DAMODAR VALLEY CORPORATION

2X800 MW KODERMA TPS PHASE II
&
2X660 MW RAGHUNATHPUR PHASE II
SG ISLAND PKG

TECHNICAL SPECIFICATION

FOR

AIR CONDITIONING & VENTILATION SYSTEM

SPECIFICATION NO.: - PE-TS-CB-553-002-A001

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
BHEL SADAN
SECTOR-16A, PLOT NO.-25, NOIDA, INDIA

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DAMODAR VALLEY CORPORATION

2X800 MW KODERMA TPS PHASE II
(2 X 800 MW)

TECHNICAL SPECIFICATION

FOR

HVAC SYSTEM

SPECIFICATION NO.: - PE-TS-519-553-002-A001 (REV-00)

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
BHEL SADAN
SECTOR-16A, PLOT NO.-25, NOIDA, INDIA

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SECTION-I

SUB-SECTION-A

INTENT OF SPECIFICATION

1.0 INTENT OF SPECIFICATION

1.1 The specification covers design (i.e. preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles, fill of lubricants, chemicals, reagents and consumables required for pre-commissioning, commissioning , performance testing, mandatory spares along with spares for erection, start-up and commissioning as required, forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation, storage & preservation at site, in-site transportation, assembly, erection & commissioning, final painting at site, minor civil and structural work, trial run at site and carrying out Performance guarantee / Functional / Demonstration tests at site, training of customer/client O&M staff, handing over and handover in flawless condition to BHEL's customer of **HVAC SYSTEM with mandatory spares** as per the details in different sections / volumes of this specification and various pre award agreements for **2X800 MW KODERMA TPS PHASE II at Koderma, Jharkhand**

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 items required for completion of the system and not withstanding that they may have been omitted in drawings / specifications or schedules.

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

1.6 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure

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

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

1.8 Deviations, if any, should be very clearly brought out clause by clause along with cost of withdrawal in the enclosed schedule (in Sec – II); 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 & requirements of different codes/standards and between respective clauses of subsection C & sub-section D, more stringent clause as per the interpretation of the owner shall apply.

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

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

SECTION: I

SUB-SECTION: B

PROJECT INFORMATION

SUB-SECTION–I-B

PROJECT INFORMATION

CLAUSE NO.	PROJECT INFORMATION

1.00.00 BACKGROUND

KTPC PH-I (2X500 MW) units are in operation near Benjhidih Village of Koderma District in Jharkhand. The Present proposal is for KTPS PH-II (2x800 MW) as an extension of the existing Phase-I.

2.00.00 LOCATION AND APPROACH

The Koderma Thermal Power Station project is located near Benjhidih Village of Koderma District in Jharkhand. National Highway NH-19, which is referred to Delhi–Kolkata highway is about 25 Km from the Site. The nearest National Highway NH- 20 is about 8 Km from the site.

The Site is located at latitudes of 24°23'00" N and longitudes of 85°33'15" E respectively.

The Site can be approached from District Head Quarters through National Highway NH-20 and thereafter the internal road of the town. The nearest airport is Gaya Airport at Bodh Gaya at about 108 Km from the project site. The project is situated about 150 Km from Ranchi, the capital of Jharkhand.

Town/City

Nearest Town	Koderma About	7 Km
District Head Quarters	Koderma Collectorate	About 16 Km
Nearest Major Town	Hazaribagh	About 60 Km
Nearest Major	City Gaya	About 115 Km

2.01.00 RAIL LINK

Nearest Railway Station	Koderma	About 2 Km
Other Nearby Important Stations	Gomo Junction	About 124 Km
Other Major Stations	Gaya Junction	About 114 Km

2.02.00 AIRPORT

Nearest Commercial Airport	Gaya Airport, Gaya	About 108 Km
Other Important Commercial Airport	Birsa Muda International Airport, Ranchi	About 170 Km

The vicinity Plan is placed in **Annexure-I.**

3.00.00 CAPACITY

Phase-I	:	1000 MW (2x500 MW) – Under Operation
Phase-II	:	1600 MW (2x800 MW) - Present proposal

4.00.00 LAND

About 1879 Acres of Land has been acquired for the Koderma Thermal Power station. The expansion project is envisaged to be accommodated within the land already acquired during Phase-I.

5.00.00 WATER

The water requirement of Koderma TPS is being met from the Barakar River above Tilaiya Reservoir, which is about 8 Km from the Site.

As per MOEF&CC vide notification dated 07.12.2015 and its amendment dated 28.06.2018, the water requirement for the Ph-II project is limited to 48 Cusecs. The project shall be provided with Water Cooled Condenser (WCC) and accordingly, the consumptive make-up water requirement would be about 48 Cusecs.

A total water allocation of 18.50 MGD (29 Cusecs) is available with DVC for 2x500 MW units of KTPS. The water requirement for the Ph-II project (2x800 MW) is about 48 Cusecs (with ash water recovery) and about 68 Cusecs (without ash water recovery). Damodar Valley Reservoirs Regulating Committee (DVRRC) vide its minutes of the 145th meeting held on 24.11.2022 has consented to allocate additional water of 44.30 MGD (70 Cusecs) to the Ph-II project (2x800 MW) on a provisional basis for a period of 4 years (30.11.2026) and thereafter water allocation would be as per actual requirements of the project..

A closed cycle cooling water system using cooling towers is envisaged for Ph-II of the project.

6.00.00 COAL

6.01.00 The coal requirement for the project is estimated at about 7.43 MTPA corresponding to 85% PLF considering GCV of 3500 Kcal/Kg. The likely coal source for the project is from the Central Coalfields Ltd (CCL). The coal linkage for the project is yet to be tied up/ to be established.

6.02.00 Coal Transportation

The transportation of Coal from Coal Mines to Koderma Ph-II is proposed through Rail mode.

6.03.00 Coal Quality

The primary fuel for the main steam generator shall be coal. The coal quality parameters indicated in **Annexure-IV-2** are to be considered for steam generator design.

7.00.00 Fuel Oil

The fuel oils to be used for start-up, coal flame stabilization and low load operation of the steam generator shall be Light Diesel Oils having the characteristics given in **Annexure-IV-1**.

8.00.00 MODE OF OPERATION : Middle load (two shifting and load cycling)

9.00.00 STEAM GENERATOR TECHNOLOGY

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

10.00.00 FLUE GAS DESULPHURIZATION SYSTEM (FGD) & DeNOx ready System:

The project is envisaged with environmental emission control devices and steam generator design towards compliance with the applicable emission norms. The secondary NOx control system (SCR/SNCR or a hybrid of both) is not included in the scope of this contract. Necessary provisioning as detailed in specifications shall however be in the scope of the Contractor. The limestone to be used for the design of the FGD system shall be as per the characteristic given in **Annexure-IV-5**.

11.00.00 CONSTRUCTION POWER

The requirements of the construction power supply for the project would be met from already existing 50MVA 132/11kV Construction power transformer under Ph-I. Necessary 11 KV ring main/LT sub-stations shall be provided for Ph-II.

12.00.00 POWER EVACUATION SYSTEM

It is proposed to consider 400kV step up voltage for the Ph-II project in line with all the existing units of Koderma TPS. Two (2) numbers of 315 MVA, 400/220/33kV ICT exist at KTPS switchyard. These shall be replaced with new two (2) numbers 500 MVA, 400/220/33kV ICTs. Along with this, a new 500 MVA, 400/220/33kV ICT is proposed for power evacuation at 220kV voltage level. For this 3rd ICT, new 400kV switchyard Bay has been envisaged.

The issue of power evacuation of the proposed project shall be taken up by Damodar Valley Corporation with the appropriate Transmission Utility (CTU) as per regulatory provisions. The above scheme considered presently shall be reviewed based on the finalized ATS of the project.

13.00.00 PLANT WATER SCHEME

13.01.00 Equipment Cooling Water (ECW) System (Unit Auxiliaries)

All plant auxiliaries and station auxiliaries shall be cooled by De-mineralized water (DM) in a closed circuit. The primary circuit DM water shall be cooled through plate type heat exchangers by Circulating Water tapped from CW system in a closed secondary circuit.

It is proposed to provide independent primary cooling water circuit for TG & its auxiliaries and Steam Generator & auxiliaries (including FGD & station auxiliaries) on Unit basis.

13.02.00 Other Miscellaneous Water Systems

CW system blow down water shall be used in Ash Handling System, FGD process water and CHP dust suppression, service water etc. (Refer Plant Water Scheme). Further, the plant service water requirement, sealing of Vacuum pumps (if applicable) of Ash Handling plant, make-up to fire water system, APH wash & FGD system (gypsum cake wash) make up shall be met from PT plant of CW system (PT-CW). The

waste service water collected from various areas and coal-laden water from coal handling plant shall be treated as per requirement and reused.

The quality of Raw water, & DM water is given in this sub-section at **Annexure-III-A, and IIIB**.

13.03.00 Condenser Cooling (CW) Water System

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

Plant water scheme is included in **Part-E** of the technical specification.

14.00.00 ENVIRONMENTAL ASPECTS

Koderma TPS, Phase-II is proposed to be constructed on the land already acquired for ultimate capacity of KTPS, which conforms to the siting criteria for thermal power plants. Environment and Forest Clearances for KTPS Ph-I have already been accorded by MoEF&CC.

16.00.00 METEOROLOGICAL DATA

The meteorological data from nearest observatory is placed at **Annexure-II.**

17.00.00 CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT

All power plant structures and equipment, including plant auxiliary structures and equipment shall be designed for seismic forces as given in Part-B Civil Works D-1-12(E) of this section.

18.00.00 CRITERIA FOR WIND RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT

All structures and equipment of the power plant, including plant auxiliary structures and equipment, shall be designed for wind forces as given as given in Part-B Civil Works D-1-12(D) of this section

19.00.00 Vulnerability Atlas of India(VAI), prepared by Building Materials, Training and Promotion Council (BMTPC) under Ministry of Housing and Urban Affairs, is a comprehensive document which provides existing hazard scenario for the entire country and presents the digitized State/UT-wise hazard, maps with respect to earthquakes, winds and floods for district-wise identification of vulnerable areas. It also includes additional digitized maps for thunderstorms, cyclones and landslides. The main purpose of this Atlas is its use for disaster preparedness and mitigation at policy planning and project formulation and construction stage. The VAI provides necessary information for risk analysis and hazard assessment and is available at website www.bmtpc.org.

As per Government's directive, it is mandatory for the bidders to refer VAI for multi-hazard risk assessment and include the relevant hazard proneness specific to project location while planning, designing and execution of the project in terms of following details:

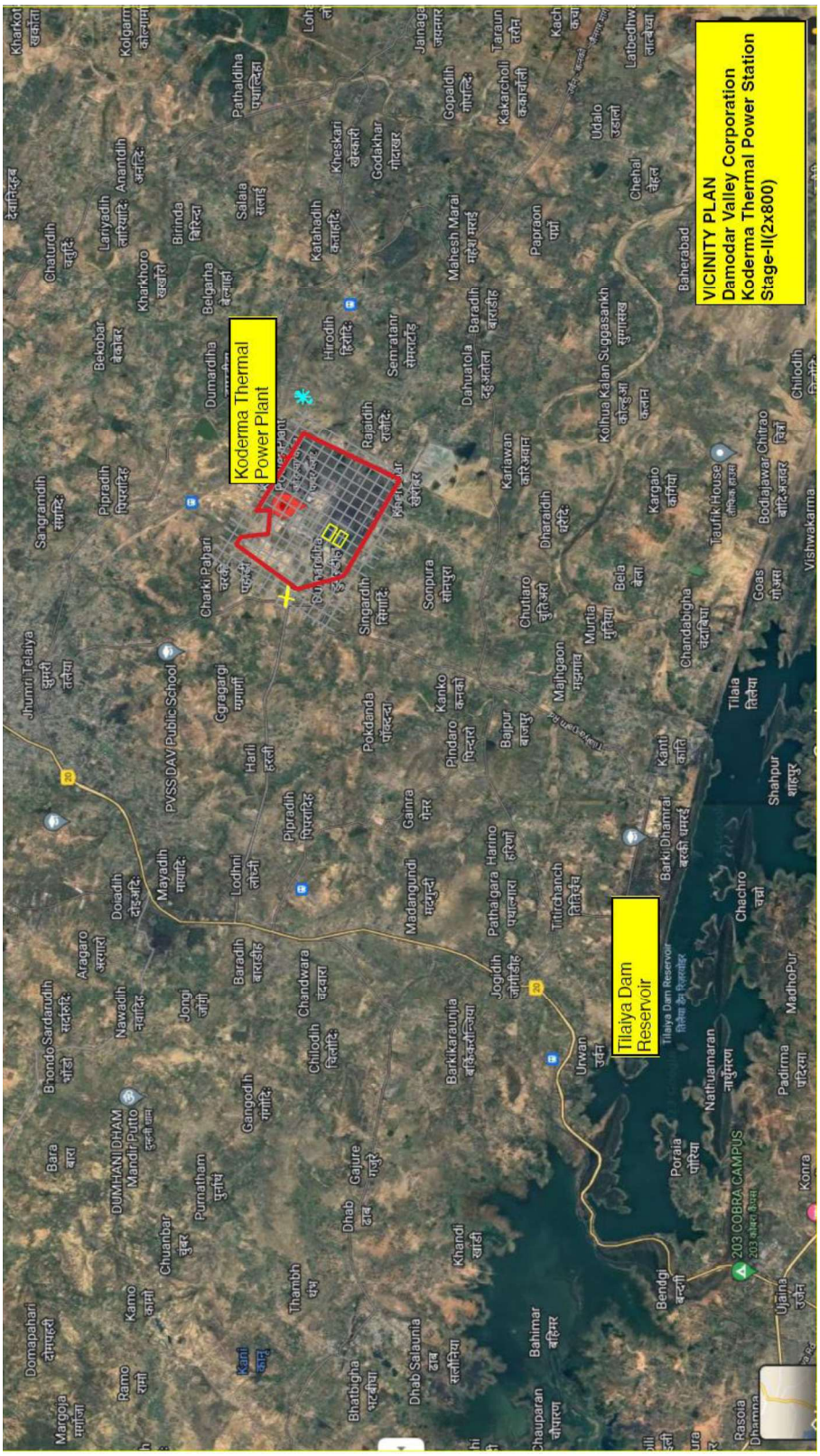
i) Seismic zone (II to V) for earthquakes
ii) Wind velocity
iii) Area liable to floods and Probable max. surge height
iv) Thunderstorms history
v) Number of cyclone storms/sever cyclone storms and max sustained wind specific to coastal region
vi) Landslides incidences with Annual rainfall normal
vii) District wise Probable Max. Precipitation

Accordingly, bidder should refer VAI while planning, designing and execution of the project.

However, for design of structures/facilities and equipment, the criteria for earthquake resistant design of structures and equipment, the criteria for Wind Resistant Design of Structures and Equipment and design parameters for drainage facilities, stipulated in the Technical Specification shall be followed.

For other information like area liable to floods, probable max. surge height, landslide, thunderstorm, cyclone etc. agencies are required to refer the VAI.

Annexure-I


VICINITY PLAN
Damodar Valley Corporation
Koderma Thermal Power Station
Stage-II(2x800)
Koderma Thermal Power Plant
Tilaiya Dam Reservoir
PVSS DAV Public School
DUMHANI DHAM Mandir Putto
203 COBRA CAMPUS

Annexure-II

Table
Climatological Data

Month	Temperature (^{0}C)		Rel.Humidity(%)		Vapour Pressure (hpa)		Mean Wind Speed (km/hr)	Rainfall (mm)	Cloud Amount (Oktas)	
	Min	Max	Morning	Evening	Morning	Evening			Morning	Evening
Jan	9.1	22.8	62	49	11.0	10.8	4.0	20.1	1.2	1.3
Feb	11.9	25.9	53	38	11.3	10.1	5.6	16.6	1.0	1.0
March	17.0	31.7	39	27	11.8	10.1	5.8	12.8	1.1	1.2
April	22.7	37.0	33	23	13.6	11.6	7.5	18.8	1.2	1.5
May	25.7	38.6	41	28	19.0	15.7	7.6	27.2	1.3	1.4
June	26.5	35.8	61	50	26.0	24.6	8.1	159.2	4.0	4.6
July	24.7	31.5	81	74	29.8	30.0	7.9	270.7	5.8	5.8
Aug	24.4	30.7	82	76	29.8	30.0	7.1	279.6	5.7	5.9
Sep	23.8	30.6	80	73	28.3	28.0	6.9	203.8	4.3	5.0
Oct	20.8	29.9	69	62	22.9	22.4	4.5	110.5	2.3	2.4
Nov	14.0	26.8	58	52	15.4	15.0	3.3	4.0	1.3	0.9
Dec	9.6	23.2	60	48	11.7	11.2	3.8	1.7	1.0	1.0

Source: IMD Station at
Tilaya (1956 to 1978)

CLARIFIED WATER ANALYSIS

S.No.	Constituent	Expected Clarified Water Analysis		Expected Circulating Water Analysis Considering 5 COC	
		As	mg/l	As	mg/l
1	Calcium	CaCO3	101	CaCO3	504
2	Magnesium	CaCO3	29	CaCO3	145
3	Sodium	CaCO3	37	CaCO3	185
4	Potassium	CaCO3	2	CaCO3	10
5	Total Cations	CaCO3	169	CaCO3	844
6	Bicarbonates	CaCO3	107	CaCO3	535
7	Carbonates	CaCO3	0	CaCO3	0
8	Nitrate	CaCO3	0	CaCO3	0
9	Chloride	CaCO3	24	CaCO3	120
10	Sulphate	CaCO3	38	CaCO3	188
11	Total Anions	CaCO3	169	CaCO3	843
12	Silica	SiO2	15	SiO2	75
13	Iron (Total)	Fe	0.3	Fe	2
14	pH Value	-	7.4	-	7.4
15	Turbidity	NTU	10	NTU	50
16	Total Suspended Solids	ppm	-	ppm	-
17	Total Dissolved Solids	ppm	249	ppm	1247
18	Organics (As per KMnO4 method)	ppm	0	ppm	0

SECTION: I

SUB SECTION: C-1

TECHNICAL SPECIFICATION

1. FUNCTION

The purpose of the system is to provide Air Conditioning & Ventilation system for different areas of 2X800 MW KODERMA TPS PHASE II under the scope of this tender.

2. SYSTEM DESCRIPTION

2.1 Central Air Conditioning System with Water Cooled Chiller for Main Plant areas (Control Room, CER, UPS & Battery Charger room (except battery room), SWAS room, Water Analysis Lab etc.

2.1.1 As per DVC spec. clause no. 3.01.00 a) of Section VI, part B, sub section A-17.
2.1.2 All the pumps shall be horizontal split casing type. Fans in cooling tower shall be top discharged mounted at top of cooling tower.
2.1.3 Chilled water & Condensate water pipes shall be routed outside of the CCR & CER area and pipes supporting arrangement shall be suitably done from outside of the control tower area.
2.1.4 Fresh Air fan with damper (for each AHU room): 1X100 % or 2X50 %

2.2 Central Air Conditioning System with Water Cooled Chiller for ESP Control Room Unit-3 & 4.

2.2.1 As per DVC spec. clause no. 3.01.00 b) of Section VI, part B, sub section A-17.
2.2.2 All the pumps shall be horizontal split casing type. Fans in cooling tower shall be top discharged mounted at top of cooling tower. Further, Pump head in Chilled water system shall be optimised by selecting higher pipe size for long routed pipes.
2.2.3 Fresh Air fan with damper (for each AHU room): 1X100 % or 2X50 %

2.3 Central Air Conditioning System with Water Cooled Chiller for Service Building

2.3.1 As per DVC spec. clause no. 3.01.00 c) of Section VI, part B, sub section A-17.
2.3.2 All the pumps shall be horizontal split casing type. Fans in cooling tower shall be top discharged mounted at top of cooling tower.
2.3.3 Fresh Air fan with modulating Fresh Air Damper and CO2 sensor (for each AHU room): 1X100 % or 2X50 %.
2.3.4 BTU meter for energy metering in chillers and other instrumentations as required as per ECBC to make it Green building shall be provided.

2.4 Central Air Conditioning System with D-X type Condensing Unit for CEP VFD Unit-3 & 4

2.4.1 Air cooled (D-X Type) condensing units: 2X 100% or 4X 50%
2.4.2 AHUs: 2X 100% or 4X 50 %

2.5 Offsite Building. Offsite Control Rooms/Rio Room Etc.

2.5.1 Please refer Customer spec. clause no. 3.01.00 e) of Section VI, part B, sub section A-17.

2.5.2 Split AC shall be supplied along isolation switch (MCB of suitable rating with MCB box), voltage stabilizer, ISI-marked power accessories for each single-phase Split AC (1 No. 5-pin power socket of min. 20A rating, 1 No. 3-pin power plug of min. 20A rating, and 1 No. MCB with MCB box) cabling, all supporting structure, refrigerant piping to suite actual site condition, drain piping up to nearest drain etc.

2.6 Evaporative Cooling System for Main Power House & ESP building

2.6.1 As per DVC spec. clause no. 2.00.00 a) & b) of Section VI, part A, sub section A-12.

2.6.2 Ten (10) nos. Containerized Air washer shall be placed on operating floor towards "A" row (5 air washers per unit). No separate masonry room is required to place these air washers.

2.6.3 Another 10 nos. Containerized Air Washers shall be placed on Deaerator floor towards "BC" bay (5 air washers per unit). No separate masonry room is required to place these air washers.

2.6.4 Two No. of Containerized Air Washer shall be placed in CD bay for Boiler MCC, cable vault of Boiler MCC, Cable vault of CCR and Cable vault of UPS (one for each Unit).

2.6.5 Fan Filtration Unit shall be provided for Pressurization of all Staircase wells in TG Hall C row side and also all doors/shutters provided this side shall have a provision of Air Curtains to avoid ingress of coal/ash dust from boiler side.

2.7 Evaporative Cooling System for ESP Control room for Unit-3 & 4 (Non-A/C areas Switchgear and cable gallery areas)

2.7.1 As per DVC spec. clause no. 2.00.00 c) & d) of Section VI, part A, sub section A-12.

2.7.2 UAF shall be placed at the roof of ESP Control building for Unit-3 & 4 respectively.

2.8 Ventilation System for Miscellaneous areas

2.8.1 Mechanical Ventilation (using roof extractors/Supply/ Exhaust Fans and fresh air intake/ back draft dampers) shall be provided for various other areas/buildings. For ventilation of battery rooms and oil rooms, flame proof motor shall be provided.

2.8.2 Ventilation provision for Auxiliary Buildings in various locations (offsite area) is envisaged as per DVC specification, section-VI, part-A, Sub Section – A – 12, clause number 2.00.00.e) & f).

2.8.3 RE unit/ wall mounted axial fans shall be selected so as to have motor rating as under:

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

b	10,000 CMH	1.5 KW	800mmx800mm
c	7,500 CMH	1.1 KW	700mmx700mm
d	2,000 CMH	0.55 KW	500mmx500mm
	Axial flow exhaust fans with 10 mmwc static pressure.		
	Capacity	**Motor rating**	**Wall opening**
a	15,000 CMH	1.1 KW	900mmx900mm
b	10,000 CMH	0.75 KW	800mmx800mm
c	7,500 CMH	0.55 KW	700mmx700mm
d	6,000 CMH	0.55 KW	600mmx600mm
e	2,000 CMH	0.37 KW	500mmx500mm
	Exhaust fan (propeller type) with 5 mmwc static pressure.		
	Capacity	**Motor rating**	**Wall opening**
a	1200 CMH	100 W	330 mm circular

2.8.4 DESIGN CRITERIA: As per section C2-A, DVC Technical Specification Section-VI, part-B, sub section-A-01, clause no. 3.13.00 and 3.13.01.

2.8.5 Tentative Heat Dissipation data for various Air-Conditioned Rooms to be served with Central AC System

Sl No.	Room Description	Tentative Heat Dissipation (kW)
1	AC Area at 0.0M & 9.0 M Power House served by AHUs located at 9.0M elev.	100
2	CCR at 18.0M Power House served by AHU at 28.0M elev.	180
3	CEP VFD Room for Unit-3 & 4	120
4	ESP building Unit-3	40
5	ESP building Unit-4	40

Note: The above heat dissipation data is for the estimation of AHU capacities envisaged for various areas. However, total capacity of the working AHUs shall match with the working capacity of the corresponding chiller plant /condensing Unit. This heat dissipation data shall be finalized during detail engineering, any variation in the AHUs capacity of any area keeping overall capacity of working AHU's same corresponding to respective chiller capacities as already mentioned in BOQ shall not have any commercial impact.

3. LAYOUT CONSIDERATION:

3.1 AC PLANT -1

3.1.1 The central chilled water plant, Condenser Water & Chilled Water Pumps for AC Plant shall be housed in AC Plant Room at 0.0 M level in Control Tower area.

3.1.2 AHU Room at 9.0 M level of Power House Building in Control Tower area.

3.1.3 AHU Room at 28.5 M level of Power House Building in B-C Bay between grid 14a-17.

3.1.4 The Cooling Towers, Make-up water Storage Tank, Expansion Tank, water softening plant and soft water storage tank shall be located at 34.5 M level in F'-G'-H' Bay between grid 15-17.

3.2 AC PLANT -2

3.2.1 The central chilled water plant, Condenser Water & Chilled Water Pumps, Cooling Tower, softening plant, Soft water storage tank, expansion tank etc. shall be placed at roof of ESP control room of Unit-3

3.2.2 AHUs shall be place inside AHU room at different location of ESP control room unit-3, ESP control room of Unit-4.

3.3 AC PLANT -3

3.3.1 The Central Chilled Water Plant, Condenser Water, Primary & Secondary Chilled Water Pumps for AC Plant shall be located In AC Plant Room at Ground Floor of Service Building.

3.3.2 The AHUs for this ac plant would be located at each floor of Service Building.

3.3.3 The Cooling Towers, Make-Up Water Storage Tank, Expansion Tank, Water Softening Plant and Soft Water Storage Tank shall be located at Roof of Service Building.

3.4 AC PLANT-4

3.4.1 Outdoor unit of condensing unit shall be placed at roof of CEP VFD unit-3 & 4 building.

3.4.2 AHUs for CEP VFD shall be place inside AHU room above/adjacent CEP VFD unit -3 & 4 building.

4. Terminal Points, Ducting Interface, and Performance Testing

4.1 **Terminal Points:**

For AC System: Terminal Points shall be downstream of the wall openings / floor openings of AHU Room. Final Connection of the high side Equipment with the ducting system shall be in the scope of bidder. Installation, mounting and integration of VAV boxes along with occupancy sensors in the ducting system shall be fully included in the bidder's scope in accordance with the specification."

For Ventilation System: Terminal Points shall be flange of Volume Control Damper of the Ventilation equipment. (Air Washer/UAF). Final Connection of the high side equipment with the ducting system shall be in the scope of bidder.

4.2 **Ducting System (Design & Approval):**

The design, engineering, and drawing submission for approval from the end customer AC & Ventilation System along with the entire ducting system & associated accessories shall be in the scope of the bidder.

4.3 **Duct Leak/Smoke Test:**

The Leak Test / Smoke Test required to establish a leak-proof ducting system shall be conducted by the Low side /Duct System Supplier. However, the bidder shall supervise and certify the execution of such tests to ensure that the ducting system performance meets the technical requirements.

4.4 **Performance Guarantee (PG) Test:**

The Performance Guarantee (PG) Test for the entire AC and Ventilation System (including ducting & accessories) shall be carried out by the bidder as per approved procedures to meet performance parameters as per the specification.

5. General

5.1 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.

5.2 Bidders shall make Site visit in order to familiarize themselves with existing condition of site before submitting the bid in order to make their offer complete. BHEL shall also not entertain any cost implication for any lack of input data with regard to site during detail engineering.

5.3 All drawings and documents shall be computer based.

5.4 All commissioning spares & consumables for trouble free operation until handing over of the system shall be provided.

5.5 The bidder shall be responsible for providing necessary storage facilities for materials supplied.

5.6 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.

6.0 SCOPE OF SERVICES

Scope of services by bidder will include but not necessarily limited to the following:

6.1 Unloading, Storage, handling and transportation at site.

6.2 Erection & Commissioning of AC & Ventilation System.

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

6.4 **Foundations for HVAC Equipment:** Plain Cement Concrete (PCC) / Reinforced Cement Concrete (RCC) foundations for all HVAC equipment shall be provided as per approved foundation drawings. However, the Bidder shall be responsible for ensuring the adequacy of foundation dimensions and locations based on the final equipment selection and vendor drawings. Any modifications required to suit the equipment shall be carried out at no extra cost to the BHEL.

6.5 **Pockets / Openings / Embedded Inserts:** The Bidder shall provide all necessary pockets, sleeves, embedded inserts, and openings in the foundation required for anchoring, grouting, or fixing of HVAC equipment. The Bidder shall furnish the details such as size, location, and quantity of anchor bolts, pockets, and inserts to the BHEL well in advance to facilitate timely incorporation during foundation casting.

6.6 Minor civil work like chipping of foundation, grouting below base plate for all structures, equipment, grouting of anchor bolts wherever these are not placed in the foundation during casting of foundation itself including special type of grouting like GPX2 etc, making opening to suit / finishing of opening after completion of AC Equipment erection, sealing of duct / pipe opening etc.

6.7 Making Good / Repairing / replacement of and damaged done by bidder to adjacent structure, pipes etc. while erecting equipment's related to AC & Ventilation System.

6.8 Drain piping up to the drain point to be provided by the Vendor.

6.9 Pre-Commissioning work such as flushing, hydraulic testing etc. Necessary consumables and instrumentation like refrigerant, grease, lubricants, anemometer, tachometer, ammeter, voltmeter etc. for inspection and testing at works as well as at site including pre-commissioning activities shall be arranged by the successful bidder at their own cost.

6.10 Inspection & testing, Performance Requirements and Performance Guarantees as per the specification.

6.11 Painting of equipment's, valves, pipes and other accessories within scope of supply.

6.12 Electrical scope as per enclosure elsewhere in the specification.

6.13 Training of plant Owner's personnel O&M operators' personnel on plant operation and maintenance as per Customer specification.

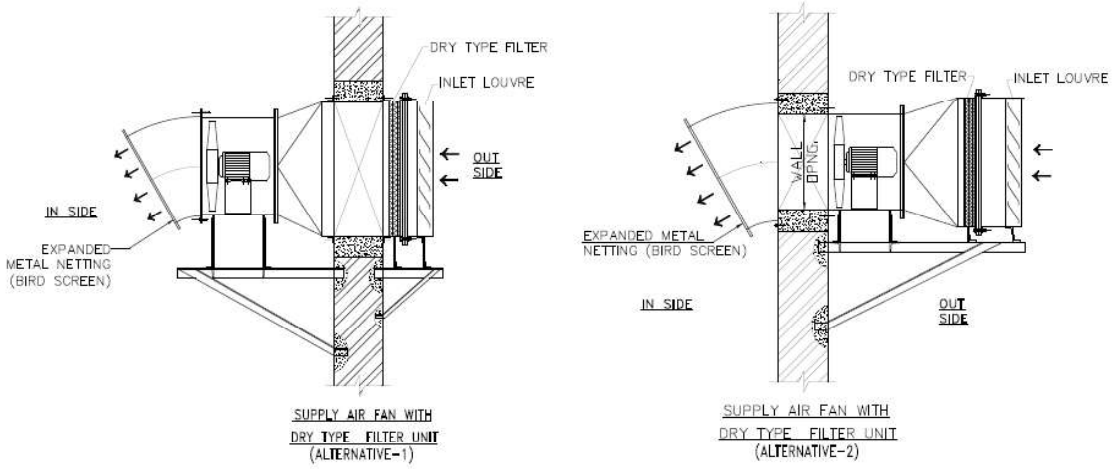
6.14 Relevant requirements as per GTR, GCC & SCC.

6.15 Any other service required for making the installation complete in all respect within battery limits and for satisfactory erection & commissioning of the system as well as to meet any statutory requirement relevant to the package, unless specifically EXCLUDED from scope of services.

6.16 For motorized fire damper / 3 Way valve actuators / motorized valves, power supply shall be derived by vendor from respective control panels. 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.

6.17 Bidder should suitably group the signals coming from various instruments etc. & the same shall terminate in local JB, from Local JB common cable to DCS / 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.

6.18 Supports required for supporting the fan and/or filter section for Axial fans shall be under bidder's scope.



6.19 All VVFD drives shall be provided with enclosure.

Power Supply and DG Operation: Air-conditioning equipment (including Chiller, Chilled Water Pump, Condenser Water Pump, Cooling Tower fan, AHUs and Fresh Air Fan nominated for emergency/DG operation) for **Main power house** shall be capable of continuous, safe operation on the Normal supply as well as on the DG supply. The DG supply for the emergency feeders is 3-phase, 3-wire (no neutral). The supplier shall ensure and warrant that motors, starters, control panels and ancillary controls will operate correctly on both supplies without site modification and shall provide any required control transformer or neutral-creating device for control power, and be tested and demonstrated on both Normal and DG supplies during commissioning.

6.20 In case of chiller unit with multiple compressor, single source of power supply shall be provided by BHEL and further distribution shall be in the scope of the bidder.

6.21 Local push button station shall be provided for local operation of the Air Handling Unit (AHU), Air Washer Unit (AWU) and Unitary Air Filter (UAF). In case multiple AHU's, AWU or UAF are kept in a room or in vicinity, common Local Push Button Station shall be provided for local operation of all the AHU / UAF / AWU in the room or located in vicinity.

6.22 6 Sets (3 sets to DVC Head Quarter and 3 Sets to Koderma Site) is to be submitted for each approved drawing/document.

7.0 Operation services & consumables

7.1 Commissioning of various HVAC plants & Equipment's under scope of this tender is expected in phased manner depending upon front availability and other site conditions. Bidder shall include in their scope operation of such AC plants & Ventilation equipment's which are commissioned, until final handing over of complete system to customer. Consumables like chemicals for softening plant, lube oils, refrigerants, etc. during this period of operation shall also be considered by bidder in their scope. Any shortcoming in the System which may have happened during the operation of the plant, due to regular wear and tear or otherwise, shall be made good before handing over of complete AC & ventilation system to customer.

7.2 **Instruments to be used for PG test shall be additionally supplied over and above the instruments shown in tender P&IDs.** PG test equipment being supplied, installed and commissioned for each unit, shall be retained by employer after completion of PG test.

7.3 Water softening plant – Water softening plant shall be complete in all respect with ACF, DMF, Softener, Pumps for water softening plant, pumps for regeneration, pumps for transferring softening plant reject and cooling tower blow down to CMB, chemical cleaning/dozing pump with necessary tank and circulating water system. Dedicated control panel shall be provided each softening plant with proper interlock of pump, desired parameter of soft water quality. Power of pump shall be routed through control panel of softening plant having inbuilt starter panel. A single source supply feeder shall be provided for each softening plant which shall be terminated at control panel. Soft water outlet quality shall be maintained such that it shall not be corrosive in any condition by blending clarified water maintaining quality of soft water within acceptable limit suitable for chiller. Cooling coil and pipe. Provision for Blowdown, corrosion inhibitor, scale inhibitor and chemical dosing shall also be provided along with suitable quantity of salt.

8.0 EXCLUSIONS

Items of works listed below are excluded from scope of the air-conditioning & Ventilation System supplier.

8.1 Construction of AC plant room, air handling unit room, foundations for AC equipment's i.e. Chillers, Condensing Units, Package AC, AHU, Pumps, roof/wall openings for ducts, dampers/louvres.

8.2 False ceiling, drop ceiling.

8.3 Slab cut out for running ducts, pipes, cables, grilles/dampers. Underground masonry trenches and masonry risers.

8.4 Various cable & pipe trenches, pipe pedestals, drains, sumps, insert plates for pedestals for pipe supports.

8.5 DCS Control panel for Operation and control of AC System and Ventilation System. However, all logic for implementation of control and monitoring from DCS shall be provided by successful bidder during detail engineering.

8.6 For Electrical scope, refer Electrical scope matrix sheet.

9.0 PAINTING / CORROSION PROTECTION REQUIREMENT

Refer customer specification, C-2A.

10.0 CONTROL PHILOSOPHY

Control of both AC & ventilation system shall be done from DCS based control panel located CCR area at 18.0M. Refer Customer Specification in Sub Section C2 A for details.

11.0 QUALITY ASSURANCE, QUALITY PLANS, INSPECTION & TESTING PROCEDURE:

As per the details given elsewhere in the specification.

12.0 SUB-VENDOR ITEMS

Sub-Vendor for AC & Ventilation System is enclosed under Annexure-I, Sub- Section – E

13.0 DOCUMENTS TO BE SUBMITTED WITH THE BID

The documents to be submitted with the bid shall strictly as per list given under **SECTION-II**. Any documents other than those indicated in the list will not be reviewed and will not be considered as part of bid.

14.0 DRAWINGS/ DOCUMENTS REQUIRED DURING DETAIL ENGINEERING

List of drawings / documents along with submission schedule is attached in Annexure-VI, Sub- Section –E

SECTION-C1

TECHNICAL SPECIFICATION

(OPERATION AND MAINTENANCE SERVICES FOR AIR CONDITIONING SYSTEM)

1.0 OPERATION AND MAINTENANCE SERVICES

The bidder scope also covers the Operation and Maintenance (O&M) services for Preventive and Breakdown maintenance from the date of successful commissioning till handing over to end customer. However, actual date of start of O&M services shall be communicated to successful bidder by BHEL site personnel.

Bidder to note that the spares and consumables required for maintenance of the equipment during this O&M period shall be in bidder's scope of supply. Bidder shall use only genuine parts as mentioned in O&M Manual. Any damage or malfunction caused by the use of unauthentic parts or unqualified personnel shall be responsibility of bidder and as a consequence of above bidder is required to replenish the unauthorized part and abridge the qualified person without any commercial implication to BHEL.

O&M Services scope also covers all regular maintenance by trained service engineers and supply of genuine parts and lubricants as per the original equipment manufacturer's recommendations.

For the purpose of Operation of Air Conditioning System, One-day shall be considered as 24 hours i.e. 3 shifts of 8 hours each. The AC System (along with related accessories) shall be operated on Round-the-clock basis on all the days of the year including Sundays and Public Holidays

O & M Personnel should be acquainted with local language. Governmental / Statutory approval w.r.t. O&M service as applicable shall be in bidder's scope.

Total duration of the Operation and Maintenance services has been envisaged as per price format for individual AC System / buildings identified in price format/specification. The duration of operation & maintenance services can be increased or decreased as per requirement and payment in such case shall be made on pro-rata basis.

The operation and maintenance services can be continuous or intermittent as per site requirement for individual AC System / buildings identified in price format/specification.

Bidder has to compulsorily maintain log book for the O & M staff engaged for O&M jobs and submit to Engineer-in charge for certification for realization of the bills. After certification of the bill by Engineer in charge of BHEL, bidder shall claim the amount after completion of minimum 30 days.

Depending on start of O&M services, there is a possibility that some period of O & M services and Warranty period may overlap. However, it is clarified that any maintenance required or any spare of AC System required to be replaced during Warranty period (as part of warranty clause requirement) shall not be made part of O&M Services. Bidder may take care of this fact while working out the prices of O & M services

Wherever AC system has been written in O&M Service Specification, the same shall bedeemed as complete AC System.

The vendor shall deploy following minimum manpower for Operation of AC System.

i. Two qualified and experienced operator per shift on "Round the Clock" basis throughout the year for all days of the year including Sundays & Public Holidays. There must be minimum 30 minutes overlapping between two shift operators to get familiarize with the status of AC System.

ii. One Helper per shift on " Round the Clock" basis throughout the year for all the days of the year including Sundays and Public Holidays. The helper shall assist the Ventilation System Operator in day to day operation of AC System and accessories and shall assist him for keeping AC System equipment's in neat and tidy condition.

1.1 Responsibility of System Operator

i. AC System operator shall be responsible for proper sequential operation of AC System in a predefined sequence and stopping the same (when necessary) as per the procedural practice. In case of any abnormality (like non- availability of power supply at incomer of Ventilation System), he shall immediately report the matter to BHEL site Engineer for further action. Similarly, any malfunctioning in the system shall be immediately reported by him to BHEL site Engineer for suitable corrective actionirrespective of time of occurrence of malfunctioning / abnormality in the system. A log book of all such outrages shall be maintained by AC system operator, which shall be shared with BHEL site engineer on periodic basis.

ii. AC System operator shall take hourly readings of all the parameters of AC System / Equipment's including reading on main electrical panel of AC System.

1.2 Responsibility of Helper.

i. The AC System helper shall assist AC System operator for day to day smooth operation of AC System, like Checking of water levels of cooling tower, cleaning of Tanks, cleaning of strainers, checking water parameters of softening plant cleaning of AHU filters and other filters etc. as and when required. He shall be responsible for keeping all the equipment's of AC System as applicable in clean and tidy condition. He shall also carry out general cleaning of all AC equipment including Electrical Panels (Part of AC System), etc. on regular basis.

ii. The helper shall work under the control of AC System operator and shall always ensure that unusable junk materials are not allowed to be kept in AC plant room or ahu room.

iii. Under such eventuality, he will report the matter to Plant Operator, who in turn will take suitable action including reporting the matter to BHEL site Engineer.

1.2.1 All the log book registers shall be arranged by vendor. Log book register duly paged and bounded will be maintained in good condition by vendor.

1.2.2 All the necessary tools & tackles and other materials, required for operation of AC System shall be kept by vendor under the control of AC System operator. These tools & tackles shall be separate from tools & tackles (as per price format) which shall be handed over to customer in new condition. Required testing instruments like refrigerant leak detector, Multi Meter (for Electrical portion of AC System), Sling psychrometer, Line Tester, Tool Kit, Torch, vacuum pump, oil charging pump, Pressure testing kit etc. should also be always available with Plant Operator.

1.2.3 In case of any operator / helper being on leave, vendor shall immediately take advance action and provide substitution so that minimum manpower as indicated above is not reduced on any day. In case a particular shift duty Operator or helper does not turn up due to any reasons, the earlier duty person shall continue to make sure that System never remains unattended.

2.0 Maintenance of AC System

i. Maintenance work under scope of the vendor shall broadly include but in no way limited to the following:

a) Preventive maintenance of the plant.

b) Servicing of the plants and associated equipment's at regular interval

c) Attending to complaints.

d) Replacement of worn out or defective components

e) Replacing of consumables as and when required.

No consumable or any other items of system shall be arranged by Customer and no extra payment shall be made by customer in this regard.

ii. Vendor shall be responsible at all time, during the entire period of contract for satisfactory performance of Ventilation system (including accessories) with zero down time. During emergency or breakdown, vendor's Engineer along with related technicians shall be available immediately even though it may be beyond normal working hours or on public holidays till the AC System is restored back into normal satisfactory condition. Response time for attending breakdown complaints shall not exceed 2 hours.

iii. Defective / worn out components shall be replaced only by genuine and original parts. OEM or its authorized dealer's invoice shall be submitted as proof of using genuine parts. All common spares required for Ventilation system shall normally be kept available in the plant by the vendor. However, for critical spares, the same shall be made available in not more than 72 hours from the time of break-down requiring such spare.

iv. Preventive Maintenance, servicing of AC System equipment's and accessories etc. shall be done by vendor in a planned manner in consultation with concerned customer's engineer. Preventive maintenance and service should be done as per the recommendations / guidelines of various OEMs

v. Major servicing & over handling of equipment's like fans, pumps, piping / ducting works, valves etc. shall be done by vendor once in a year.

vi. In case any repair/services of particular equipment of system is to be carried out by vendor through OEM (or their authorized dealer), all the arrangements including tools, O&M spares etc. shall be the total responsibility of vendor.

vii. Vendor shall arrange and maintain separate logbook register for services / maintenance of AC System. Record of work done for services/maintenance repairs etc. shall be recorded by vendor's engineer in this register. This register shall always be with updated records & shall be produced to customer's engineer on weekly basis or as & when required by him.

viii. Vendor shall arrange and maintain sufficient stock of spares and consumable at site. Similarly, all necessary tools & instruments required for the purpose of servicing / maintenance / routine testing etc. shall also be arranged by vendor and should be available at site at all times.

ix. Repairs / servicing works shall normally be done by vendor at site up to maximum possible extent. However, in case any equipment or accessories is essentially required to be taken by vendor out of the plant premises for repairing / servicing, all necessary arrangements including to and fro transportation shall be the responsibility of vendor. Vendor shall also inform concerned customer's engineer for doing procedural formalities (like issue of gate pass etc.), prior to taking out the materials out of Plant premises.

x. In case bidder fails to supply the spares required for maintenance of the equipment, same shall be provided by BHEL at Bidders risk and cost.

xi. Vendor shall be fully responsible for safety of his personal at all times. Vendor shall also be responsible for taking all safety precautions at all the times, especially during servicing / preventive maintenance and repairs of Ventilation System equipment's etc.

xii. All the safety controls, inter locking etc. shall be positively checked at least once a month and same shall be recorded by vendor engineer

xiii. Technicians & helpers engaged by the vendor shall wear uniform with nameplate for easy identification, while being within plant premises

xiv. Vendor's engineer shall be focal point for customer. He shall report to customer engineer on daily basis, for taking necessary instructions and to update the status of Ventilation system

xv. If any damage to the equipment and its accessories has happened due to improper maintenance by bidder shall be recovered from the bidder.

xvi. Bidder is to arrange all the safety gears like helmets, air plugs, safety shoes etc. during the maintenance for the O&M Staff.

xvii. Bidder shall have to maintain storage shed along with site office during O & M contract also

xviii. Fabrication and erection of platform/extra support for Ventilation areas if felt necessary during operation and maintenance of the system has to be done by the bidder.

Notes:

1. The bidder shall take approval from Engineer-in charge of BHEL by submitting organization Chart of O&M staff for this site clearly indicating man power deployment with their educational background & experience with supporting documents.

2. The bidder shall be solely and wholly responsible for safety and security of workers engaged in the job and the BHEL property. In case of any accident the contractor shall pay proper compensation to the workers as per workmen's compensation act and repair/replace BHEL property at their own cost & arrangement. The bidder shall also make adequate provision of insurance for their workers at their own cost to cover them against the risk of accident.

3. The bidder and their workers engaged in the job shall follow all safety rules at the time of execution of work. It shall be responsibility of the bidder to supply all safety equipment as necessary to its O&M staff.
4. Beyond general shift if any trouble/breakdown occurs in the plant, Maintenance team must reach the plant without any delay along with Engineer/Site In-charge.
5. No Person from the list of manpower shall leave the plant site without prior permission from the Engineer in charge of BHEL.
6. However, in operation part, if any person is absent, substitute must be given immediately otherwise proportionate deduction will be made
7. The replacement / substitute personnel for maintenance, manpower shall have the same educational qualification and experience.
8. If any additional manpower is required during O&M whatsoever under the scope of contract the same shall be made available by bidder in time within the cost. To cater the need of time bound maintenance jobs, the bidder shall depute additional manpower without any cost implication to BHEL

9. During execution of work if any personnel is found not suitable for the job or his presence inside powerhouse premises is felt undesirable, the personnel has to be replaced within 15 days.
10. BHEL will not be responsible for payment towards idle labour charges

Water Quality Aspect in Air Conditioning System

Water plays a crucial role in water-cooled air-conditioning systems for condenser and heat exchanger cooling. Proper treatment is essential to maintain system efficiency and avoid issues such as:

Key Issues and Solutions:

1. Scaling:
   - Caused by hardness salts (e.g., calcium bicarbonate).
   - Preventive measures:
     - Convert temporary hardness with sulfuric acid.
     - Use soft water cautiously (may cause corrosion).
     - Use scale inhibitors and dispersants.
2. Corrosion:
   - Electrochemical in nature; leads to metal damage.
   - Controlled by:
     - Corrosion inhibitors.
     - Maintaining a slightly positive Langelier Saturation Index (LSI).
     - Appropriate material selection.
3. Microbial Fouling:
   - Caused by algae, fungi, and bacteria.
   - Controlled using oxidizing and non-oxidizing biocides (e.g., hypochlorite).
4. Dirt & Silt Fouling:
   - Suspended particles cause deposits and under-deposit corrosion.
   - Controlled by using dispersants.
5. Chilled Water System Concerns:
   - Less prone to scaling, but leakage and microbes (like sulphate/nitrate reducers) can cause issues.
   - Regular microbial analysis and biocide treatment are necessary
6. Recommendations:

- Analyse all water quality parameters (physical, chemical, biological).
- Use corrosion-resistant materials for soft/desalinated water.
- Maintain cooling water conductivity (≤1500 µS/cm) and pH (8–8.5).
- Implement regular chemical treatment and biocide dosing.
- For Vapour Absorption Machines (VAMs), monitor water quality per supplier guidelines.
- Maintain water quality logs and perform regular analysis of chilled water.

Statutory Compliance by the bidder:

All Statutory compliances related to Labour, Health & Safety, Quality & Environment protection and insurance shall be as per the tender GCC shall be followed by the bidder.

SECTION: I

SUB-SECTION: C 2A

CUSTOMER SPECIFICATION
TECHNICAL REQUIREMENT

CLAUSE NO.	SCOPE OF SUPPLY AND SERVICES
1.00.00	**AIR CONDITIONING SYSTEM** **a) General** Complete air conditioning system consisting of water cooled chilling units, condensing units, chilled water pumps & drives, condenser water pumps & drives, piping, valves & fittings, cooling towers, air handling units, VFD drives for motors (wherever applicable), hi-wall / cassette split air conditioners, fresh air fans, air distribution system (ducting, filters, isolation/volume control dampers, motorized fire dampers, diffusers, grills, VAV box as applicable, etc.) along with all electrical equipment and instrumentation as per the detailed specification in Part-B of technical specification. **b) Centralized air-conditioning system for main plant TG building** There shall be one (1) central chilled water type air-conditioning plant comprising of screw chilling units, chilled water pumps, condenser water pumps, AHUs, cooling towers, etc. to cater to the A/C requirement of the areas identified for main plant areas like common control rooms, control equipment rooms, UPS/Battery charger rooms, static excitation control rooms (if applicable), SWAS room, water analysis lab, etc. of both units. **c) Centralized air-conditioning system for ESP control room buildings** There shall be one (1) central, water cooled chilled water type air-conditioning plant comprising of screw chilling units, chilled water pumps, condenser water pumps, AHUs, cooling towers, etc. to cater the A/C requirement of the areas identified for ESP Control Room Buildings etc. of both units. **d) Centralized air-conditioning system for service building** Energy efficient air-conditioning system for service building shall be designed in-line with ECBC code to make it "Green Building". There shall be one (1) central chilled water type air-conditioning plant comprising of screw chilling units, chilled water pumps, condenser water pumps, AHUs, cooling towers, etc. to cater to the A/C requirement of the office areas, etc. of service building. **e) Air-conditioning system for Water System Control Building** Air cooled condensing units (D-X type) mainly comprising scroll compressor, drive unit, condenser, AHUs, interconnected refrigerant piping, controls, instruments, base frame, etc. to cater to the A/C requirement of the CER, etc. f) Packaged air conditioners shall be provided for AHP control room as per the detailed specification in Part-B of technical specification. g) Packaged/Split air-conditioners for various auxiliary control rooms/RIO rooms/VFD rooms and office areas of other buildings (like stores, switchyard annex building, workshops, etc. as applicable) as per the detailed specification in Part-B of technical specification.

h) Apart from the above, any area/building which are in the scope of the Bidder and require air conditioning, those areas/buildings shall be provided with air conditioning system, as per the detailed specification in Part-B of technical specification.

i) Supply of mandatory spares as specified.

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

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

l) Control system of air-conditioning system is indicated in Sub-Section-IIC, Control & Instrumentation, Scope of Supply & Services, Part-A of Technical Specifications.

2.00.00 VENTILATION SYSTEM

a) **General**

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

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

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

ii) Minimum one (01) no. of air washer unit (of metallic construction-modular type) each of minimum capacity 50,000 m^3/hr, with all accessories, 1 no. DIDW centrifugal fan, 1 no. circulating water pump, etc. as detailed out in technical specification shall be provided for boiler MCC of each unit.

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

c) **E.S.P. Control Room Building (Non-A/C areas)**

Minimum One (1) no. of Unitary Air Filtration (UAF) unit (of metallic construction-modular type) of minimum capacity 75,000 m^3/hr, with all accessories, 1 No. DIDW centrifugal fan, 1 No. circulating water pump, etc. as detailed out in technical

specification shall be provided for each unit.

d) **FGD Control Room Building (Non-A/C areas)**

Minimum One (1) no. of Unitary Air Filtration (UAF) unit (of metallic construction-modular type) of minimum capacity 75,000 m^3/hr, with all accessories, 1 No. DIDW centrifugal fan, 1 No. circulating water pump, etc. as detailed out in technical specification shall be provided.

Note: If ESP & FGD control room buildings are provided in a common building(s), evaporative ventilation system (UAF system) shall be provided for non-A/C areas (MCC/Switchgear/Cable Vault, etc.) of combined ESP & FGD control room building(s) accordingly.

Further, evaporative ventilation system (UAF system) shall also be provided for non-A/C areas (MCC/Switchgear/Cable Vault, etc.) pertaining to FGD system in any other separate/common electrical/ control building(s).

e) All other areas like ash silo utility building, all compressor houses, all pump houses, all MCC/switchgear rooms, Electrical and C&I battery rooms, oil room, H2/CO2 gas rooms, switchyard annex building, water system control building, service building, workshops, stores, etc. & all other buildings covered under Bidder's scope and shall be ventilated by a combination of 'supply air fans & roof exhauster fans' or 'supply air fans & exhaust fans' or 'supply air fans & back draft dampers' or 'fresh air in-take louvers & exhaust air fans'. For ventilation of battery rooms and oil rooms, flame proof motor shall be used. Further, toilets shall be provided with propeller type exhaust air fans.

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

g) Supply of Mandatory spares as specified.

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

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

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

(d) The gas shall be discharged after a set time delay on receiving signal from the fire detection system. The duration of the timer shall be upto a range of 0- 5 minutes (adjustable in 1 minute variation) at site after conducting test to find out the duration for evacuation of the personnel from the area.

(e) To prevent the loss/release of gas automatically or manually during maintenance, the system shall have the facility of "LOCKOUT". The status of the system lockout condition shall be annunciated audio-visually in the panel.

Pressure Venting

Since huge quantity of gas is envisaged to be released, proper pressure relief and ventilation systems such as fans, dampers, etc. shall be provided by the contractor. Required openings in the civil structure shall be provided by the owner. The contractor shall submit pressure relief, venting calculations, its requirement and suggestive mode of ventilation during detailed engineering for approval.

3.12.06 **Fire protection for Biomass Silos:**

Bidder to provide primary supply of gas & its cylinders/storage system, along with 100% (one hundred percent) standby reserve gas quantity and cylinders/storage system.

3.13.00 **AIR CONDITIONING AND VENTILATION SYSTEM**

Season	Dry Bulb Temp. (Deg. C)	Wet Bulb Temp. (Deg. C)
Summer	43	27.5
Monsoon	35	28.5
Winter	10.0	8.0

GENERAL REQUIREMENTS

1. The layout of all equipment and accessories shall be developed in a way to facilitate easy accessibility and maintenance of all equipments.

2. Each equipment shall be provided with suitable lifting arrangement, e.g. Lifting lugs, eye bolts, etc to facilitate maintenance.

3.13.01 **DESIGN PHILOSOPHY - Air conditioning system**

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

2. All equipments of Air Conditioning system shall be designed for continuous duty.

3. All air conditioned areas like control room, control equipment rooms, office area in control tower , etc. shall be maintained at 24 deg. C ± (plus or minus) 1 deg. C and relative humidity of 50% ± (plus or minus) 5%.

4. The fresh air quantity for air-conditioned areas of ESP Control Room / AHP Control Room /FGD control room, Control Room / Control Equipment Room / UPS, Water System Control Room Building, AIS Control Room Building, etc. shall be 0.45 M3/minutes/person or 1.0 air change per hour whichever is greater. However, for

areas like office area in Service Building, etc. quantity of fresh air shall be minimum 1.5 air changes per hour.

5. Lighting load shall be one (1) Watts/Sq.feet or actual whichever is higher.

6. The occupancy for general area shall be minimum one person per 10 Sq. M and for conference room/meeting room the same shall be one per 3 Sq.M. In the control rooms, control equipment rooms etc, the occupancy may be one person per 25 Sq.M (Minimum).

7. In Air conditioning system the return air shall be through ducts and use of plenum space for return air shall be avoided. Further, FGD control room and ESP Control Room, office area in control tower , etc. where various floors are air-conditioned and no intermediate or intervening floor are left non-air-conditioned, the space above false ceiling shall be used as return air plenum.

8. The supply and return air ducts shall be provided with automatic (motorised) fire dampers (of 90 minutes fire rating) at locations where ducts pass through walls (with perfect partition i.e. partition both above & below false ceiling) and floors. Operation of these 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 A/C plant by the Contractor for further wiring upto fire alarm panels.

9. Soft water make up (if required) for complete air conditioning and ventilation system shall be provided by the bidder.

10. Design Chilled water flow shall not be less than 0.7 Cu.M/hr per TR air-conditioning load and design condensing water flow shall not be less than 1 Cu.M /hr per TR air-conditioning load.

11. Coil face area of Air Handling units shall be designed considering a face velocity of not more than 2.5 m/sec. Water piping shall be sized for a maximum velocity of 2.0 m/sec. However, gravity flow / pump suction line shall be sized for a maximum water velocity of 1.5 m/sec.

12. Air distribution system shall be sized to have a constant frictional drop along its length and velocity through ducts shall not exceed 7.6 m/sec.

13. Requirement of Underdeck Insulation (for A/C area)

14. Underdeck insulation shall be provided if

i) Non A/C area is located just above the A/C area. In this case, underdeck insulation shall be provided underneath of the ceiling of A/C area.

ii) Non A/C area is located just below the A/C area. In this case, underdeck insulation shall be provided underneath of the ceiling of Non A/C area.

iii) Underneath the ceiling of AHU room located below the non-A/C area or exposed to Atmosphere. Underneath the floor of AHU room located above the non-A/C area.

v) Underneath the ceiling of A/C areas exposed to sun.

15. For air handling unit (AHU) serving main plant control area, where microprocessor based equipments are located, the dehumidified air shall be filtered at three different stages i.e. pre (coarse) filter followed by fine filter followed by HEPA filter before discharge it to conditioned space. For all other areas, AHU's shall be provided with

two stage of filteration i.e. pre and fine filter. All fresh air supply fans shall also be filtered using pre and fine filter.

16. A minimum design margin of ten (10) % shall be considered in design of AC Plant Capacity for each area. Twenty (20) % design margin shall be considered for the cooling tower capacity over the selected A/C capacity provided. Head of the pumps shall take into account min. ten (10)% margin on friction head. For pumps, continuous motor rating (at 50^{O}C ambient) shall be atleast 10% above the maximum load demand of the pump in the entire operating range.

17. For other areas, where A/C load is of the order of 25-60 TR, Direct Expansion (D-X) type air cooled condensing units alongwith AHUs shall be provided depending on the availability of space/ layout etc. For areas, where A/C load is of the order of 5-25TR, ductable split/packaged A/C shall be provided. Smaller areas which are away from the D-X type condensing unit /central chilling units which may require air conditioning upto 5 TR rating shall be served with Hi-wall Split/Cassette air conditioner units as per requirement. Above 60TR of A/C load, chilled water type centralized A/C system shall be provided.

18. Valves at discharge of pumps, outlet of chillers and inlet of cooling towers or any other valve (if needed as per system requirement) in the system shall be motor operated type for remote operation of the Air conditioning system.

19. Mandatory Requirements to be followed for A/C Equipments:

19.1. Refrigerant : Refrigerant should be CFC/HCFC free.

19.2. Insulation for A/C air ducts: A/C ducts shall be insulated.

19.3. All types of Insulation used for HVAC application shall be CFC/HCFC free.

20. During normal operation period, all the working equipment shall run on A.C. power supply. However, in case of complete black-out condition, DG sets being provided are required to cater the load of some of the air-conditioning equipment so that Main Plant Control Rooms and CER remain air-conditioned. The equipment to run on DG set are:

- 1 No. Chilling machine
- 1 No. chilled water pump.
- 1 No. condenser water pump.
- 1 No. cooling tower fan.
- 2 nos. AHUs for CR & CER
- 1 No. fresh air fan.

21. As per ECBC codes minimum coefficient of performance (COP) for the chiller shall be as follows (based on AHRI conditions):

A. COP of the water cooled chiller:

Sl. No.	Chiller Capacity (kWr)	Min COP
01.	<260	4.7
02.	≥ 260 & < 530	4.9
03.	≥ 530 & < 1050	5.4

B. COP for air-cooled chillers:

Sl. No	Chiller Capacity (kWr)	Min COP
01.	< 260	2.8
02.	≥260	3.0

22. Air Conditioning system for Service Building shall be designed in- line with ECBC code to make it "Green Building". Mandatory Requirements of ECBC to be followed for A/C Equipments:

22.1 Pumping System : Pumping System: Chilled water pumping system should be of variable flow type i.e. pumps should be VVVFD driven. Condenser water pumping shall be constant flow type.

22.2 Variable air flow: AHU Fans & CT Fans should be of variable flow type i.e VVVFD driven.

22.3 CO2 Sensors for optimum use of fresh air and Occupancy Sensors for operation of VAV Box.

3.13.02 DESIGN PHILOSOPHY – Ventilation System

1. Minimum Air changes per hour in evaporative/ mechanically ventilated areas shall be as follows:

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

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

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

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

Note : (i) Dry bulb temperature during summer season shall be as mentioned in air conditioning clause above. The criteria which gives higher number of air changes/higher quantity of air of either of condition (Cl. 1 or 2) flow shall be selected.

(ii) To calculate air quantity based on air changes per hour (ACPH) method, height of operating floor (17M) in AB Bay shall be taken as 4 meter.

3. All ventilation systems shall operate on 100% fresh air. Fan envisaged for MCC & Switchgear rooms shall be provided with pre-filters and fine filters and for other areas shall be provided with pre-filter only.

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

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

6. Circulating water Capacity for Air washer units shall be minimum 1 Cu.M/hr per 1000 Cu.M /hr of air flow and for UAF it shall be minimum 0.7 Cu.M/hr per 1000 Cu.M /hr of air flow. Velocity through piping shall be limited to 2.0 m/sec and for gravity flow the same shall be limited to 1.5 m/sec. Air distribution system shall be sized to have a constant frictional drop along its length and air velocity through ducts shall not exceed 12.5 m/sec.

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

8. All mechanically ventilated areas shall be positively ventilated. However, Battery rooms and other fumes/odour generating areas like fuel oil pump houses, central lube oil purification room etc. shall be negatively. Type of ventilation for various buildings shall be as follows:

S.No	Area	Type of Ventilation system
(i)	General area like pump house, compressor houses, etc.	Combination of Supply air fan & Exhaust air fans/Roof Extractor Fans
(ii)	MCCs and Switchgear room, Cable Vault (other than served by evaporative ventilation system), etc.	Supply air fans & Back draft dampers
(iii)	Battery rooms & other fumes/odour generating areas	Combination of Air Intake Louvers & Exhaust air fans
(iv)	Cable Galleries of TG Building, ESP Building and FGD Control Room Building	AWU/UAF systems along with back draft dampers
(vi)	Toilet/pantry etc.	Exhaust air fans
(vi)	For underground ventilation of CHP & Mill reject handling	Refer relevant clause in this sub section.

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

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

3.14.00 Compressed Air System

The compressed air system shall consist of Instrument Air compressors & their motor drives, Air Drying (ADPs) Plants, Service Air compressors & their motor drives, air receivers for each Air compressors, instrumentation and control, control panels, interconnecting compressed air

53. A suitable rail track and associated facilities like Jacking pads, mooring posts etc., shall be provided to facilitate the movement of Generator transformers. Station and Unit transformers to the maintenance bay. These rail tracks shall be accessible from the equipment unloading area of TG bay by a rail track.

54. Approach platform shall be provided from ESP outlet to ID fan suction gate.

55. Flue Gas Desulphurization (FGD) shall be located within the main plant block beyond ESP. The common facilities of FGD can be located outside the main plant block. Bidder to bring out the details regarding FGD and its location basis clearly in bidding documents. FGD Switchgear/MCC room shall be sized for LT & HT Switchgear meeting the functional requirements.

56. In boiler area layout for each unit, the bidder shall consider space provisions for future installation of SCR System. As per the Employer's assessment the min. requirement of area on both sides of boiler centerline for such future purpose is 25mX25m each. Space provision may be planned either towards downstream of APH (i.e. between Air pre-heaters and first row of ESP column) or on both sides of the boiler.
Bidder to clearly bring out the details regarding suitability of the provisioned area for future SCR system and its location basis with bid documents along with references of previously executed SCR System(s).

57. An area of 3000 sqm at a single location of min. 40 m width, to be kept near chimney for owner facility (required for carbon capture).

58. All facilities of mill reject handling system specified elsewhere in the specification such as pump, tank, conveyor, piping etc shall be above ground level in boiler area.

59. all staircase wells in TG hall C-row side, shall be pressurized and also all doors/ shutters provided this side shall have a provision of air curtains to avoid ingress of coal/ash dust from boiler side.

60. In case Centralised oil storage and purification system is located outside T.G building, the complete Centralised oil storage and purification system including Tanks, Pumps, Motors, Purifier etc. should be kept under covered shed. Throughout clear headroom of min. 2500mm between bottom most point of the roof shed supporting structure (like truss, purlin, etc.) and the topmost point of component of Centralised oil storage and purification system should be available.

1.04.00 Laydown area for maintenance and overhauling.

1. The layout of the steam turbine building/units shall permit sufficient lay down area for all the parts/components to enable carrying out maintenance and

SUB-SECTION–A-17

AIR CONDITIONING
&
VENTILATION SYSTEM

AIR CONDITIONING & VENTILATION SYSTEM

1.00.00 GENERAL

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

2.00.00 CODES & STANDARDS

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

2.02.00 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.

3.00.00 REDUNDANCY OF EQUIPMENTS

3.01.00 Redundancy of various A/C system equipments shall be as follows:

a) For Main Plant Areas [control room, control equipment room, UPS room, battery charger, static excitation control rooms (if applicable), SWAS room & water analysis lab for Unit 3 & 4:

i) Vapor compression type water cooed screw chiller units: 3X50%
ii) Chilled water pumps: 3X50%
iii) Condenser water pumps: 3X50%
iv) Cooling Towers: 3X50%
v) AHUs: At least one (1) no. unit, capacity same as each working unit shall be provided as common standby.

b) For ESP control rooms/CER, FGD control rooms/CER, etc. of Unit # 3 & 4:

i) Vapor compression type water cooled screw chiller units: 2X100%
ii) Chilled water pumps: 2X100%.
iii) Condenser water pumps: 2X100%.
iv) Cooling Towers: 2X100%.
v) AHUs: 2x100% AHUs for each ESP/FGD Building.

c) For Service Building:

i) Vapor compression type water cooled screw chiller units: 2X50%
ii) Primary Chilled water pumps: 2X50%.
iii) Secondary Chilled water pumps (with VVVFD): 2X50%.
iv) Condenser water pumps: 2X50%.
v) Cooling Towers (with VVVFD Fan): 2X50%.
vi) AHUs (with VVVFD Fan): All working & no standby

d) Water System Control Room Building:
i) Air cooled (D-X Type) condensing units: 2X100%
ii) AHUs: 2x100%

e) 100% standby shall be provided for control rooms/RIO room/VFD rooms, etc. served by ductable split/package type air conditioners.

At least one (1) no. unit, capacity same as each working unit as a common standby shall be provided for control rooms/RIO room/etc. served by non-ductable split (cassette / Hi-wall) type air conditioners.

No stand-by shall be provided for office areas of other buildings (like stores, workshops, etc.).

f) Fresh air fans shall be 1 x 100 % capacity for each AHU room. However, AHUs of Service Building shall be provided with modulating fresh air dampers (with filters) to regulate fresh air based on feedback from CO2 Sensors.

g) 24 hours operational rooms/areas (located in buildings served by 12 hours operational centralized A/C system) shall be provided with standalone A/C system as standby. Type of A/C system shall be as per design criteria stipulated in the specification.

h) VFD (if applicable) shall be provided with bypass contactor for motors with standard features like indication, manual and Auto set point facility, control power source, capable of changing supply frequency from 50% to 125%, bypass harmonies suppression, etc.

3.02.00 Redundancy of ventilation system equipments shall be as follows:

a) Pump and fan for Air washer / UAF units shall be 1x100% for each unit.

4.00.00 EQUIPMENT DESCRIPTION – AIR CONDITIONING SYSTEM

4.01.00 **Vapour compression type machines**

4.01.01 Each chilling unit shall comprise of compressor with drive motor, Water Chiller/evaporator, Chilled water pumps, Condenser Cooling Water pumps (if applicable) other accessories such as supporting structure, vibration isolators, insulation, piping, valves, instrumentation, microprocessor / PLC based Control panel, etc. Chilling unit shall have stepless capacity control. The screw/centrifugal compressor based chilling unit to be supplied shall be ARI /Eurovent/Equivalent standard certified (if applicable).

4.02.00 **Chilling Unit**

Type		Water-cooled type. (Chillers for main plant shall preferably be with multiple compressors)
Vibration isolators	:	Steel spring/ Neoprene rubber cushy foot/ neoprene serrated rubber pad type with isolation efficiency not less than 85%.
Compressor Type	:	Compressor shall be Screw type (open/semi-hermetic/multiple hermetic)
Type of drive	:	Motor driven, along with Star delta/Double delta Starter.
Capacity	:	Minimum capacity shall be suitable for the identified/selected evaporating temperature and condensing temperature.
Condenser		
Type	:	Water cooled shell and tube type.
Fluid	:	Shell side – Refrigerant
	:	Tube side - Water
Capacity	:	To match with respective compressor and to provide atleast 2 deg. C sub-cooling. To store full charge of refrigerant.

Design fouling Factor	:	Not less than 0.0002 (in MKS units)
Shell material	:	Mild steel (IS: 2062) / SA 106 Gr. B
Tube material	:	Replaceable seamless copper
Fin material		Copper
Accessories	:	As required such as Purge and drain connections, relief valves, liquid line shut-off valves, refrigerant filling charging, flow switches, Isolating valves, pressure & temperature indicators at inlet and outlet etc.
Refrigerant	:	The refrigerant shall be R-134a/R-410A/R-407C or any other environment friendly refrigerant.
Steel structure	:	The complete condensing/ chilling unit shall be mounted on steel structure and shall be provided with necessary vibration isolators
Inlet temperature		33-36 o C.
Leaving temperature differential	:	Maximum 5 o C.
Evaporator		
Type	:	Shell and tube type
Superheating of	:	At least 2 deg.C
Design Fouling Factor	:	Minimum 0.0001 (MKS units)
Fluid	:	Shell side - Refrigerant
	:	Tube side - Water
Capacity	:	To match with respective plant capacity.
Shell material	:	Mild steel (IS : 2062) / SA 106 Gr. B
Tube material		Plain tube internally /externally finned copper as per the manufacturer's standard practice.
Fin material	:	Integral
Accessories	:	Purge and drain connections, Isolating valves, flow switches, Pressure & temperature indicators at inlet and outlet, Anti-freeze thermostats, electronic expansion valve or float assembly as applicable, pilot solenoid valve, Relief valves, Operating thermostats for capacity control, supporting frame, etc.
Steel Structure	:	The complete condensing/ chilling unit shall be mounted on steel structure and shall be provided with necessary vibration isolators.

4.03.00 Condensing Unit -Air-Cooled (D-X type)

Condensing unit

Type	:	Air cooled scroll type
Vibration isolators	:	Steel spring / Neoprene rubber cushy foot type with isolation efficiency not less than 85%.
Compressor		
Type	:	The Compressor shall be scroll, serviceable, either hermetic type or semi-hermetic type with automatic capacity control (minimum 3 steps).
Type of drive	:	Motor driven.
Refrigerant	:	The refrigerant shall be R-134a/ R-410A/R-407C 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.
Capacity	:	Minimum capacity shall be suitable for the identified/selected at evaporating temperature and condensing temperature and shall be indicated.

4.04.00 **Air Handling Unit (AHU)**

4.04.01 Each AHU shall consist of casing, fan impeller section, cooling coil section, damper section, steel frame with anti vibration mountings (AVMs) having minimum 85% vibration dampening efficiency and flame retardant, water proof neoprene impregnated flexible connection on fan discharge. Isolation dampers at the suction and discharge of each AHU shall be provided, in case return air duct is directly connected to AHU. However, in case AHU room is used for return air, isolation dampers are required to be provided only at AHU discharge of each AHU. Pre-filter at the suction and fine (micro-vee type) and absolute (HEPA type) filters (wherever applicable) at the discharge of each individual AHU, and heater section in the common discharge of AHUs. NRD shall be provided at outlet of each AHU when multiple AHU used for a common plenum.

4.04.02 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 (thickness of galvanization as per manufacturer's standard) , 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.

4.04.03 Sloping condensate drain pan shall be made of minimum 1.2 mm thick Stainless Sheet Steel. It shall be isolated from bottom floor panel through 25mm thick heavy duty treated for Fire (TF) quality expanded polystyrene or polyurethane foam. Drain pan shall extend beyond the coil.

4.04.04 Cooling coil (min. 4 row deep) shall be made of seamless copper tubes with aluminium fins firmly bonded to copper tubes and shall be provided with suitable drains and vents connections.

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

4.04.06 **Centrifugal fan**

a)	Fan Type	:	Double Width Double Inlet (DWDI) Centrifugal Type
b)	Fan impeller	:	Backward curved blades
c)	Casing material	:	GI /Mild steel with minimum thickness of 3 mm.
d)	Impeller material	:	Carbon steel
e)	Shaft	:	EN 8 Steel
f)	Fan bearings	:	Self aligning type, permanently lubricated, heavy duty with a design life of 10,000 operating hours.
g)	Critical speed	:	First critical speed of rotating assembly shall be at least 25% above the operating speed.

h)	Drive	:	Motor driven with removable belt guard. Motor rating (at 50 deg.C ambient) shall be atleast fifteen percent (15%) above the maximum load demand of drives at the design duty point.
i)	Fans	:	For AHUs of capacity 50,000 CMH and above, Bidder may offer two (2) Nos. centrifugal fans of equal capacity for each AHU provided all such AHUs are accommodated within the space identified by the Employer.

4.04.07 **Mixing Box:**

Mixing box shall be complete with fresh and return air dampers. Mixing box shall be provided whenever the return air is ducted back to the AHU.

4.04.08 **Pan Humidifier:**

Pan humidifier shall be made of 22 gauge SS 304 tank, duly insulated with 25 mm thick resin bonded fiber glass insulation (min. 24 Kg/m3 density) with 0.5 mm GSS cladding. The humidifier shall be complete with stainless steel immersion heaters, safety thermostat, float valve with stainless steel ball, sight glass, overflow and drain connections, steam outlet nozzle and float switch. Step controller shall be provided for switching on / off heater banks as per system requirement.

4.05.00 NON DUCTABLE SPLIT (HI-WALL/CASSETTE), DUCTABLE SPLIT, PACKAGED AIR-CONDITIONERS

4.05.01 Air conditioners shall in general consist of the following:

i) Casing
ii) Hermetically sealed rotary/scroll Compressor
iii) Air-cooled condenser
iv) Evaporator and condenser cooling fan
v) Cooling coil
vi) Filters
vii) Piping, valves, refrigerant strainer, etc.
viii) Controls, instruments, control panel/starter panels.
ix) Vibration isolator pads, ducting (if applicable), etc. as required.
x) Refrigerant as per manufacturer practice.

Note: (1) Humidity control inside air-conditioned space served by split air conditioners (Hi-wall / Cassette/ Ductable) is not envisaged.
(2) Split air conditioner shall conform to minimum three (3) star (***) rating and above of latest version of Bureau of Energy Efficiency (BEE) HVAC code issued by Ministry of Power, Govt of India.

4.05.02 Indoor unit of Ceiling Mounted Cassette Type Unit (Multi Flow Type):

The housing of the unit shall be powder coated galvanized steel. All the indoor units regardless of their difference in capacity should have same decorative panel size for harmonious aesthetic point of view.

Unit shall have four-way supply air grills on sides and return air grill in center.

Each unit shall have high lift drain pump and very low operating sound.

CLAUSE NO.	TECHNICAL REQUIREMENTS
4.05.03	**PACKAGED AIR-CONDITIONERS** (a) Packaged air conditioners shall be an encased assembly as a self-contained unit primarily for floor mounting, designed to provide free delivery of conditioned air to the conditioned space. It shall include a primary source of refrigeration for cooling and dehumidification, means for circulating and cleaning air and means for heating and humidifying air. Fresh air fan shall be provided in PAC Room. (b) The cabinet, housing the components of packaged air conditioners, shall be of heavy gauge sheet steel and suitable for floor mounting. The access panels shall be of easily removable type. The entire casing shall be thermally insulated with 25 mm thick insulation of totally flame proof type (T.F. type). Suitable drain connection shall be provided for removal of condensate collected inside a tray under cooling coil. (c) Controls shall be so provided that failure of one equipment of PAC will automatically trip that PAC unit. (d) HP and LP cutout shall be provided for compressor protection. A thermostat with adjustable setting shall also be provided in the return air circuit to control the room temperature by ON-OFF mode. (e) Provision shall also be made for manual re-starting and stopping of the compressor. (f) Interlock shall be provided such that compressor can start only starting the air handling fan. (g) Interlock shall be provided so that compressor can start only if condenser fan in running. Further if the condenser fan stops, the compressor shall also trip. (h) To control the humidity throughout the year, the humidistat shall be interlocked with humidifier and reheater.
4.06.00	**COOLING TOWERS (for chilling units)**
4.06.01	Type : Induced draft, cross or counter flow, vertical discharge
4.06.02	Casing & Sump tank : F.R.P/G.R.P
4.06.03	Fan : Cast Aluminum / FRP Propeller type and multi-blade aerofoil construction with adjustable pitch.
4.06.04	Fill : Non combustible PVC or equivalent
4.06.05	Louvers : F.R.P. /PVC/ Aluminum.
4.06.06	Nozzles : Brass with chrome plating / Polypropylene.
4.06.07	Eliminators : In removable sections to reduce the drift loss to 0.2% of water flow.
4.06.08	Supporting structure : Mild steel with spray galvanization or epoxy painting.
4.06.09	Strainer at water outlet : Plate strainer made of GI/SS wire mesh of 16 gauge.

4.06.10	Bird screen on top of tower	:	25 mm square made of GI/SS wire mesh of 16 gauge.
4.06.11	Distribution Pipe (if any)	:	Galvanised MS pipe.
4.06.12	Accessories		a) Drain connection with isolation valve. b) Make up connection with ball – float valve, back up gate valve and a bypass with a gate valve for manual operation. c) Overflow connection. d) Equalizing connection to connect sump of all the towers wherever applicable. e) Access door in louvers/fan deck.

5.00.00 EQUIPMENT DESCRIPTION - VENTILATION SYSTEM

5.01.00 Air Washer Unit

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

Housing/Casing of Air Washer Unit

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

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

5.01.02 The air washer tank shall be fabricated from MS plate of minimum 6 mm thick and inside and outside surface of the tank shall be spray galvanized **(minimum 60 microns DFT).** Minimum depth of the tank shall be 600 mm. Tank construction shall be such that the suction screen can be replaced while the unit is operating. Tank shall be provided with overflow, drain with valve, float valve makeup connection with a gate valve backup, quick fill connection with globe valve etc. The overflow pipe shall be connected to drain pipe after isolating valve on drain pipe.

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

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

5.01.05 The spray nozzles shall be of brass or bronze with chrome plating and shall be self cleaning type. The nozzle shall be designed to produce fine atomized spray and shall be properly spaced to give a uniform coverage of the air washer section. The pressure drop through the nozzle should be in the range of 1.4 to 2.4 Kg/cm2

CLAUSE NO.	TECHNICAL REQUIREMENTS
5.01.06	The eliminator plates shall be of 24G thick GS sheets class 275 or from 100% virgin PVC of minimum finished thickness of 2 mm. The eliminator section made of GSS shall have minimum six bends. The PVC eliminators shall be UV stabilized using Titanium di-oxide and shall withstand the weathering test as per IS:4892 for 500 hrs. Type test report of the compound testing carried out in any reputed laboratory shall be submitted for approval. All supports, tie rods and space bar shall be of either galvanised steel or PVC construction and shall be complete with suitable drip tray and drain pipe.
5.01.07	An airtight inspection door of 600mm X 700mm size and a water marine light be provided for each air washer unit.
5.01.08	Suitable number of brass screen shall be provided in the air washer tank to arrest the dirt entering the circulating water pump suction. Suitable GI grid shall be used inside the screen for reinforcement
5.01.09	The specification for centrifugal fans shall generally be as indicated below. Centrifugal fans for air washer units shall be of DIDW type.
5.01.10	Saturation efficiency of Air Washer units shall be minimum 90%.
5.01.11	Air washer units shall be provided at various elevations in TG building (AB & BC Bay). However, air washer units if required to be placed on the roof shall be provided with steel shed (open).
5.02.00	**Unitary Air Filtration**
5.02.01	Each modular unitary air filtration shall consist of Casing, Tanks, Fans, Distribution plates, Moisture eliminator and water repellant type nylon filter with frame and support, Header and standpipe with support, Spray and flooding type nozzle. Screen type suction strainer, Pumps, Necessary controls & Instrumentation, and all other required accessories.
5.02.02	The housing/ casing of air washer unit shall be double skin construction. Double skin panels shall be made of 22G galvanized sheet on outer side and 20G galvanized sheet inside with 25mm thick polyurethane foam insulation of minimum 38 kg/cum density in between. Thickness of galvanization shall be minimum 60 microns DFT. Framework for section shall be joined together with soft rubber gasket in between to make the joints airtight. The entire fan section shall be mounted on rolled formed GSS channel framework.
5.02.03	The unitary air filtration tank shall be fabricated from MS plate of minimum 6 mm thick and inside and outside surface of the tank shall be spray galvanized **(minimum 60 microns DFT).** Minimum depth of the tank shall be 600 mm. Tank construction shall be such that the suction screen can be replaced while the unit is operating. Tank shall be provided with overflow, drain with valve, float valve makeup connection with a gate valve backup, quick fill connection with globe valve etc. The overflow pipe shall be connected to drain pipe after isolating valve on drain pipe.
5.02.04	The distribution plate shall be fabricated out of 18G galvanized steel sheets & galvanized steel angle supports with minimum 50% free area.
5.02.05	Unitary air filtration shall be one-bank construction. All header and standpipes shall be galvanized. Cat walks of suitable width shall be provided for maintenance of nozzle, filter etc.
5.02.06	The spray nozzles shall be of brass or bronze with chrome plating and shall be self-cleaning type. The nozzle shall be designed to produce fine atomized spray and shall be properly spaced to give a uniform coverage of the air washer section. The pressure drop through the nozzle should be in the range of 1.4 to 2.4 Kg/cm2.

CLAUSE NO.	TECHNICAL REQUIREMENTS
5.02.07	The eliminator plates shall be of 24G thick GS sheets class 275 or from 100% virgin PVC of minimum finished thickness of 2 mm. The eliminator section made of GSS shall have minimum six bends. The PVC eliminators shall be UV stabilized using Titanium di-oxide and shall withstand the weathering test as per IS:4892 for 500 hrs. Type test report of the compound testing carried out in any reputed laboratory shall be submitted for approval. All supports, tie rods and space bar shall be of either galvanized steel or PVC construction and shall be complete with suitable drip tray and drain pipe.
5.02.08	Air tight inspection doors of suitable size shall be provided for suction chamber. Spray chamber and fan suction for easy accessibility and maintenance and a water marine light be provided for each unitary air filtration.
5.02.09	Suitable number of brass screen shall be provided in the air washer tank to arrest the dirt entering the circulating water pump suction. Suitable GI grid shall be used inside the screen for reinforcement.
5.02.10	The specification for centrifugal fans shall generally be as indicated below. Centrifugal fans for UAF units shall be of DIDW type.
5.02.11	All equipments, components used in unitary air filtration system shall be in line with the specification requirements stipulated in air washer units.
5.02.12	Saturation efficiency of Unitary Air Filtration (UAF) units shall be minimum 60%.
5.02.13	UAF units placed in open or on the roof shall be provided with steel shed (open).
5.03.00	**Centrifugal Fan**
5.03.01	The casing shall be of welded construction fabricated with heavy gauge galvanised sheet steel or MS sheet with spray galvanization (**minimum** 60micron DFT). The minimum thickness of casing shall be 3 mm. It shall be rigidly reinforced and supported by structural angles. The seams shall be permanently sealed air tight. Split casings shall be provided on larger sizes of fans. Casing drain with valves shall be provided wherever required.
5.03.02	The impeller shall have die-formed backward-curved blades tie welded to the rim and back plate to have a non-overloading characteristic of the fan. Rim shall be spun to have a smooth contour. If required intermediate stiffening rings shall be provided. Shaft sleeves shall be furnished wherever required. The impeller, pulley and shaft sleeves shall be secured to the shaft by key and/or nuts.
5.03.03	The bearing shall be self-aligning, heavy duly ball, roller or sleeve bearing. They shall be adequately supported. They shall be easily accessible and lubricated properly from outside.
5.03.04	Inlet guard shall be spun to have a smooth contour. Inlet screen, if provided, shall be of galvanized wire mesh of 25 mm square.
5.03.05	Base plate with necessary number of spring type vibration isolators or ribbed neoprene rubber pad or cushy foot mounting shall be provided. The vibration isolators should have a minimum of 70% efficiency.
5.03.06	The first critical speed of the rotating assembly shall be at least 25% above the opening speed.
5.03.07	The fans shall be provided with V-belts and sheaves. All belts shall be sized for 150% rated HP. All V-belt shall be equipped with removable belt guards that do not impede the air flow to the fan inlet. There shall be a minimum of two belts per drive. Motor rating (at 50 deg.C ambient) shall be atleast fifteen percent (15%) above the maximum load demand of drives at the design duty point.

CLAUSE NO.	TECHNICAL REQUIREMENTS

6.00.00 BALANCE EQUIPMENT SPECIFICATION

6.01.00 **CENTRIFUGAL PUMPS**

a)	Type	:	Horizontal Centrifugal, Axially split type casing pump End suction, top discharge horizontal centrifugal pump may be provided for modular UAF unit.
b)	Impeller	:	Closed type
c)	Material of Construction		
	i) Casing	:	2% Ni Cast Iron : IS:210 Gr. FG-260
	ii) Impeller	:	Bronze IS:318 Gr-2
	iii) Wearing rings	:	Bronze
	iv) Shaft	:	SS 316
	v) Shaft sleeve	:	SS 316
	vi) Lantern ring	:	Brass / Bronze
	vii) Packing	:	Asbestos free
	viii) Base Plate	:	Carbon steel as per IS:2062
	ix) Speed	:	Maximum 1500 rpm
	x) Other requirements	:	To refer to **Annexure-I** titled "Horizontal Pumps" of this sub section.

6.02.00 **Material of Construction for Piping & Fittings**

a)	Piping for Chilled and Condenser water lines	:	Heavy grade-IS:1239 or Equivalent upto150 NB and Grade 410 of IS:3589 or Equivalent for pipes beyond 200 NB with thickness as indicated in **Annexure-II**
b)	Circulating water piping of Ventilation System		Heavy grade-IS: 1239 or Equivalent upto150 NB and Grade 410 of IS: 3589 or Equivalent for pipes beyond 200 NB with thickness as detailed at **Annexure-II.** The piping upto 100 mm diameter shall be of galvanized steel **(galvanization shall be as per IS: 4736)** and those above 100 mm dia. shall be black steel. The piping shall be adequately supported
c)	Refrigerant piping :	:	Seamless steel tubes conforming heavy grade IS:1239 or copper tubes as per IS:2501 (copper material as per IS:191 hard copper grade).
d)	Drain piping	:	Same as (a) above & galvanized as per IS:4736.
e)	Fittings	:	1) The steel fittings shall conform to ASTM A234 Gr. WPB and dimensional standard to ANSI B 16.9/ANSI B16.11 / equivalent for sizes 65 NB and above. 2) For sizes 50 NB and below, the material shall conform to ASTM A-105. 3) All steel flanges shall be of slip on type and shall conform to ANSI B 16.5 4) For pipe sizes above 350 NB, fabricated fittings from sheets of adequate thickness may be used. The bend radius in case of mitre bends shall be minimum 1.5 times the nominal pipe diameter and angle between two adjacent sections shall not be more than 22.5 deg and shall be as per BS:2633/BS:534. 5) Fittings, flanges and pipe joints of refrigerant piping shall conform to ANSI B31.5

6.03.00 **VALVES**

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

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

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

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

6.03.05 Valves shall be furnished with back seating arrangement for repacking while working under full working pressure.

6.03.06 Manual gear operators be provided for valves of size 200 NB and above.

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

6.03.08 The refrigerant line valves shall have steel or brass body with TEFLON gland packing. The construction of disc shall be either globe or angle type. The valve seat shall have white metal lining or equivalent.

6.03.09 **Balancing / Controller Valves:**

The valves of sizes 32 mm to 50 mm dia shall be of gun metal / cast iron construction with screwed ends. Whereas valves of sizes 65 mm and above shall be of cast iron construction with internal parts of SS 410 and EPDM / nitrile seat with flanged ends.

6.04.00 **AIR FILTERS**

6.04.01 **Pre Filter**

1)	Type : Flange / Cassette	
2)	**a) Fabric Filter*:** Pre-filter shall contain washable non-woven synthetic fiber or High density Polyethylene (HDPE) media having 18G GSS / 16G Al alloy frame. The filter media shall be supported with HDPE mesh on air inlet side & Aluminium expanded metal on exit side or G.I. wire mesh on both sides. **b) Metallic Filter*:** Filter medium, aluminium alloy shall be supported on galvanized expanded metal casing. Frame shall be fabricated from aluminium alloy of minimum 16G thickness conforming to IS: 737 or 18 gauge. * For air washer units taking suction from C-row side, only metallic pre-filters shall be provided. However, for other air washer units, Contractor may provide fabric or metallic pre-filters.	
3)	**Other requirements : (as applicable)**	
	a)	Suitable aluminium spacers be provided for uniform air flow;
	b)	Casing shall be provided with neoprene sponge rubber sealing.
	c)	Capable of being cleaned by water flushing.
	d)	Density of filter medium shall increase in the direction of air flow in case of metallic filter.
	e)	Filter media shall be fire retardant and resistant to moisture, fungi, bacteria & frost.
4)	**Efficiency :**	

	Average arrestance of 65 - 80 % when tested in accordance with BS:6540/ASHRAE – 52 – 76 / EN-779.		
5)	Minimum thickness	:	50 mm
6)	Face Velocity	:	Not more than 2.5 m/sec.
7)	Pressure drop	:	Initial pressure drop - Not to exceed 5.0 mm WC at rated flow. Final pressure drop - Upto 7.5 mm WC.
8)	Location	:	a) At the suction of each AHUs
		:	b) At the discharge of each Fresh air fan
		:	c) At the discharge of each Supply air fan

6.04.02 **Fine Filters (Microvee type)**

1)	Type	:	Flange / Cassette
2)	Fine filter shall contain washable non-woven synthetic fibre or High density Polyethylene (HDPE) media having 18G GSS / 16G Al alloy frame. The filter media shall be supported with HDPE mesh on air inlet side & Aluminium expanded metal on exit side or G.I. wire mesh on both sides.		
3)	Other requirements	:	a) A neoprene sponge rubber sealing shall be provided on either face of the filter frame. b) Capable of being cleaned by air or water flushing. c) Filter media shall be fire retardant and resistant to moisture, fungi, bacteria & frost.
4)	Efficiency	:	Average arrestance > 90% when tested in accordance with BS:6540/ASHRAE–52-76 / EN-779.
5)	Minimum thickness	:	150 mm or 300 mm.
6)	Face Velocity	:	Not more than 1.2 m/sec for 150 mm and not more than 2.4 m/sec. for 300 mm.
7)	Pressure drop	:	Initial pressure drop - Not to exceed 10 mm WC at rated flow ; Final pressure drop-Up to 25 mm WC.
8)	Location	:	i) At the discharge of each individual AHU. ii) At the discharge of each Fresh air fan. iii) At the discharge of each supply air fan having static pressure 30mm wc or more.

6.04.03 **Absolute Filter / Hepa Filter**

1)	Media	:	100% sub-microscopic glass fibers.
2)	Frame	:	Aluminium alloy of (minimum 16 gauge conforming to IS: 737) with handles.
3)	Other requirements	:	A neoprene sponge rubber sealing shall be provided on either face of the filter frame.
4)	Efficiency	:	99.97 % down to 0.3 micron when tested in accordance with BS: 3928 (Sodium flame test)/FED–209B.
5)	Minimum thickness	:	300 mm
6)	Face Velocity	:	Not more than 1.2 m/sec.
7)	Pressure drop	:	Initial pressure drop - Not to exceed 25 mm WC at rated flow; Final pressure drop - Up to 75 mm WC.
8)	Location	:	At the discharge of each individual AHUs for Control Equipment Room / Control room /UPS & battery Charger Rooms.

6.05.00 **LOW PRESSURE AIR DISTRIBUTION SYSTEM**

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

6.05.02 **Thickness of rectangular ducts shall be as follows:**

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

6.05.03 **Thickness of round ducts shall be as follows :**

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

6.05.04 **Duct Fabrication and Supports:**

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

b) Ducts for A/C system may be site fabricated or factory fabricated and installed at site. However, in case of partly used factory fabricated ducts, vendor shall take back the unused ducts.

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

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

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

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

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

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

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

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

6.06.00 **Factory fabricated ducts:**

i) All ducting shall be fabricated of LFQ (Lock Forming Quality) grade prime G.I.

ii) Unless otherwise specified here, the construction, erection, testing and performance of the ducting system shall conform to the SMACNA-1995 standards ("HVAC Duct Construction Standards-Metal and Flexible-Second Edition-1995" SMACNA)

iii) All ductwork including straight sections, tapers, elbows, branches, show pieces, collars, terminal boxes and other transformation pieces must be factory fabricated by utilizing the machines and processes as specified in SMACNA or by equivalent technology. In equivalent method, the fabrication shall be done by utilizing the following machines and process to provide the requisite quality of ducts and speed of supply:

a. Coil lines to ensure location of longitudinal seams at corners/folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any face side of the duct.
b. All ducts, transformation pieces and fittings to be made on CNC profile cutters for required accuracy of dimensions, location and dimensions of notches at the folding lines.
c. All edges to be machine treated using lock formers, flangers and roll-bending for turning up edges.
d. Sealant dispensing equipment should be used for applying built-in sealant in Pittsburgh lock where sealing of longitudinal joints are specified. Sealing of longitudinal joint is compulsory for the ducts over 2" w.g. static pressure

iv) All transverse connectors shall be 4-bolt slip-on flange system with built-in sealant, if any. To avoid any leakage additional sealant shall be used.

v) Factory fabricated ducts shall have the thickness of the sheet as follows:

Sl.No.	Size of Duct	Sheet Thickness
i)	upto 750 mm	0.63 mm
ii)	751 mm to 1500 mm	0.80 mm
iii)	1501 mm to 2250 mm	1.00 mm
iv)	2251 mm and above	1.25 mm

6.07.00	**Diffusers, Grills & Dampers:**
6.07.01	Supply air diffusers/grills with factory fitted volume control dampers be provided for all air-conditioned areas and evaporative cooling system areas.
6.07.02	Return air diffusers of air-conditioned areas shall be without volume control dampers. Inlet/Exhaust air grills/louvers are required for all negatively pressure ventilated areas. Back draft dampers shall be provided for all areas pressurized under ventilation system.
6.07.03	For AC system the diffusers/grills shall be of extruded Aluminum of minimum 1.2 mm thick with powder coating. The color of power coating shall be as per the interior Décor. The diffusers/grills shall be of powder coated mild steel construction for Ventilation system.
6.07.04	For AC system Supply air grills shall be of double deflection type and return air grills shall be of single deflection type. For ventilation system supply air grills shall be of double deflection type.
6.07.05	The nozzle type diffusers shall be fabricated from minimum 1.5mm aluminium sheet. The base shall be fixed type. The nozzle shall be of volute design with the Spout diameter being half the base dia. and designed for low noise and long throw. The nozzle shall be able to rotate to any angle within the base. The whole assembly shall be powder coated as per interior decor.
6.07.06	All volume control (VC) damper shall be operated by a key from the front of the grills/diffusers and shall be of GI sheet.
6.07.07	The thickness of VC dampers shall be of minimum 20 gauge and thickness of louvers shall be of minimum 22 gauge.
6.07.08	Suitable vanes shall be provided in the duct collar to have uniform and proper air distribution. Bank of Baffles wherever required shall also be provided.
6.07.09	Fire dampers shall be motor operated type and shall have fire rating of minimum 90 minutes.
6.07.10	All plenum chambers of connections to fans, dampers etc. shall be constructed in 18 gauge GS sheet and supported on MS angle frames,
6.07.11	All ducting surfaces coming in contact with corrosive fumes or gases shall be painted with three coats of epoxy paint over a coat of suitable primer.
6.07.12	Suitable number of VAV box (if applicable) shall be provided for optimum use of VFD driven AHU.
6.08.00	**Thermal and Acoustic Insulation**
6.08.01	**A)** Application with Glass Wool (a.) All surfaces to be insulated both thermally and acoustically shall be thoroughly cleaned, dried and an adhesive (CPRX compound of Shalimar Tar Products or Equivalent) be applied @ 1.5 Kg /Sqm on the surface. (b.) Insulation material (either expanded polystyrene foam or Glass Wool/ Glass fiber or Equivalent) shall be struck to the surface. All the joints shall be sealed with bitumen. (c.) Insulation mass to be covered with 500 gauge polythene sheet with 50 mm overlaps and sealing all joints on hot side.

(d.) Insulation Finish of types specified under shall be provided thereafter.

B) Application with Nitrile Rubber:

(a) All surfaces to be insulated shall be properly cleaned.

(b) A suitable adhesive such as SR 998 or equivalent shall be applied over the surfaces to be insulated and insulation material surfaces.

(c) Insulating material shall than be pasted onto the surfaces in a manner to avoid stretching and any air entrapment within.

(d) Two layers of Glass Cloth with a suitable adhesive as SR 998 or equivalent shall be then applied over the insulating material to avoid surface weathering.

C) Application with Polyurethane Foam & Polyisocyanurate Foam

(a) All surfaces to be insulated shall be cleaned.

(b) A suitable adhesive such as CPRX or Loid Bond 83 or equivalent shall be applied over the surface to be insulated and insulation material surfaces.

(c) Insulating material with aluminum foil lamination shall then be pasted onto the surface in a manner to avoid stretching and any air entrapment within.

(d) Two layers of Glass Cloth with a suitable adhesive as Loid Bond 130 shall be then applied over the insulating material, to avoid surface weathering.

(e) Insulation Finish of types specified under shall be provided thereafter.

D) Application with FR Closed Cell Chemically Cross Linked Polyethylene Material (XLPE)

(a) All surfaces to be insulated shall be properly cleaned of any dust, grease and moisture.

(b) A suitable adhesive, normally, a pressure sensitive acrylic base, such as SR 998/STAR Glue R242 or Neosole AA 900 or equivalent shall be used to paste the insulating material over the cleaned surface.

(c) XLPE cut to size for each surface, with overlaps provided for two faces shall be stuck to the surfaces in a manner to avoid air entrapment. The extent of over-lap shall be equivalent to the thickness of the material to be applied. The adhesive is applied on both the surfaces to be insulated and the insulation foam material.

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

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

6.08.02 **Type of Insulation & Finish**

Sl. No.	Surface	Insulation Material	Insulation Form	Thick (mm)	Finish (mm)

Sl. No.	Surface	Insulation Material	Insulation Form	Thick (mm)	Finish (mm)
1.	Supply & return air duct of AC System	Resin bonded glass wool or	Roll /Slab	50	F-3
		Closed Cell Elastomeric Nitrile Rubber	sheet	19	As per manufacturer std.
		Or Polyisocyanurate Foam	Slab	30	F-3
2.	Refrigerant (Suction and liquid lines)	Closed Cell Elastomeric Nitrile Rubber	tube	19	As per manufacturer std.
		Or Rigid Polyurethane Foam	Pipe Section	50	F-1 (a)
3.	AHU drain pipe	Closed Cell Elastomeric Nitrile Rubber	tube	19	As per manufacturer std.
		or Rigid Polyurethane Foam	Pipe Section	50	F-1 (a)
4.	AHU condensate pan (insulation if required)	Mineral wool or resin bonded glass wool	Slab	25	As per manufacturer std.
5.	Chilled water piping, valves & specialties	Resin bonded Mineral wool or resin bonded glass wool	Pipe section	75	F-1/F-3
		or Rigid Polyurethane Foam	Pipe Section	50	F-3
6.	Chiller (insulation if required)	---------- As per manufacturer std.----------			
7.	Chilled water pumps	Resin bonded Rockwool wool or resin bonded glass wool	Slab	75	F-1/ F-3
		or Rigid Polyurethane Foam	Slab	50	F-3
8.	Expansion tank with associated piping	Resin bonded Rockwool wool or resin bonded glass wool	Slab/ Pipe section	75	F-1/ F-3
		or Rigid Polyurethane Foam	Slab	50	F-3
9.	Acoustic insulation of duct	Resin bonded Glass wool	Slab	25	As per specifications
10.	Exposed air duct	Resin bonded Glass wool/Rockwool	Roll/Slab	50	F-4
		or Polyisocyanurate Foam	Slab	50	F-4(a)

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

Insulation Material	Code	Thermal conductivity (w/m/^{O}C	Density Kg/m^3

Resin bonded glass wool	IS:8183	0.049 at 50oC 0.043 at 50oC	i) 24 (For Glass wool) ii) 48 (For Rockwool) iii) 48(For acoustic insulation)
Mineral wool pipe section. Min.Gr.2	IS:9842	0.043 at 50oC	144
Closed Cell Elastomeric Nitrile Rubber		0.036 at 20oC	40 – 60
Polyurethane Foam Polyisocyanurate Foam	IS12436	0.03 at 50 oC 0.03 at 50 oC	34 + 2 34 + 2
Note : Insulation used for HVAC application shall be CFC/HCFC free			

6.08.04 The specification for various finishes shall be as follows

a)	Finish F-1 (with Resin Bonded Glass Wool/Resin Bonded Mineral Wool) Step-1 Wrapping of Poly-Bonded Hessain (PBH – to act as vapour seal) on outer surface of insulation with 50 mm overlap stitching and sealing of overlap with synthetic adhesive like CPRX or Equivalent compound.
	Step-2 The surface then shall be wrapped with 19 mm mesh 24 SWG GI wire netting, butting all the joints and laced down with 22 SWG lacing wire.
	Step-3 Sand cement (4:1) plaster shall be applied in two layers totalling to 12.5 mm thick, the second layer being brought to a smooth finish. A water proofing compound shall be added to the cement before its application.
aa)	**Finish F-1(a) (With Polyurethane Foam & Polyisocyanurate Foam)** Wrapping of two layers of 7 mil 10 x 10 mesh glass cloth dipped in suitable adhesive such as SR 998 or Loid Bond 130 equivalent
b)	Finish F-2 Step-1 Insulation shall be covered with 500g polythene with 50mm overlap and sealing of overlap with synthetic adhesive like CPRX/ Loid Bond 83 or Equivalent compound.
	Step-2 Same as Step-2 of Finish F-1 above.
	Step-3 Same as Step-3 of Finish F-1 above.
c)	Finish F-3 Step-1 Same as Step-1 of Finish F-2 above
	Step-2 The polythene shall be covered with 26 gauge Aluminium sheet and locking of joints with self-locking screws at a pitch of minimum 100 mm.
d)	Finish F-4 Step-1 Same as Step-1 of Finish F-1 above. Step-2 Same as Step-2 of Finish F-1 above. Step-3 Same as Step-3 of Finish F-1 above. Step-4 Application of 3 mm thick coat of suitable water proofing compound and wrapped with fibre glass RP tissue followed by final coat of 3 mm thick water proofing compound over the RP tissue. Step-5 After the above treatment, 22G Aluminium sheet cladding, properly stiched at all joints shall be provided over the external surface.
dd)	Finish F-4(a) (With FR Closed Cell Chemically Cross Linked Polyethylene) Application of aluminium sheet 22G cladding to be provided over the XLPE insulating material. Cladding sheet is held in position with SDST screws @ 150 mm C/c over tongue-in-groove joints applied with a felt for sealing joint

	against water ingress. All sheet joints to be done in a manner to shed water.

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

6.08.06 **ACOUSTIC INSULATION**

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

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

6.09.00 Axial Fans

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

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

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

d) The speed of the fan shall not exceed 1000 rpm for fan with impeller diameter above 450 mm and 1500 rpm for fan with impeller diameter 450 mm or less. However for fans having static pressure of 30 mm WC or above the speed of the fan shall not exceed 1500 rpm for fan with impeller diameter of above 450 mm and 3000 rpm for fan with impeller diameter of 450 mm or less. The first critical speed of rotating assembly shall be atleast 25% above the operating speed.

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

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

g) Fuel oil pressurizing pump house, fuel oil unloading pump house (if applicable), central lube oil purification room, Gas rooms in TG building and battery rooms of TG building, switchyard control annex building, etc. shall be provided with spark proof (with flame proof motor) fans.

6.10.00 Roof Ventilators

6.10.01 The roof extractors shall be “COWL” type.

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

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

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

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

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

CLAUSE NO.	TECHNICAL REQUIREMENTS
7.00.00	**PLANT CONTROL OF AC SYSTEM:**
7.01.00	Brief scheme of controlling the operation is described below. Detailed description of the control system for safe and efficient operation of the plant shall be elaborated, got approved from employer. The descriptions in the sub-sections of the control & instrument sections shall also be referred to.
7.02.00	**Control Scheme for Air-Conditioning System**
7.02.01	All the functional requirements specified below and general control logic specified under this section shall be implemented in the respective control system.
7.02.02	The basic function of the system shall be to closely control and monitor temperature and humidity conditions inside the air-conditioned spaces, to optimize / minimize energy consumption by automated operation, to provide remote centralized monitoring & control for various mechanical facilities including sequential start/stop of the whole Air conditioning System, automatically calculate record and cooling load for each hour /day/season, to generate maintenance data & alarms, to maintain records of plant operation & energy consumption for varying loads, duty cycling to operate all the equipment including standby equipment for equal duration, automatic startup of standby equipment in case of failure of operating unit and displaying fault alarm status of the tripped unit, activating /deactivating water valves to startup/stop water flow through chiller/condenser circuit. For sequential operation /duty cycling, programmed startup/stop of individual AHU as per operating requirements and inside room temperature and humidity of "CR, CER, SWAS control room, UPS and Battery Charger room, etc.", "ESP control rooms & FGD control rooms" shall be maintained by controlling the chilled water flow by means of motor operated three way modulating valve at chilled water line, humidified system and duct heater.
7.02.03	For Service Building, inside room temperature and humidity shall be maintained by varying the chilled water flow of secondary chilled water pumps through VFD driven motor and by varying the air flow of AHU through VFD driven motor, humidified system and duct heater. For sequential operation/duty cycling, programmed startup/stop of individual AHU's, pumps and cooling towers as per operating requirements and inside room temperature and humidity. Adequate no's of VAV box shall be provided for optimum use of VFD driven AHUs. Adequate nos. of occupancy sensor shall be provided. CO2 sensor shall be provided in each AHU room to regulate the fresh air.
7.02.03	The operation of each Air Conditioning system shall be possible through Microprocessor based dedicated controllers to be provided by Contractor for each Screw /centrifugal Chiller units with local start / stop & indication for main plant A/C system in addition to Main DDCMIS based Control system of A/C plant for "Main plant area", "ESP control rooms and FGD control rooms" and Service Building. Further these microprocessor-based control panels of Chiller units shall be suitably interfaced with DDCMIS based Control panels.
7.02.04	Air-Conditioning system for "Water system control room" shall be controlled through microprocessor based Distributed Digital Control Monitoring and Information System (DDCMIS).
7.03.00	**Water Chilling Plant Control**
7.03.01	Microprocessor based controls shall be provided as per manufacturer's standard practice along with facilities to interface with control system and to meet the requirement of all system operations and controls. Water chilling unit control system shall be designed to have a constant chilled water outlet temperature from evaporator at all load condition by means of controlling ON-OFF thermostat (one for each compressor). The closure of liquid line solenoid valve and tripping of compressor at lower water temperature and opening of solenoid valve and starting of

	compressor at high water temperature set point shall be automatic through the thermostat. Between the above set points the compressor capacity shall be controlled automatically through cylinder "load-unload" mechanism activated through the suction pressure or return chilled water temperature.
7.03.02	Water chilling unit shall be equipped with superheat control of water chilling unit through thermostatic expansion valve which gets its impulse from temperature element connected with suction line after chiller outlet.
7.03.03	High discharge pressure cut-out and oil pressure (OP) differential cut-out shall be of manual reset type and low pressure cut-out shall be automatic reset type. The OP cut-out shall trip the compressor in case of low oil pressure.
7.03.04	Facility toggle switch to close the liquid refrigerant line solenoid valve shall be provided to shut the compressor by the operation of low pressure cut-out (after the refrigerant has been pumped to the condenser).
7.03.05	Switching of Crank case heaters shall be interlocked with starting and stopping/tripping of compressor motor. Further, the safety thermostat shall switch off the crank-case heater in the event temperature rises above safe limit.
7.03.06	Provision shall also be made for the manual restarting of the compressor.
7.03.07	On-off type anti-freeze thermostats, one for each chiller shall be provided in addition to the controlling on-off thermostat for safety purpose and shall act in the event of failure of on-off thermostat to close the liquid line solenoid valve and also to simultaneously trip the compressor.
7.03.08	Compressor starting/running shall be interlocked with the low / adequate flow at the outlet of each chiller and each condenser and as well as with pressure in the inlet of the condensers. In addition, closure or open status of various valves shall be used for interlock, alarm and control of Air Conditioning System.
7.03.09	Condenser water pumps shall be interlocked with the low - level switch in each cooling tower sump and operation of cooling tower fans. High level in the cooling tower shall be annunciated in the panel by means of a separate level switch.
7.03.10	The standby condenser water pumps, standby chilled water pumps & standby AHU shall be started automatically when the working equipments are stopped/ tripped. Auto/ Manual selecting and working/ standby selecting facility for the pumps/ AHU/ fresh air fan shall be provided.
7.03.11	Closure of fire dampers shall raise an alarm in the system.
7.03.12	There shall be provision for temperature and flow measurement in chilled water inlet and outlet line across AHUs to monitor the air conditioning load of each area.
7.03.13	Operation of air conditioning system shall be interlocked with the required minimum pressure and temperature of cooling tower at inlet to the condenser. Status indication of condenser water pumps and associated cooling towers shall be provided in the control panel of air conditioning plant.
7.04.00	**Air Handling Unit**
	a) Inside room temperature and humidity shall be maintained by controlling the chilled water flow by means of motor operated three way modulating valve and by varying the

flow by means of VFD driven AHU's which shall get its signal from the Control system for main plant A/C system and ESP/FGD control rooms A/C system.

b) Humidity sensor and gyserstat located in the return air duct shall actuate the PAN humidifier to obtain the desired degree of humidification.

c) Humidity and temp. sensor shall be provided and interlocked in steps with winter heater / re-heater / strip heaters for monsoon and winter re-heating or heating as the case may be.

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

e) AHU shall be started either locally or from the main control room of AC system by means of Remote / Manual selection facility.

f) The closure of fire dampers, automatic tripping of AHU fans and fresh air fans shall be interlocked with fire detection system.

g) Each AHU shall be provided with temperature indicators and pressure transmitter in the chilled water piping inlet and outlet to monitor the air-conditioning load of each area.

7.05.00 **D-X Air-Conditioning System**

a) The control and interlocks described above for water chilling plants are applicable for this system also.

b) Further the compressor starting/running shall be interlocked with the flow switches in condenser water (if applicable) circuit as well as with AHU motors.

c) The standby condenser water pumps (if applicable) & standby AHU shall be started automatically when the working equipments are stopped / tripped. Auto/ Manual selector Switches and working / standby selector switches for the pumps, fresh air fans and AHU shall be provided in the panel.

7.06.00 **Cassette /Hi-wall Split Air Conditioners**

Control and interlocks for these type of units shall be as per manufacturer's standard practice.

7.07.00 **Miscellaneous Control Requirements**

a) Separate emergency local stop push button shall be provided for each pump, compressor, fans etc. of A/C system.

b) Status shall be provided of each pump, compressor, fans etc. of A/C system and Ventilation system on HMI system at control room.

c) All the annunciations related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped/tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc. shall be provided for each pump, fan, compressor, AHU, PAC, etc. of centralized A/C system.

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

e) Relative humidity and temperature measurement of all control rooms, CERs and all major air-conditioned areas shall be available in DDCMIS. Relative humidity and temp. measurement for main plant control room and CERs to be available in multiple numbers.

8.00.00 PLANT CONTROL OF VENTILATION SYSTEM

8.01.00 GENERAL

CLAUSE NO.	TECHNICAL REQUIREMENTS
8.01.01	Brief scheme of controlling the operation is described below. Detailed description of the control system for safe and efficient operation of the plant shall be elaborated, got approved from Employer.
8.01.02	**Control Scheme of Ventilation System** The Ventilation system for main Plant area (excluding roof extraction fans, standalone Air supply and Air Exhaust fans) shall be controlled through microprocessor based Distributed Digital Control Monitoring and Information System (DDCMIS). This DDCMIS system shall perform all functions such as auto/manual operation of valves, pumps, drives, local/remote selection of operation, status indication, annunciation, interlock and protection of pumps/drives, etc.
8.02.00	**Air Washer Units (AWU) & Unitary Air Filtration Units (UAF)**
8.02.01	Air washer units shall be started/stopped by initiation from Main DDCMIS based control system of A/C plant (provided by contractor) for Main plant area and ESP/FGD control rooms. Starting/stopping of pumps shall be automatic upon such initiation.
8.02.02	The operation of the pumps shall be interlocked with the low level of water in the sump. High level of the sump shall be alarmed.
8.03.00	**Miscellaneous control requirements**
8.03.01	Separate emergency local stop push button shall be provided for each pump, fans, etc. of Ventilation system.
8.03.02	The status of each pump, centrifugal fans, etc. of centralized ventilation system is available on OWS in control room locally.
8.03.03	All the alarms related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped / tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, AWU etc. in the control system.
8.03.04	The fans (both supply and exhaust fans) associated with mechanical ventilation system shall be operated locally.
9.00.00	**PAINTING:**
9.01.00	All the Equipments shall be protected against external corrosion by providing suitable painting.
9.02.00	The surfaces of stainless steel, Galvanized steel, Gunmetal, brass, bronze and non-metallic components shall not be applied with any painting. The Contractor shall clean the external surfaces and internal surfaces before Erection by wire brushing and air blowing. The steel surface to be applied with painting shall be thoroughly cleaned before applying painting by brushing, shot blasting, etc. as per the agreed procedure.
9.03.00	For all the steel surfaces (external) exposed to atmosphere (outdoor installation), one (1) coat of red oxide primer of thickness 30 to 35 microns followed up with three (3) coats of synthetic enamel paint, with 25 microns as thickness of each coat, shall be applied. For plant at coastal area, epoxy resin-based zinc phosphate primer followed by epoxy resin-based paint pigmented with titanium di-oxide shall be used in place of enamel paints.

CLAUSE NO.	TECHNICAL REQUIREMENTS
9.04.00	For all the steel surfaces inside the building (indoor installation), One (1) Coat of red oxide primer of thickness 30 to 35 microns followed up with two (2) coats synthetic enamel paint, with 25 microns as thickness of each coat shall be applied. For plant at coastal area, epoxy resin-based zinc phosphate primer followed by epoxy resin based paint pigmented with titanium di-oxide shall be used in place of enamel paints.
9.05.00	For centrifugal fans/axial/Roof extractor fans - Casing shall have hot dip/ spray galvanization (**minimum** 60-micron DFT).
9.05.00	However for all parts coming in contact with acid fumes (in Battery rooms), a coat of epoxy resin-based zinc phosphate primer of minimum thickness 30 to 35 microns followed up with undercoat of epoxy resin-based paint pigmented with Titanium dioxide of minimum thickness of 25 microns shall be applied and a top coat consisting of one coat of epoxy paint of approved shade and color with glossy finish of minimum thickness of 25 microns.
9.07.00	Touch up painting shall be as per standard industrial practice.
10.00.00	Cooling Tower, Expansion Tank, Water Softening Plant (if required) of A/C System shall preferably be placed on the roof of respective building under open sky.

Annexure –I

GENERAL SPECIFICATION FOR HORIZONTAL PUMPS

Annexure –I

1) **SCOPE**

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

2) **CODES AND STANDARDS**

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

3) List of Applicable Standards.

IS : 1520 : Horizontal Centrifugal Pumps for clear cold fresh water
IS : 5120 : Technical requirements of roto dynamic special purpose pumps
API : 610 : Centrifugal pumps for general refinery service.
IS : 5639 : Pumps Handling Chemicals & corrosion liquids
IS : 5659 : Pumps for process water
HIS : Hydraulic Institute Standards, USA
ASTM-1-165-65 Standards Methods for Liquid Penetration Inspection.

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

4) **DESIGN REQUIREMENTS**

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

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

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

Annexure –I

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

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

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

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

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

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

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

5) **DESIGN CONSTRUCTION**

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

b) **Pump Casing**

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

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

Annexure –I

c) **Impeller**

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

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

d) **Impeller/Casing Wearing Rings**

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

e) **Shaft**

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

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

f) **Shaft Sleeves**

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

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

Annexure –I

g) **Bearings**

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

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

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

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

h) **Stuffing Boxes**

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

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

i) **Mechanical Seals**

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

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

k) **Pump Shaft Motor Shaft Coupling**

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

Annexure –I

l) **Base Plate**

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

m) **Assembly and Dismantling**

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

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

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

ANNEXURE-II

PIPING THICKNESS: Pipes for sizes 200 NB & above shall confirm to IS: 3589 Grade 410. The final thickness shall not be less then that specified as per IS: 3589 as indicated below.

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

ANNEXURE-III

I. DATA SHEET FOR WATER LINE GATE / SLUICE VALVES

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

II. DATA SHEET FOR GLOBE VALVES

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

III. DATA SHEET FOR CHECK VALVES

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

	d) Gaskets	———	Non-Asbestos

IV. DATA SHEET FOR BUTTERFLY VALVE

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

SUB–SECTION – E – 17

AIR CONDITIONING

AND

VENTILATION SYSTEM

CLAUSE NO.	QUALITY ASSURANCE
	AIR CONDITIONINGAND VENTILATION SYSTEM
1.00.00	**CHILLING UNIT**
1.01.00	**Refrigerant Compressor (Screw/Scroll)**
1.01.01	Hydraulic/Pneumatic test of castings of casings shall be carried out. No leakage shall be permitted.
1.01.02	DPT of screw, impeller, shaft, vanes, casing etc. after machining shall be carried out.
1.01.03	All rotating parts of screw and centrifugal compressor shall be dynamically balanced to ISO 1940 Gr. 6.3/IS 21940.
1.01.04	Leak tightness & vacuum check for chilling units / compressor in assembled condition shall be carried out. No leakage shall be permitted.
1.01.05	Performance test of assembled compressor and Chiller assembly shall be done to check for following : i) No load air run (free run) test of all types of compressor to check FAD (Free air delivery), Noise, Vibration & Temp. rise of bearing & body. ii) Functional run test for Chiller assembly shall be carried out.
1.02.00	**CONDENSER & EVAPORATOR**
1.02.01	DPT shall be carried out on welds if applicable.
1.02.02	10% RT of butt weld joint on shell shall be carried out if applicable.
1.02.03	Dimensional check including tube hole dia, ligament, pitch etc. shall be carried out.
1.02.04	Mock-up test of tubes to tube sheet expansion shall be carried out.In case such test is already carried out for similar tube/tube sheet thickness and materials, records for the same shall be furnished for NTPC review.
1.02.05	Hydraulic/Pneumatic test of Shell Side and Tube Side of condenser and evaporator as applicable shall be carried out. 'No leakage' shall be permitted.
2.00.00	**AIR HANDLING UNIT**
2.01.00	For Fans refer tests as mentioned at 4.00.00
2.02.00	One per type of assembled AHU (AHU casing and fan assembly) shall be subjected to free run test. Noise, Vibration and Temp. Rise of bearing shall be measured during run test.
2.01.00	All cooling coil shall be pneumatically tested and no leakage shall be permitted.
3.00.00	**CENTRIFUGAL PUMP**
3.01.00	UT on pump shaft (dia equal to or above 40 mm) and MPI/DPT on pump shaft and impeller after machining shall be carried out.
3.02.00	All rotating components of the pumps shall be dynamically balanced to ISO-1940 Gr. 6.3/IS 21940.
3.03.00	A standard hydrostatic test shall be conducted on the pump casing with water at 1.5 times the shut off pressure on the head characteristics curve or twice the rated pressure whichever is higher, for a minimum duration of 30 minutes.
3.04.00	Standard Running Test

CLAUSE NO.	QUALITY ASSURANCE
	i) All pumps shall be tested in the manufacturer's works preferably with contract motor (or as specified in Engg Tech spec) for capacity, efficiency, head and brake horse power. Pump shall be given running test over the entire operating range covering from the shut-off head to the maximum flow. The duration of test shall be minimum one (1) hr. A minimum of seven readings approximately equidistant shall be taken for plotting the curves with one point at design flow. Testing of pumps shall be in accordance with stipulations of Hydraulic Institute Standard (HIS) and/or as per applicable Indian Standard or equivalent. Acceptance norms shall be as per approved datasheet & HIS standard and/or as per applicable Indian Standard or equivalent only.
	ii) Noise and vibration shall be measured at shop for reference purpose only.
	iii) Pumps shall be subjected to strip down examination visually to check for mechanical damages after testing at shop in case abnormal noise level and/or excessive vibration are observed during the shop test.
	iv) NPSH test shall be conducted with water as the medium, if required as per approved data sheets.
4.00.00	**FANS:**
4.01.00	20% DPT of welding on fan hub, blades, casing and impeller as applicable shall be carried out.
4.02.00	DPT of fan shafts shall be carried out after machining.
4.03.00	UT of fan shafts (dia equal to or above 40mm) shall be carried out.
4.04.00	Rotating components of all fans shall be dynamically balanced to ISO-1940 Gr. 6.3/IS 21490
4.05.00	All Fans shall be subjected to run test for 4 hrs. or till temperature stabilization is reached. Vibration, Noise level, Temp. rise and current drawn shall be measured during the run test.
4.06.0	One fan of each type and size will be performance tested as per corresponding BIS code/ AMCA for Air flow, Static Pressure, Speed, Efficiency, Power Consumption, Noise, Vibration and Temp. Rise.
5.00.00	**LOW PRESSURE AIR DISTRIBUTION SYSTEM**
5.01.00	Functional test for fire damper along with solenoid shall be done.
5.02.00	Prototype tests report of fire damper (duly approved/accepted by ENGG) for each type and size as per UL-555 for fire rating shall be furnished.
5.03.00	Site Test- After completion, all ducting system shall be checked/tested for air leakages/tightness (smoke test) at site.
6.00.00	**INSULATION:**
6.01.00	Insulation material shall be tested for all mandatory tests only as per relevant code/standard.
6.02.00	Resin bonded mineral wool/Glass wool: Thermal conductivity tests (for thermal insulation only) shall be done the same density of material as applicable as per IS:3346 or equivalent standard//Engg spec.
6.03.00	XLPE/Nitrile Rubber: Thermal conductivity tests (for thermal insulation only) shall be done as per relevant code for the same density and thickness of material and validity of test shall be as per relevant standard/Engg spec.
7.00.00	**COOLING TOWER**
7.01.00	UT of fan shaft and drive shaft (dia equal to or above 40mm) shall be carried out.
7.02.00	DPT of fan hub and shafts shall be carried out after machining.
7.03.00	Color of fills shall be as per approved data sheet.

CLAUSE NO.	QUALITY ASSURANCE
7.04.00	Fan assembly shall be statically/dynamically balanced.
7.05.00	Cooling Towers being supplied to site in assembled condition shall be subjected to run test at shop to measure FAD, Noise & Vibration. For Cooling Towers being supplied in knocked-down condition, these tests shall be done at site
8.00.00	**AIR FILTERS:**
	Pre/Fine filters shall be tested for initial and final pressure drop Vs flow, efficiency and average synthetic dust weight arrestance as per the requirement of BS 6540/ASHARE-52-76/EN779. HEPA (Absolute) filters shall be tested as per applicable code.
9.00.00	**PIPES & FITTINGS:**
9.01.00	All pipes and fittings shall be tested as per applicable codes / standard.
9.02.00	Site test- Pipes shall be tested at site hydraulically/pneumatically as per application requirement
10.00.00	**VALVES & SPECIALTIES**
10.01.00	Visual and dimensional check of valves as per relevant codes and approved drawing.
10.02.0	All the water line valves shall be hydraulically tested for body, seat and back seat (wherever provided) as per the relevant standard to which these valves are supplied irrespective of the working pressure for which these valves are selected. Check valves shall also be tested for leak tightness test at 25% of the specified seat test pressure.
10.03.0	Refrigerant line valves shall be pneumatically tested for body and seat leakage test.
10.04.00	Valves shall be offered for hydro test and pneumatic test in unpainted condition.
10.05.0	Functional check of the valves for smooth opening and closing shall be done.
10.06.0	Performance test to check pressure drop Vs flow shall be carried out for one valve of each type, size and rating for 'Balancing Valve'/Globe Valves with orifice.
11.00.00	**SPLIT, CASSETTE, WINDOW, PRECISION/PACKAGED AC (PAC) & CONDENSING UNITS**
11.01.00	Split/Cassette/ Window AC/PAC will be accepted on the basis of Manufacturer Standard Guarantee and Warrantee certificate.
11.02.00	PAC/Condensing unit: Each Unit shall be subjected to production routine Test as per relevant standard.
11.03.00	Capacity, noise level and vibration of PAC/ Condensing unit shall be demonstrated as per relevant standard on one unit of each type and rating.
12.00.00	**Air Washer and Unitary Air Filter (UAF)**
12.01.00	Random 10% DPT on weld joints shall be carried out.
12.02.00	Hydraulic test of pressure parts at 1.5 times the design or 2 times of working pressure whichever is higher. Pressure and water fill test of tanks shall be carried out.
12.03.00	Trial assembly of Air washer/UAF for one of each size shall be done in shop.
12.04.00	Performance test to check pressure drop Vs flow shall be carried out for one Nozzle of each type, size and rating.

C) LOW PRESSURE PIPING													
1	All Piping, fittings / components, valves, Equipments etc.	SP3/SP5	PS3/ PS5	2	25	PS 4	1	30	PS 4	2	35	150	As per DVC Color shade/ coding scheme.
2	Stainless steel surface, Galvanized steel surface and gun metal surface.	No Painting											
3	On the internal surface for pipes 1000 Nb and above	A coat of primer followed by hot coal-tar enamel or coal tar epoxy painting (cold) shall be applied.											
D) Fire Detection & Protection System, Compressed air system and Air-conditioning & Ventilation System													
For Fire Detection & Protection System, Surface preparation and painting of Fire Water Storage Tanks, all Steel Surfaces (external) exposed to atmosphere (outdoor & indoor installation), Deluge Valves, Alarm Valves, Foam monitors, Water monitors, Foam Proportioning equipments, Foam makers, etc. should be as per the Part-B, Sub Section-A-18, Fire Detection & Protection System For Air Conditioning System, Surface preparation and painting of all the steel surfaces (external) exposed to atmosphere (outdoor & indoor installation), centrifugal fans – Casing etc. should be as per the Part-B, Sub Section-A-17, Air Conditioning System. For Ventilation System, Surface preparation and painting of all the steel surfaces (external) exposed to atmosphere (outdoor & indoor installation), centrifugal fans – Casing etc. should be as per the Part-B, Sub Section-A-17, Ventilation System. For compressed air system, Surface preparation and painting of all the steel surfaces should be as per the Part-B, Sub Section--A-16 compressed air system.													
E) ESP													
1	All surfaces with surface temperature 95°C or less (with or without insulation)	SP3/SP4	PS3/ PS3*	1	25	-	-	-	PS 4	1	30	55	
2	All surfaces with surface temperature above 95°C (with or without insulation)	SP3/SP4	PS5	2	30	-	-	-	-	-	-	60	

SECTION: I

SUB-SECTION: C 2
PART-B

CUSTOMER SPECIFICATION
PROJECT SPECIFIC GENERAL REQUIREMENTS

DAMODAR VALLEY CORPORATION

KODERMA THERMAL POWER STATION
PHASE-II (2x800 MW)

TECHNICAL SPECIFICATION

FOR

EPC PACKAGE

PART - C

(GENERAL TECHNICAL REQUIREMENTS)

BIDDING DOCUMENT NO.: DVC/C&M/Engineering/KTPS(2X800 MW)/EPC/IPHB

(This document is meant for the exclusive purpose of bidding against this Package and shall not be transferred, reproduced or otherwise used for purposes other than that for which it is specifically issued).

PART - C

GENERAL TECHNICAL REQUIREMENTS

1.00.00 **INTRODUCTION**

This part covers technical requirements which will form an integral part of the Contract. The following provisions shall supplement all the detailed technical 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 NOT USED.

4.00.00 **COMPLETENESS OF FACILITIES**

4.01.00 Bidders may note that this is a EPC Package 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 personnel, as required by applicable codes, though they may not have been specifically detailed in the respective specifications, unless included in the list of exclusions.

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

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

5.00.00 **CODES & STANDARDS**

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

a) Indian Electricity Act

b) Indian Electricity Rules

c) Indian Explosives Act

d) Indian Factories Act and State Factories Act

e) Indian Boiler Regulations (IBR)

f) Regulations of the Central Pollution Control Board, India

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

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

i) State Pollution Control Board.

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

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

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

(m) Explosive Rules, 1983

(n) Petroleum Act, 1984

(o) Petroleum Rules, 1976,

(p) Gas Cylinder Rules, 1981

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

(r) Workmen's Compensation Act, 1923

(s) Workmen's Compensation Rules, 1924

(t) DVC Safety Rules for Construction and Erection

(u) DVC Safety Policy

(v) CERC (Indian Electricity Grid Code) Regulations, 2023

(w) CEA (Flexible Operation of Coal Based Thermal Power Generating Units) Regulations, 2023

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

5.02.00 Unless covered otherwise in the specifications, the latest editions (as applicable at the date fifteen (15) days prior to the date of bid submission), of the codes and standards given below shall also apply:

a) Bureau of Indian standards (BIS)

b) Japanese Industrial Standards (JIS)

c) American National Standards Institute (ANSI)

d) American Society of Testing and Materials (ASTM)

e) American Society of Mechanical Engineers (ASME)

f) American Petroleum Institute (API)

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

h) International Organization for Standardization (ISO)

i) Tubular Exchanger Manufacturer's Association (TEMA)

j) American Welding Society (AWS)

k) National Electrical Manufacturers Association (NEMA)

l) National Fire Protection Association (NFPA)

m) International Electro-Technical Commission (IEC)/ European Norm (EN)

n) Expansion Joint Manufacturers Association (EJMA)

o) Heat Exchange Institute (HEI)

p) IEEE standard

q) JEC standard

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

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

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

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

5.07.00 In case of any change in codes, standards & regulations between the date fifteen (15) days prior to the date of bid submission 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.

5.08.00 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 as indicated in this Part C and elsewhere in the specification.

6.00.00 **EQUIPMENT FUNCTIONAL GUARANTEE**

6.01.00 The functional guarantees of the equipment under the scope of the Contract is given in Section-VI Part - A & B of Technical 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 AVILABILITY CONSIDERATIONS

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

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

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

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

8.00.00 DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY CONTRACTOR

8.01.00 Bidders may note that this is an **EPC Package 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, civil & structural works as per the scope.

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

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

A comprehensive engineering and quality coordination procedure shall be finalized with the successful bidder covering salient features as described in this section of specifications.

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

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

8.03.01 A) **BASIC ENGINEERING DOCUMENTATION**

Prior to commencement of the detailed engineering work, the Contractor shall furnish a Plant Definition Manual within 12 weeks from the date of the Notification of Award. This manual shall contain the following as a minimum:

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

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

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

iv) Optimization studies including thermal cycle optimization.

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

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

vii) Water Balance diagram.

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

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

x) Basic layouts and cross sections of the main plant building (various floor elevations), boiler, fuel oil area, transformer yard, switchyard and other areas included in the scope of the bidder.

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

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

B) **DETAILED ENGINEERING DOCUMENTS**

i) General layout plan of the station.

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

iii) Flow diagram, Process and Instrumentation diagrams along with write up and system description.

iv) Start-up curves for boiler and both turbines and boiler combined together as a unit for various start-ups, viz. Cold, Warm and Hot start up.

v) Piping isometric, composite layout and fabrication drawings, design philosophy & design parameter selection for each piping system, Pressure drop calculation & flash tank sizing calculation.

vi) Piping engineering diagrams, pipe and fittings schedules, System-wise or P&ID wise prepared pipe schedule, valve schedule, insulation schedule, hanger and support schedule and Piping isometric /

fabrication isometric drawings for pipe size 65mm NB and above with BOM, Painting schedule. Hanger / support arrangement drawing with BOM, Valve GA drawings, Layout drawings for site routed piping (i.e. for pipe sizes below 65NB) along with BOM (and submission of the same to the employer / project manager before start of work) and System wise stress analysis / dynamic analysis report (including input) along with stress isometric drawing / sketch marked with node points. Also As-Built drawing for information & Records: (i) Piping fabrication isometric drawing (ii) composite piping layout drawing (iii) Hanger / Support arrangement drawing.

vii) 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.

viii) Detailed design calculations for components, system, piping etc., wherever applicable including sizing calculations for all auxiliaries like Mills, Fans, BFPs, CEPs, Heaters/ Deaerators, Water cooled Condensers, Vacuum pumps etc.

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

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

xi) Thermal cycle information (heat balance diagrams, boiler performance calculations, condenser, design ramp rates of SG and TG and heat exchanger thermal calculations etc.).

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

xiii) Comprehensive list of all Terminal Points which interface with Employer's facilities, giving details of location, terminal pressure, temperature, fluid handled & end connection details, forces, moments etc.

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

xv) Protection system diagrams and relay settings.

xvi) Cables schedules and interconnection diagrams.

xvii) Cable routing plan.

xviii) 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.

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

xx) Sequence and protection interlock schemes.

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

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

xxiii) Detailed DDCMIS system manuals.

xxiv) Detailed flow chart for digital control system.

xv) Mimic diagram layout, Assignment for other application engg.

xxvi) Civil and Structural works drawings and documents for all structures, facilities, architectural works, foundations underground and overground works and super-structural works as included in the scope of the bidder civil calculation sheets including structural analysis and design alongwith output results.

xxvii) Underground facilities, levelling, sanitary, land scaping drawings.

xxviii) Geotechnical investigation and site survey reports (if and as applicable).

xxix) Model study reports wherever applicable.

xxx) Functional & guarantee test procedures and test reports.

xxxi) Documentation in respect of Quality Assurance System, and Documentation in respect of Commissioning, as listed out elsewhere in this specification.

xxxii) BOP documents such as P&IDs, Sizing calculations for various equipment's, performance curves, datasheet etc. (For CHP, AHP, PU, Water System etc.) shall be as per MDL.

xxxiii) Bidder shall submit all tabulated design calculations/ data (e.g. Pipe schedule, valve schedule, etc.), in both EXCEL format as well as in PDF format to enable DVC for fast review /approval.

8.03.02 **INSTRUCTION MANUALS**

The Contractor shall submit to the Employer, draft Instruction Manuals for all the equipments covered under the Contract by the end of one year from the date of 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-IV.** 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 at least three (3) months prior to the commencement of erection activities of a 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 tools, tackles, heavy equipments like cranes, dozers, etc.

f) Bill of Materials

g) Procedure for erection and General Safety procedures to followed during erection/installation.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(b) Limiting values of all protection settings.

(c) Various settings of annunciation/interlocks provided.

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

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

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

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

(h) Equipment isolating procedures.

(i) Trouble shooting with causes and remedial measures.

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

(k) Routine Operational Checks, Recommended Logs and Records

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

(m) Preservation procedure on long shut down.

(n) System/plant commissioning procedure.

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

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

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

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

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

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

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

(g) Long term maintenance schedules

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

(i) List of lubricants with their Indian equivalent, Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation and quantity required for complete replacement.

(j) Tolerance for fitment of various components.

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

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

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

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

Signature Not Verified
Digitally signed by ANCHAL CHOUDHARY
Date: 2025.12.20 14:55:38 IST
Location: BHEL