Contractor shall carefully control relative humidity and temperature before and during applying any coating. In any case, the relative humidity shall not exceed 80%.

All traces of condensation shall be eliminated before protection is applied. If the relative humidity remains between 50 and 80%, the first coat shall be applied four (4) hours after the surface preparation.

The undercoats or finish coats shall be applied in compliance with the drying time required between each application.

Each coat shall be of a different color.

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10.00.00 TOUCH-UPS

If more than 20 % of the total surface area of a given zone shall be touched-up, the Contractor shall replace the surface treatment over the entire surface.

11.00.00 PROTECTION OF THE SURROUNDING SURFACES

The Contractor shall take every measure to protect the surrounding equipment and surfaces from product spattering, and from any damage caused by the surface preparation that he performs.

Equipment or surfaces that are soiled or deteriorated in spite of these measures shall be repaired or cleaned, or if this is impossible, replaced at the Contractor's expense.

12.00.00 CARBON STEEL - STAINLESS STEEL CONNECTION

When carbon steel and stainless steel parts are connected, the surface coating shall be prolonged by 50 cm on the stainless steel part.

13.00.00 TYPES OF COATING

The coatings to be applied, except when expressly stipulated otherwise in the equipment specifications, shall be defined as follows:

14.00.00 CARBON STEEL SURFACES IN CONTACT WITH WATER

System chosen	Thickness
• 1 zinc epoxy priming coat	40 µm
• 2 or 3 coats of epoxy-coal pitch finishing paint	2 x 225 or 3 x 150 µm

The system's minimum thickness shall be 450 µm.

The complete protection shall be applied in the shop, except when expressly waived by the Employer, and on site intervention shall be limited to touch-ups.

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15.00.00 CARBON STEEL SURFACES IN CONTACT WITH AIR AND INSTALLED OUTSIDE

System chosen	Thickness
• 1 epoxy priming coat	40 µm
• 2 or 3 coats of epoxy-coal pitch finishing paint	2 x 225 or 3 x 150 µm

The system's minimum thickness shall be 450 µm.

The complete protection shall be applied in the shop, except when expressly waived by the Employer, and on site intervention shall be limited to touch-ups.

16.00.00 CARBON STEEL SURFACES UNDER COVER THAT STILL RISK CONDENSATION

System chosen	Thickness
• Zinc epoxy priming coat	40 µm
• 2 coats colored solvented epoxy pitch	2 x 150 µm minimum

The system's minimum thickness shall be 300 µm.

The complete protection shall be applied in the shop, except when expressly waived by the Employer, and on site intervention shall be limited to touch-ups.

17.00.00 CARBON STEEL SURFACES UNDER COVER WITH NO RISK OF CONDENSATION

System chosen	Thickness
• Zinc epoxy priming coat	50 µm
• 2 coats colored solvented epoxy pitch	2 x 100 µm minimum

The system's minimum thickness shall be 200 µm.

The complete protection shall be applied in the shop, except when expressly waived by the Employer, and on site intervention shall be limited to touch-ups.

5.2

18.00.00 **CARBON STEEL SURFACES IN CONTACT WITH OIL**

System chosen	Minimum thickness
• 2 coats of epoxy-polyamide paint containing aluminum	2 x 75 µm minimum

The Contractor shall ensure that the paint chosen is compatible with the oil in contact.

The complete protection shall be applied in the shop.

19.00.00 **TEMPORARY PROTECTION OF GROOVES**

The grooves, along with an area from 100 to 150 mm on either side of them, shall receive a temporary protective coating, according to the following system:

System chosen	Minimum thickness
• 1 coat of weldable epoxy-zinc paint	40 µm

The complete protection shall be applied in the workshop.

20.00.00 **TEMPORARY PROTECTION FOR MACHINED SURFACES**

The surfaces shall be degreased, rinsed and dried before application of the temporary protective coatings.

System chosen	Minimum thickness
Solvented corrosion resistant paint	
• 2 coats for oxidizing surfaces	2 x 35 µm
• 1 coat for non-oxidizing surfaces	1 x 35 µm

The protection shall be applied in the shop and eliminated on site before erection, using a rag impregnated with a solvent compatible with the materials temporary protected.

21.00.00 **CONDENSATION PROTECTION**

The Employer and the Contractor shall mutually agree on the products to be used.

22.00.00 **SPARE PARTS**

The spare parts' surface coating shall be applied in compliance with the present specifications.

All temporary surface protections (until the spare parts are used) shall be designed to last for 15 years storage of the parts.

23.00.00 **COLOR OF THE FINISH COAT**

The Employer shall define the color of the finish coat.

24.00.00 **PROTECTION THICKNESS**

Protection thickness shall be checked in compliance with the following specifications:

24.01.00 Number of measurement points

The number of measurement points is defined in the following table:

Size of the surface to be tested (reference zone, in m² or in linear meter))	Number of measuring points recommended
< 10	10 to 20
10 to 100	20 to 50
100 to 1000	50 to 100
1000 to 10000	100 to 200

24.02.00 Tolerance on system minimum thickness

Spot measurements less than the minimum thickness shall be accepted if both following conditions are fulfilled:

- the average of all the measurements performed on the reference zone is equal to or greater than the required minimum value, and
- no measurement point is less than 80% of the required minimum value.

In case of non-compliance with the criteria listed here above, the Contractor shall be obliged to touch up surface protection, either locally or completely.

The touch-up procedure shall be submitted to the Employer.

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25.00.00 **PRODUCT CHARACTERISTICS DATA SHEET**

For each product, the Contractor shall provide a characteristics data sheet specifying:

- the manufacturer's references,
- product characteristics,
- application conditions.

The Contractor shall submit a model data sheet to the Employer. This sheet shall then be used for all surface protection works.

26.00.00 **PAINT/COATING QUALITY CONTROL SHEET**

During coating operations, the Contractor shall follow quality control procedure as agreed between the Employer and the Contractor:

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ANNEXURE - V

TRAINING FOR ELECTRO-MECHANICAL PERSONNEL

Sl No.	Description of Training	Training Duration	Place of Training	Number of Trainees from Employer
1.00.00	**Training During Engineering / Manufacturing Phase**			
1.01.00	**TURBINE, GOVERNING & AUXILIARIES**			
1.01.01	**Design & Quality Assurance** (a)Turbine, Governing & Auxiliaries • System description, Specific Design and engineering & Quality Assurance concepts for the offered equipment. Selection criterion for the Turbine, Governing and auxiliaries. (b) Turbine Hydraulic characteristics • Significance of Model & Model Testing • Visit to Hydraulic Lab • Explanation of Model Test Report (Efficiency , Runway speed and Hydraulic Transient) (c) Mechanical Characteristics • Construction & Quality Assurance of Turbine Components (d) Study of Manufacturing & Quality Assurance Process • Shop Tour • Manufacturing Process of Key Components	10 Days	Manufacturers works	5

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Sl No.	Description of Training	Training Duration	Place of Training	Number of Trainees from Employer
1.01.02	**Operation & Maintenance** • Brief description of Turbine, Governing & Auxiliary Systems • Shop Tour • Instruction to Assembly and Disassembly of Unit. • Operation & Maintenance Practices • Trouble shooting	10 Days	Manufacturers works	5
1.02.00	**GENERATOR, GENERATOR EXCITATION SYSTEM INCLUDING AVR AND AUXILIARIES**			
1.02.01	**Design & Quality Assurance** • Design, Dimensioning, Testing & Quality Assurance aspects of Generating System, Insulation system, Cooling medium and arrangement, Winding and core support system and other auxiliary systems. • Familiarization with different sub-systems & their process controls. • Study of Manufacturing Process & Quality Assurance aspects for Core, Winding, and Assembly. • Shop Tour • Testing & Inspection Facilities familiarization. • Functioning at reference plants	10 Days	Manufacturers works	5

Sl No.	Description of Training	Training Duration	Place of Training	Number of Trainees from Employer
1.02.02	Operation & Maintenance • Brief description of Generator, excitation system, AVR & Auxiliary Systems • Shop Tour • Instruction to Assembly and Disassembly of equipments • Operation & Maintenance Practice	10 Days	Manufacturer's works	5
1.03.00	SUBSTATION AUTOMATION SYSTEM • Design & Quality Assurance aspects of various sub-systems, • Relay configuration, control configuration, setting calculations & Testing	5 Days	Manufacturer's works	4
2.00.00	TRAINING DURING ERECTION/ INSTALLATION/ SITE WORK - Lecture Hall Training by Contractor's Experts (besides demonstration at site)		SITE AND LECTURE HALL AT RAMMAM STAGE-III PROJECT	
	Imparting On the job Training (including training on Assembly & dismantling) at site to employer's Project Manager(s), associated during Erection, Installation / site work			
	(a) Turbine & Mechanical Aux.	10 Days		8
	(b) Generator, Excitation System & Electrical Aux.	10 Days		8

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Sl No.	Description of Training	Training Duration	Place of Training	Number of Trainees from Employer
	(c) Switchyard	2 Days		5
	(d) Substation Automation System	2 Days		5
3.00	**TRAINING DURING TESTING & COMMISSIONING** - Lecture Hall Training by Contractor's Experts besides demonstration at site (including training on Assembly & dismantling, O&M and Trouble Shooting.		SITE AND LECTURE HALL AT RAMMAM STAGE-III PROJECT	
	(a) Turbine & Mechanical Aux.	10 Days		8
	(b) Generator , Excitation System & Electrical Aux.	10 Days		8
	(c) Switchyard	3 Days		5
	(d) Substation Automation System	3 Days		5

ANNEXURE-VI

TRAINING FOR C&I PERSONNEL

1.00.00 GENERAL

The Contractor shall provide course material, equipment, and trainers to train the Employer's personnel. Such training shall consist in formal training in operation, hardware, equipment and software maintenance, as set out in the paragraphs hereafter. When training is conducted outside the Employer's country, and in particular for participation of the Employer's engineers in the Contractor's studies, the Contractor shall be responsible for organization, all costs (including communications, documentation, office facilities, etc.) and correct running of the training.

All lectures, courses and course documents shall be in English. The trainers shall speak English. If necessary, interpreters shall be provided by the Contractor.

2.00.00 TRAINING COURSES

2.01.00 **Training in operation**

The Contractor shall provide operation training including at least:

- screen-keyboard operations,
- manipulation of the trackball or mouse,
- on-screen display,
- interpretation of the display,
- sets of tests,
- reloading the printers with paper,
- refilling the ink in the printers,
- exchanging peripheral devices,
- UPS operation,
- synchronizer,
- unit measurement system,
- LVS maintenance
- CRT maintenance

- LCU maintenance
- Telecommunication maintenance
- Historical data server maintenance
- Log station maintenance
- Plant Computer Maintenance
- Closed Circuit Television maintenance
- Public Address System maintenance

It shall cover:

- Operation from the power house Control Room,
- Operation from the Spillway Control Room,
- Operation from the switchyard Control Room,
- Operation from local control boards, at each location,
- Operation from drive control boards,
- Operation from each Operator Workstation,
- Monitoring from remote operator workstation in the Employer's OS control room.
- Engineering functions of the engineering station

Operation training shall be provided on site during commissioning.

2.02.00 **Hardware and equipment training**

The Contractor shall provide SCADA System hardware maintenance training and equipment training at the Contractor's premises. This training shall include at least the following:

- Basic studies:
  - processor,
  - hardware configuration,
  - electronic board and bus configuration,
  - tests,

- network,
- functional architecture.

♦ Detailed studies:

- plant computer,
- operator workstation,
- engineer station,
- Local supervision station,
- local control units,
- internal communication network,
- interface devices
- synchronization devices of the unit on the grid,
- UPS,
- clock synchronization and distribution equipment

2.03.00 **Software maintenance training**

The Contractor shall provide real time software maintenance training at the Contractor's premises. This training shall include at least the following:

♦ Basic studies:

- operating system,
- operating system nucleus,
- data base kernel,
- diagnostic programs,
- application programs.

♦ Detailed studies:

- modification of the data base,
- modification of views,
- system fault management,

6.2

- start/stop,
- communication

♦ Process description:

- normal operation,
- process fault management.
- Emergency operation

3.00.00 DURATION AND TRAVEL

The duration and number of trips indicated in the table hereafter are to be considered as minimum.

	Location	Number of trainees	Duration of training
Training in operation & maintenance	RAMMAM STAGE-III PROJECT SITE	10	10 days
Hardware and Equipment Training -Basic studies -Detailed studies -Equipment	Manufacturer's Premises	5	10 days
Software Maintenance Training - Basic studies - Detailed studies - Process description	Manufacturer's Premises	5	10 days

ANNEXURE-VII

NOISE

OBJECT: THE PRESENT SPECIFICATION DEFINES ACCEPTABLE NOISE LEVELS IN THE POWER STATION, ASSOCIATED PREMISES AND OUTSIDE THE POWER STATION ENCLOSURES.

1.00.00 GENERAL

The Contractor shall be responsible for the noise emitted by his equipment within its immediate environment and the areas around it.\

Generally, the Contractor shall attempt to reduce the noise emitted by his equipment, whatever its nature (impact, transmitted, echo, etc.), and shall analyse at an early stage the effects of installing noise reduction devices on neighbouring civil works structures or equipment.

This shall apply to all type of normal operation, including the transient states between one operating mode and another.

2.00.00 SOUND LEVELS

The noise emitted by the equipment shall be evaluated according to sound pressure levels expressed in decibels in compliance with IEC/IS or equivalent.

2.01.00 **Outside**

Installations' noise impact on the environment shall be limited.

If necessary, the Contractor shall fit his equipment with noise reduction devices, such as covers or silencers.

2.02.00 **Within Premises**

2.02.01 Control Room, Offices

Noise levels shall not exceed 60 dB (A) in the control room and in offices that are not always in use; in offices in permanent use levels shall not exceed 45 dB(A).

2.02.02 Power Station Noise Level

The equivalent 'A' weighted sound pressure level measurement at a height of 1.5 M above floor level in elevation and at a distance of one (1) M horizontally from the nearest surface of any equipment/machine, furnished and installed under these specification, expressed in decibels to a reference of 0.0002 microbar shall not exceed 85 dB(A) except for premises where access is prohibited when equipments are in service, like operation area of runner, thrust bearing, and generator, where no noise limit shall be imposed.

6.4

The method proposed for measurement shall be in accordance with the relevant standards/norms and shall be submitted to the Employer for acceptance.

2.03.00 **Noise Attenuation**

The Contractor shall use all possible solutions at attenuate nose produced by his equipment, and in particular:

- Installation of sound-proofed doors for access to high noise level rooms (e.g. generator),
- sufficient thick casing around the noisy parts of units,
- installation of covers on some auxiliaries,

In all cases, whatever sound-proofing methods are used, care shall be taken to seal off all ducts and feed-throughs in walls and enclosures around significant sound sources, in order to comply with specified objectives.

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ANNEXURE-VIII

VIBRATION CRITERIA

1.0 GENERAL

The Contractor shall design and install his equipment in such a way as to prevent excessive vibrations which may harm his equipment or any neighboring structures and equipment.

This shall apply to all types of normal operation, including the transient states between one operating mode and another.

Vibrations and shocks to equipment from external sources shall comply with IEC standard 721 (also regarding non-electrical equipment).

2.0 Acceptance Criteria

2.1 Turbine-Generator Unit

2.1.1 Balancing

The Contractor shall balance the unit in accordance with ISO standard 1940. In all cases of normal operation, the criterion shall be fixed at G 6.3 mm/s for the turbine runner. The criterion shall be fixed at G 2.5 mm/s for the generator.

The unit's balance shall comply with the conditions stipulated in Clause 2.1.2 of the present specification.

2.1.2. Measurements at commissioning

2.1.2.1 Preliminary vibration analysis

At commissioning of the unit, it shall be required to carry out a preliminary vibration analysis, consisting of a spectral analysis of vibration of non-rotating parts (bearings). Each individual peak shall be identified, its level (in mm/s) shall be registered. The recordings shall be transmitted to the Employer, stipulating the test conditions and the recording and sampling parameters.

The obtained values shall not be guaranteed.

2.1.2.2. Guaranteed vibration levels

*2.1.2.2.1 **Acceptance standards***

At commissioning of the unit, the Contractor shall take vibration measurements in compliance with ISO standard 10 816-5 for the non-rotating parts and ISO standard 7919-5 for the rotating shafts.

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2.1.2.2.2	***Operational conditions*** Measurements shall be carried out with the machine running under the following stationary conditions: ♦ at no-load - uncoupled, ♦ at no-load - coupled, ♦ at 25%, 50%, 75%, 100% of rated output, ♦ at maximum power. For each power stage, three reactive power levels shall be tested: none, supplied and absorbed. For each power stage, operational temperatures (bearings, etc.) shall be in a steady state.
2.1.2.2.3	***Acceptance criteria for measurements on non-rotating parts*** The guaranteed values for the 75% and 100% of rated output shall be those indicated in Appendix A of the ISO standard 10 816-5. The values taken into account shall be in compliance with this standard for the A/B area. The measurements for the other loads shall be submitted to the Employer and shall not be guaranteed.
2.1.2.2.4	***Acceptance criteria for measurements on rotating shafts*** The guaranteed values for the 75% and 100% of rated output shall be those indicated in Appendix A of the ISO standard 7919-5. The values taken into account shall be in compliance with this standard for the A area. The measurements for the other loads shall be submitted to the Employer and shall not be guaranteed.
2.2	Other Rotating Machines (pumps, motors, gearing, fans, etc.) The vibratory level of the machines shall be in compliance with the ISO standard 10816-3 Appendix A/ relevant Indian Standard. The Contractor shall also take all necessary steps to prevent the transmission of vibrations to neighboring structures (specially diesel engines).
2.3	Other equipment susceptible to causing vibrations (bypass, valves, etc.) The Contractor shall ensure that pressure fluctuations or vortices induced by the flow of water, oil or air do not cause vibrations harmful to equipment, do not transmit vibrations to civil works structures and do not constitute unpleasant acoustic sources. The Contractor shall take all necessary steps to attenuate vibrations, to isolate equipment transmitting vibrations and/or to ensure that these vibrations do not have harmful effects (adequate dimensioning, resonant frequencies sufficiently distant from excitation frequencies).

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

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

		LEGEND: * RECORDS, INDENTIFIED 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 IDENTIFY IN COLUM "N" AS ' W"		DOC. NO.:	REV..... CAT.....	
MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER		FOR NTPC USE			
SIGNATURE				REVIEWED BY	APPROVED BY	APPROVAL SEAL

SUPPLIER'S LOGO	SUPPLIER'S NAME AND ADDRESS	FIELD QUALITY PLAN		PROJECT : PACKAGE : CONTRACT NO. : MAIN-SUPPLIER:
		ITEM : SUB-SYSTEM:	QP NO.: REV. NO.: DATE: PAGE: .... OF....	

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

MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER
SIGNATURE	

LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.
LEGEND TO BE USED: CLASS # : A = CRITICAL, B=MAJOR, C=MINOR;
'A' SHALL BE WITNESSED BY NTPC FQA, **'B'** SHALL BE WITNESSED BY NTPC ERECTION / CONSTRUCTION DEPTT. AND **'C'** SHALL BE WITNESSED BY MAIN SUPPLIER (A & B CHECK SHALL BE NTPC CHP STAGE)

FOR NTPC USE

DOC. NO.:		REV.....
REVIEWED BY	APPROVED BY	APPROVAL SEAL

PART - D

ERECTION CONDITIONS OF CONTRACT

RAMMAM STAGE-III HYDRO ELECTRIC PROJECT (3 X 40 MW) ELECTRO MECHANICAL WORKS EPC CONTRACT PACKAGE BIDDING DOC NO.: CS-5602-003-9	TECHNICAL SPECIFICATION SECTION-VI

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