NTPC LIMITED

3X660 MW NABINAGAR TPP
(FGD SYSTEM PACKAGE)

TECHNICAL SPECIFICATION

FOR

HVAC SYSTEM

SPECIFICATION NO.: - PE-TS-457- (571-13000-A)-A001 (REV-0)

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

	TITLE: 3X660 MW NABINAGAR TPP (FGD SYSTEM PACKAGE) TECHNICAL SPECIFICATIONS FOR HVAC SYSTEM	SPECIFICATION No: PE-TS-457-(571-13000-A)-A001
		SECTION
		REV. 00
		SHEET : 1 OF 2

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	TITLE: 3X660 MW NABINAGAR TPP (FGD SYSTEM PACKAGE) TECHNICAL SPECIFICATIONS FOR HVAC SYSTEM	SPECIFICATION No: PE-TS-457-(571-13000-A)-A001
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SECTION - II

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SECTION - I

	3X660 MW NABINAGAR TPP (FGD SYSTEM PACKAGE) INTENT OF SPECIFICATION	SPECIFICATION No: PE-TS-457-(571-13000-A)-A001
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SECTION-I

SUB-SECTION-A

INTENT OF SPECIFICATION

	3X660 MW NABINAGAR TPP (FGD SYSTEM PACKAGE) INTENT OF SPECIFICATION	SPECIFICATION No: PE-TS-457-(571-13000-A)-A001
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1.0 INTENT OF SPECIFICATION

1.1 The specification covers design, engineering, manufacture, supply / procurement, inspection and testing at vendor's / sub vendor's / manufacturer's works, painting, forwarding, proper packing and shipment and delivery at site, unloading, handling & transportation, storage, preservation, security / safety at site, Erection & Commissioning, minor civil & structural (as applicable) works as required on FOR site basis, Performance and guarantee testing / demonstration testing and handing over to BHEL's customer of **HVAC SYSTEM** as per details in different sections / volumes of this specification and various pre-award agreements for **3X660 MW NABINAGAR TPP (FGD SYSTEM PACKAGE)**.

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

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

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

1.8 Deviations, if any, should be very clearly brought out clause by clause along with cost of withdrawal in the format attached with GCC (Annexure-II Deviation sheet (Cost of withdraw), otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification.

1.9 In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, "Section - C shall prevail over section – D", "section C1A (BHEL section C & C1B (Customer spec), later shall supersede, however more stringent requirement as per the interpretation of the owner shall apply.

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

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

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SUB-SECTION: B

PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA

SUB-SECTION-II-A8

PROJECT INFORMATION- NABINAGAR-I 3X660 MW

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1.00.00	**BACKGROUND** A Joint Venture Agreement was signed between NTPC and BSEB/ Govt. of Bihar on 14.02.2008 for Establishment and Operation & Maintenance of 3x660 MW capacity coal based thermal power project near Nabinagar Distt Aurangabad Bihar and thereafter a Joint Venture company namely, Nabinagar Power Generating Company Private Limited (NPGCPL) was incorporated with equity structure of 50% each by NTPC and BSEB on 09.09.2008.The project shall be a mega project and shall be implemented during XII Plan period.
1.01.00	**Location** The plant is located in Aurangabad district of Bihar at a distance of about 15 kms. from Barun in Aurangabad district of Bihar and is approachable from NH-2 through a 20 kms (approx.) long single lane metalled road. The Aurangabad city is about 55 kms. from project site. Nearest railway station is Ankorha on Sone – Garwa Road Section of Eastern Central Railway at about 1.0 Kms. from the project site. **Airport** The nearest airport at Gaya is at a distance of about 120 Kms from project site. The distances of site from Patna Airport and Varansi Airport are about 250 Kms & 220 Kms respectively. Vicinity plan of the proposed project is placed at **Annexure -I**
1.02.01	**Land** About 2500 acres of land required for the project (main plant, township, ash disposal areas and corridors etc.) has been identified. Govt. of Bihar have accorded in-principle clearance for availability of land vide letter dated 15.06.2007 and 27.02.2009.
1.02.02	**Coal** Coal requirement for the project is estimated about 11.25 million tonnes/annum corresponding to 90% PLF. Likely coal source for the project is North Karanpura coalfields of CCL. Application for Long Term Coal Linkage has been submitted to Ministry of Coal, Govt. of India on 21.06.2007 & 06.10.2008.
1.02.03	**Water** The project site is located near the river Sone and the make up water requirement for the project is proposed to be drawn from the pondage created by Indrapuri Barrage on river Son, which is about 3 kms from the proposed site. Make up water requirement for this project would be about 7550 Cu.M/hr with ash water recirculation system and about 8480 Cu.M/hr with once through ash water system.

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	Govt. of Bihar has accorded water commitment for availability of 125 cusecs of water vide letter dated 06.06.2007.
1.03.00	**Railway Siding** Employer intends to construct the Railway siding to project site from the nearest existing railway line. However, the same may not be available to the bidder for his use to transport equipment & material. Bidder may visit the site and acquaint themselves with the facilities available.
1.04.00	(i) **Coal Quality Parameters / Fuel Oil Characteristics & Plant Water details:** The coal quality parameters and Fuel oil Characteristics are indicated in Table-1 & Table-2A & 2B resp. below. **Water data** (ii) Process water: Source: Terminal point: Process water quality is based on COC given in Table-3. (iii) Clarified water: Terminal point: Clarified water quality is indicated in Table-3. (iv) DM water for Equipment cooling water system. Terminal point: DM water quality is indicated in Table-4.
1.05.00	**Steam Generator and ESP data:** refer Table-5.
1.06.00	Drawings are enclosed as per **Table-6** for initial overview to the Bidder.
2.00.00	NOT USED
3.00.00	**Capacity : 3 x 660 MW**
4.00.00	**Metrological Data** Important meteorological data from nearest observatory at Dehri is placed at Annexure -II.
5.00.00	**CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT** All structures and equipment shall be designed for seismic forces adopting the site specific seismic information provided in this document and using the other provisions in accordance with IS:1893 (Part 1 to Part 4). Pending finalization

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	of Part 5 of IS:1893, provisions of part 1 shall be read along with the relevant clauses of IS:1893:1984, for embankments. A site specific seismic study has been conducted for the project site. The peak ground horizontal acceleration for the project site, the site specific acceleration spectral coefficients (in units of gravity acceleration 'g') in the horizontal direction for the various damping values and the multiplying factor (to be used over the spectral coefficients) for evaluating the design acceleration spectra are as given at Appendix-I. Vertical acceleration spectral values shall be taken as 2/3rd of the corresponding horizontal values. The site specific design acceleration spectra shall be used in place of the response acceleration spectra, given at figure-2 in IS:1893 (Part 1) and Annex B of IS:1893 (Part 4). The site specific acceleration spectra along with multiplying factors specified in Appendix-I includes the effect of the seismic environment of the site, the importance factor related to the structures and the response reduction factor. Hence, the design spectra do not require any further consideration of the zone factor (Z), the importance factor (I) and response reduction factor (R) as used in the IS:1893 (Part 1 to Part 4). **Damping in Structures** The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for: a) Steel structures : 2% b) Reinforced Concrete structures : 5% c) Reinforced Concrete Stacks : 3% d) Steel stacks : 2% **Method of Analysis** Since most structures in a power plant are irregular in shape and have irregular distribution of mass and stiffness, dynamic analysis for obtaining the design seismic forces shall be carried out using the response spectrum method. The number of vibration modes used in the analysis should be such that the sum total of modal masses of all modes considered is at least 90 percent of the total seismic mass and shall also meet requirements of IS:1893 (Part 1). Modal combination of the peak response quantities shall be

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	performed as per Complete Quadratic Combination (CQC) method or by an acceptable alternative as per IS:1893 (Part 1). In general, seismic analysis shall be performed for the three orthogonal (two principal horizontal and one vertical) components of earthquake motion. The seismic response from the three components shall be combined as specified in IS:1893 (Part 1). The spectral acceleration coefficient shall get restricted to the peak spectral value if the fundamental natural period of the structure falls to the left of the peak in the spectral acceleration curve. For buildings, if the design base shear (V_B) obtained from modal combination is less than the base shear ($\bar{V}_B$) computed using the approximate fundamental period (T_a) given in IS:1893:Part 1 and using site specific acceleration spectra with appropriate multiplying factor, the response quantities (e.g. member forces, displacements, storey forces, storey shears and base reactions) shall be enhanced in the ratio of $\bar{V}_B$/ V_B. However, no reduction is permitted if $\bar{V}_B$ is less than V_B. For regular buildings less than 12m in height, design seismic base shear and its distribution to different floor levels along the height of the building may be carried out as specified under clause 7.5, 7.6 & 7.7 of IS:1893 (Part 1) and using site specific design acceleration spectra. The design horizontal acceleration spectrum value (Ah) shall be computed for the fundamental natural period as per clause 7.6 of IS:1893 (Part 1) using site specific spectral acceleration coefficients with appropriate multiplying factor given in Appendix-I. **Design/Detailing for Ductility for Structures** The site specific design acceleration spectra is a reduced spectra and has an in-built allowance for ductility. Structures shall be engineered and detailed in accordance with relevant Indian/International standards to achieve ductility.

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APPENDIX – I

SITE SPECIFIC SEISMIC PARAMETERS FOR DESIGN OF STRUCTURES AND EQUIPMENT

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

1) Peak ground horizontal acceleration : 0.16g

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

a) for ordinary moment resisting steel frames designed and detailed as per IS:800 : 0.04

b) for braced steel frames designed and detailed as per IS:800 : 0.03

c) for special moment resisting RC frames designed and detailed as per IS:456 and IS:13920 : 0.024

d) For RCC chimney : 0.08

e) For Liquid retaining tanks : 0.048

d) for Steel chimney and Absorber tower : 0.06

d) for design of structures not covered under 2 (a) to 2 (f) above and under 3 below : 0.04

3) Multiplying factor to be applied to the site specific horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') for design of equipment and structures where inelastic action is not relevant or not permitted : 0.08

Note: g = Acceleration due to gravity

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

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HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS
In units of 'g' for BRBCL project

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
0.000	1.000	1.000	1.000
0.030	1.000	1.000	1.000
0.050	1.750	1.607	1.443
0.100	3.737	3.060	2.374
0.104	3.904	3.174	2.443
0.123	3.904	3.401	2.753
0.150	3.904	3.401	2.753
0.200	3.904	3.401	2.753
0.250	3.904	3.401	2.753
0.300	3.904	3.401	2.753
0.350	3.904	3.401	2.753
0.400	3.904	3.401	2.753
0.450	3.904	3.401	2.753
0.500	3.904	3.401	2.753
0.516	3.904	3.401	2.753
0.550	3.662	3.401	2.753
0.600	3.357	3.142	2.753
0.607	3.320	3.105	2.753
0.670	3.006	2.813	2.493
0.700	2.877	2.693	2.386
0.750	2.685	2.513	2.227
0.800	2.518	2.356	2.088
0.850	2.369	2.218	1.965
0.900	2.238	2.094	1.856
0.950	2.120	1.984	1.758
1.000	2.014	1.885	1.670
1.050	1.918	1.795	1.590
1.100	1.831	1.714	1.518
1.150	1.751	1.639	1.452
1.200	1.678	1.571	1.392
1.250	1.611	1.508	1.336
1.300	1.549	1.450	1.285
1.350	1.492	1.396	1.237
1.400	1.439	1.346	1.193
1.450	1.389	1.300	1.152
1.500	1.343	1.257	1.113
1.550	1.299	1.216	1.077

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HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS
In units of 'g' for BRBCL project

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
1.600	1.259	1.178	1.044
1.650	1.221	1.142	1.012
1.700	1.185	1.109	0.982
1.750	1.151	1.077	0.954
1.800	1.119	1.047	0.928
1.850	1.089	1.019	0.903
1.900	1.060	0.992	0.879
1.950	1.033	0.967	0.856
2.000	1.007	0.943	0.835
2.050	0.982	0.920	0.815
2.100	0.959	0.898	0.795
2.150	0.937	0.877	0.777
2.200	0.915	0.857	0.759
2.250	0.895	0.838	0.742
2.300	0.876	0.820	0.726
2.350	0.857	0.802	0.711
2.400	0.839	0.785	0.696
2.450	0.822	0.769	0.682
2.500	0.806	0.754	0.668
2.550	0.790	0.739	0.655
2.600	0.775	0.725	0.642
2.650	0.760	0.711	0.630
2.700	0.746	0.698	0.619
2.750	0.732	0.685	0.607
2.800	0.719	0.673	0.596
2.850	0.707	0.661	0.586
2.900	0.694	0.650	0.576
2.950	0.683	0.639	0.566
3.000	0.671	0.628	0.557
3.050	0.660	0.618	0.548
3.100	0.650	0.608	0.539
3.150	0.639	0.598	0.530
3.200	0.629	0.589	0.522
3.250	0.620	0.580	0.514
3.300	0.610	0.571	0.506
3.350	0.601	0.563	0.499
3.400	0.592	0.554	0.491
3.450	0.584	0.546	0.484

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HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS
In units of 'g' for BRBCL project

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
3.500	0.575	0.539	0.477
3.550	0.567	0.531	0.470
3.600	0.559	0.524	0.464
3.650	0.552	0.516	0.458
3.700	0.544	0.509	0.451
3.750	0.537	0.503	0.445
3.800	0.530	0.496	0.439
3.825	0.527	0.493	0.437
3.850	0.523	0.490	0.434
3.900	0.516	0.483	0.428
3.950	0.510	0.477	0.423
4.000	0.504	0.471	0.418

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

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

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

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

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

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

It should be estimated if size and relative position of other structures are likely to enhance the wind loading on the structure under consideration. Enhancement

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	factor, if necessary, shall suitably be estimated and applied to the wind loading to account for the interference effects. **Damping in Structures** The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for: a) Welded steel structures : 1.0% b) Bolted steel structures : 2.0% c) Reinforced concrete structures : 1.6% d) Steel stacks : As per IS:6533 & CICIND Model Code whichever is more critical. **ANNEXURE-B** **SITE SPECIFIC DESIGN PARAMETERS** The various design parameters, as defined in IS: 875 (Part-3), to be adopted for the project site shall be as follows: a) The basic wind speed "V_b" at ten metres above the mean ground level : 47 M /SEC b) The risk coefficient "K_1" : 1.07 c) Category of terrain : Category-2
7.00.0	**FOUNDATION SYSTEM AND GEOTECHNICAL DATA**
7.00.01	Geotechnical data and foundation system for the respective project are enclosed at annexure-III. The corresponding bore logs are enclosed at annexure-IV.
7.00.02	The available soil data is of vicinity of proposed structures, therefore, bidder shall carryout his own detailed soil investigation for facilities under this package and shall be as per the scheme approved by owner**.** The scheme for geotechnical investigation shall be as given at Clause 7.07.00 and shall be approved by owner before execution. Geotechnical investigation work shall got executed by the Contractor through the agencies as mentioned in Clause No. 7.07.03. However, no time extension shall be given on account of soil investigation carried out by the Bidder. The geotechnical investigation report shall be prepared with detailed recommendations regarding type of foundation and allowable bearing pressure for various structures/ facilities and other soil parameters. The report shall be submitted for Owner's approval prior to commencement of design of foundation.
7.00.03	The Bidder should note that nothing extra whatsoever on account of variation between soil data collected by Owner and that found by the Bidder during geotechnical investigation by him or during execution of works, shall be payable.

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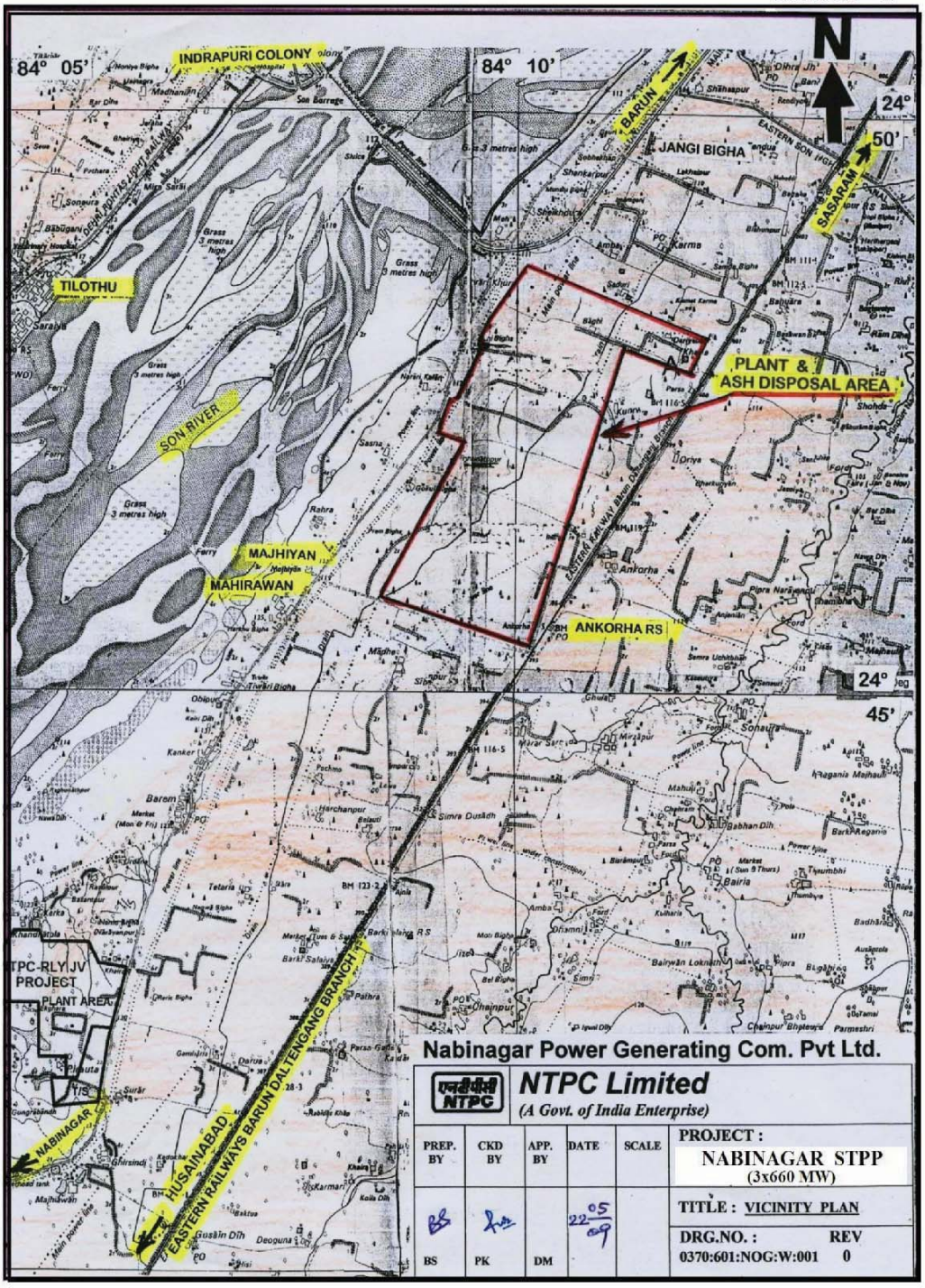
ANNEXURE – I

EXHIBIT - 1



ANNEXURE –II

ANNEXURE - I
SHEET 1 OF 2

जलवायवी सारणी
CLIMATOLOGICAL TABLE

स्टेशन : डेहरी
STATION : Dehri

अक्षांश LAT 24°55′ N   देशांतर LONG 84°11′ E

समुद्री तल माध्य से ऊँचाई HEIGHT ABOVE M. S. L.   मीटर 107 METRES

1951 से 1980 तक के प्रेक्षणों पर आधारित
BASED ON OBSERVATIONS FROM 1951 TO 1980

वायु तापमान / AIR TEMPERATURE (माध्य / MEAN; चरम / EXTREMES)

माह MONTH		स्टेशन का सतह दाब STATION LEVEL PRESSURE (एच. पी. ए. hPa)	शुष्क बल्ब DRY BULB (डि.सें. °C)	नम बल्ब WET BULB (डि.सें. °C)	दैनिक अधिक तम DAILY MAX (डि.सें. °C)	दैनिक न्यून तम DAILY MIN (डि.सें. °C)	माह में उच्चतम HIGHEST IN THE MONTH (डि.सें. °C)	माह में निम्नतम LOWEST IN THE MONTH (डि.सें. °C)	उच्चतम HIGHEST (डि.सें. °C)	दिनांक और वर्ष DATE AND YEAR	निम्नतम LOWEST (डि.सें. °C)	दिनांक और वर्ष DATE AND YEAR
जनवरी JAN	I	1004.9	15.1	12.6	23.8	10.1	27.8	6.1	30.6	28 1958	-1.0	18 1977
	II	1001.4	21.5	15.3								
फरवरी FEB	I	1002.5	18.5	14.3	27.1	12.9	32.2	8.3	35.3	23 1964	3.0	15 1974
	II	998.9	25.3	16.8								
मार्च MAR	I	999.3	24.5	17.2	33.2	17.7	38.5	12.7	41.5	31 1973	6.8	03 1976
	II	995.1	31.5	19.0								
अप्रैल APR	I	995.2	30.9	20.2	38.9	23.1	42.7	17.8	44.4	23 @ 1973	10.3	04 1976
	II	990.8	36.9	21.6								
मई MAY	I	990.7	33.3	23.2	41.1	26.2	44.7	21.3	46.7	21 1951	12.8	16 1976
	II	986.5	38.8	23.9								
जून JUN	I	987.0	32.2	25.8	38.5	26.7	44.0	22.7	47.2	09 1966	14.8	15 1976
	II	983.5	35.5	26.1								
जुलाई JUL	I	987.2	29.2	26.5	33.4	25.2	37.8	22.4	42.2	01 1962	15.3	15 1976
	II	984.3	31.1	27.0								
अगस्त AUG	I	988.6	28.6	26.6	32.3	25.0	35.0	22.7	39.4	03 1972	15.8	25 1976
	II	985.4	30.2	27.1								
सितम्बर SEP	I	992.7	28.5	25.9	32.2	24.4	34.9	22.0	37.1	12 1979	14.0	19 1976
	II	989.0	29.9	26.5								
अक्तूबर OCT	I	998.8	26.6	23.1	31.9	20.9	34.4	16.7	37.1	14 1974	9.3	31 1976
	II	995.2	29.3	24.2								
नवम्बर NOV	I	1003.2	21.3	17.5	29.2	14.6	31.9	10.7	35.1	07 1977	2.8	30 1975
	II	999.7	26.0	19.6								
दिसम्बर DEC	I	1005.3	16.2	13.6	25.1	10.9	28.2	7.1	31.7	01 1952	0.3	22 1976
	II	1001.7	22.3	16.1								
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	I	996.3	25.4	20.6	32.2	19.8	45.1	5.4	47.2		-1.0	
	II	992.6	29.9	21.9								
वर्षों की सं NUMBER OF YEARS	I	30	30	30	30	30	30	30	36		36	
	II	30	30	30								

आर्द्रता / HUMIDITY; मेघ की मात्रा / CLOUD AMOUNT; वर्षा / RAINFALL

माह MONTH		सापेक्ष आर्द्रता RELATIVE HUMIDITY (प्रतिशत %)	वाष्प दाब VAPOUR PRESSURE (एच.पी.ए. hPa)	समस्त मेघ ALL CLOUDS (Oktas of sky)	निम्न मेघ LOW CLOUDS (Oktas of sky)	मासिक योग MONTHLY TOTAL (मि.मि. mm)	वर्षा के दिनों की संख्या NO. OF RAINY DAYS	वर्षासहित सबसे नम महीने का योग TOTAL IN WETTEST MONTH WITH YEAR (मि.मि. mm)	वर्षासहित शुष्कतम महीने का योग TOTAL IN DRIEST MONTH WITH YEAR (मि.मि. mm)	24 घंटों की सबसे भारी वर्षा HEAVIEST FALL IN 24 HOURS (मि.मि. mm)	दिनांक और वर्ष DATE AND YEAR	माध्य पवन गति MEAN WIND SPEED (कि.मी. प्र. घं. Kmph)
जनवरी JAN	I	74	12.7	1.7	0.9	17.5	1.7	94.0 1930	0.0	65.0	27 1950	3.9
	II	49	12.5	1.6	1.1							
फरवरी FEB	I	62	12.9	1.5	0.7	11.2	1.3	103.9 1907	0.0	52.6	05 1915	4.9
	II	40	12.5	1.3	0.7							
मार्च MAR	I	46	13.7	1.6	0.5	11.7	1.2	88.9 1944	0.0	43.7	16 1944	5.8
	II	27	12.0	1.3	0.8							
अप्रैल APR	I	35	15.2	1.3	0.3	7.2	0.7	48.3 1914	0.0	43.2	08 1914	6.6
	II	22	13.3	1.3	0.4							
मई MAY	I	41	20.2	1.2	0.4	16.8	1.2	103.4 1914	0.0	96.0	31 1914	6.6
	II	27	17.7	1.1	0.3							
जून JUN	I	61	28.2	3.9	2.0	109.5	6.0	505.4 1961	0.0	220.0	13 1961	6.4
	II	49	26.3	4.3	2.7							
जुलाई JUL	I	81	32.5	6.4	4.8	315.2	14.5	655.6 1922	55.1 1903	202.4	01 1925	5.8
	II	73	32.5	6.3	4.9							
अगस्त AUG	I	85	33.0	6.2	4.9	277.8	15.0	748.3 1948	78.6 1979	254.5	14 1910	4.9
	II	79	33.4	6.2	5.1							
सितम्बर SEP	I	81	31.4	4.8	3.6	193.7	9.4	771.7 1976	25.1 1928	218.4	12 1936	4.6
	II	77	32.0	4.9	3.8							
अक्तूबर OCT	I	73	25.5	1.9	1.2	48.0	3.1	240.3 1928	0.0	153.7	06 1928	3.2
	II	65	26.1	1.9	1.3							
नवम्बर NOV	I	68	17.3	1.3	0.5	7.7	0.4	105.2 1915	0.0	100.8	19 1915	2.8
	II	53	18.0	1.0	0.5							
दिसम्बर DEC	I	74	13.7	1.3	0.4	4.9	0.6	47.7 1913	0.0	21.6	21 1940	3.1
	II	49	13.1	1.2	0.4							
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	I	65	21.4	2.8	1.7	1038.9	55.1	1789.8	530.1	254.5		4.9
	II	51	20.8	2.7	[illegible]			1961	1966			
वर्षों की सं NUMBER OF YEARS	I	30	30	30	23	28	28	78	78	78		30
	II	30	30	30	22							

ANNEXURE - I
SHEET 2 OF 2

जलवायवी सारणी
CLIMATOLOGICAL TABLE

स्टेशन :डेहरी
STATION : Dehri

मौसम परिघटना / WEATHER PHENOMENA — के साथ दिनों की संख्या / No. OF DAYS WITH; पवन / WIND — पवन की गति के साथ दिनों की संख्या (कि. मी. प्र. घं.) / No. OF DAYS WITH WIND SPEED (Km. p. h.)

MONTH		PPT 0.3mm or more	HAIL	THUNDER	FOG	DUST STORM	SQUALL	62 or more	20-61	1-19	0
जनवरी JAN	I	2.3	0.1	0.4	0.1	0.0	0.0	0	0	30	1
	II							0	0	30	1
फरवरी FEB	I	2.1	0.0	0.2	0.2	0.0	0.0	0	0	28	0
	II							0	0	28	0
मार्च MAR	I	1.6	0.0	0.6	0.1	0.0	0.0	0	0	31	0
	II							0	0	31	0
अप्रैल APR	I	1.0	0.0	0.4	0.0	0.1	0.0	0	0	29	1
	II							0	0	30	0
मई MAY	I	1.7	0.0	0.6	0.0	0.2	0.0	0	0	31	0
	II							0	0	31	0
जून JUN	I	7.2	0.0	0.9	0.0	0.0	0.0	0	0	29	1
	II							0	0	30	0
जुलाई JUL	I	16.9	0.0	3.1	0.0	0.0	0.0	0	0	30	1
	II							0	0	30	1
अगस्त AUG	I	17.6	0.0	5.1	0.0	0.0	0.0	0	0	30	1
	II							0	0	30	1
सितम्बर SEP	I	11.5	0.0	3.6	0.0	0.0	0.0	0	0	29	1
	II							0	0	30	0
अक्तूबर OCT	I	4.0	0.0	1.0	0.3	0.0	0.0	0	0	30	1
	II							0	0	29	2
नवम्बर NOV	I	0.5	0.0	0.0	0.1	0.0	0.0	0	0	29	1
	II							0	0	28	2
दिसम्बर DEC	I	0.7	0.0	0.0	0.3	0.0	0.0	0	0	30	1
	II							0	0	29	2
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	I	67.1	0.1	15.9	1.1	0.3	0.0	0	0	356	9
	II							0	0	356	9
वर्षों की सं. NUMBER OF YEARS	I	28						24			
	II							24			

पवन / WIND — पवन की दिशा के दिनों की संख्या का प्रतिशत / PERCENTAGE No. OF DAYS WIND FROM

MONTH		N	NE	E	SE	S	SW	W	NW	CALM
JAN	I	2	3	4	11	20	40	9	6	5
	II	18	11	5	1	2	6	34	17	6
FEB	I	3	3	4	9	17	40	16	7	1
	II	13	8	5	2	2	4	43	21	2
MAR	I	3	3	4	10	15	41	18	5	1
	II	8	9	4	2	2	5	50	20	0
APR	I	3	4	9	12	14	31	16	8	3
	II	6	11	6	3	2	6	43	22	1
MAY	I	5	12	14	17	9	21	12	8	2
	II	9	23	10	2	2	5	28	21	0
JUN	I	8	11	17	19	8	15	13	6	3
	II	10	20	21	8	2	8	19	11	1
JUL	I	5	7	16	23	10	19	10	6	4
	II	11	13	20	12	6	11	17	6	4
AUG	I	5	7	18	27	10	14	10	7	2
	II	10	15	22	10	4	9	19	8	3
SEP	I	6	7	16	24	11	11	12	9	4
	II	15	16	19	9	3	4	19	12	3
OCT	I	4	5	10	20	19	26	8	5	3
	II	18	15	12	3	3	5	23	11	10
NOV	I	4	3	6	13	21	39	8	3	3
	II	25	11	5	1	2	7	23	15	11
DEC	I	2	2	4	11	23	41	9	5	3
	II	18	9	2	1	2	5	40	16	7
ANNUAL TOTAL OR MEAN	I	4	6	10	16	15	28	12	6	3
	II	13	13	11	5	3	6	30	15	4
NUMBER OF YEARS	I	29								
	II	29								

मेघ / CLOUD — No. OF DAYS WITH CLOUD AMOUNT (ALL CLOUDS) OKTAS; No. OF DAYS WITH LOW CLOUD AMOUNT OKTAS; दृश्यता / VISIBILITY — No. OF DAYS WITH VISIBILITY

MONTH		All 0	All T-2	All 3-5	All 6-7	All 8	Low 0	Low T-2	Low 3-5	Low 6-7	Low 8	FOG 8	UP TO 1 Km	1-4 Kms	4-10 Kms	10-20 Kms	OVER 20 Kms
JAN	I	23	0	2	2	4	27	0	0	1	3	0	0.1	0.4	0.5	4.0	26.0
	II	24	0	1	2	4	27	0	0	1	3	0	0.0	0.1	0.1	0.7	30.1
FEB	I	21	0	2	2	3	26	0	0	0	2	0	0.3	0.1	0.3	1.9	25.4
	II	22	0	1	2	3	25	0	0	1	2	0	0.0	0.0	0.0	0.6	27.4
MAR	I	23	0	3	2	3	28	0	0	0	2	1	0.0	0.1	0.1	0.9	29.9
	II	24	0	2	2	3	29	0	0	0	2	0	0.0	0.2	0.2	1.5	29.1
APR	I	22	1	3	2	2	29	0	0	0	1	0	0.0	0.0	0.0	1.1	28.9
	II	24	0	2	2	2	29	0	0	0	1	0	0.0	0.0	0.1	0.3	29.6
MAY	I	25	0	2	2	2	30	0	0	0	1	0	0.0	0.0	0.0	0.2	30.8
	II	25	0	2	2	2	30	0	0	0	1	0	0.0	0.0	0.0	0.2	30.8
JUN	I	11	0	5	5	9	22	0	1	2	5	0	0.0	0.0	0.4	1.9	27.7
	II	12	0	3	5	10	19	0	1	2	7	1	0.0	0.1	0.4	2.3	27.2
JUL	I	2	0	6	7	16	10	0	2	4	15	0	0.0	0.0	0.3	3.9	26.8
	II	2	1	5	7	16	10	0	2	5	14	0	0.0	0.0	0.5	5.8	24.7
AUG	I	2	0	6	9	14	10	0	2	6	13	0	0.0	0.6	0.7	2.7	27.0
	II	3	0	5	8	15	10	0	2	6	13	0	0.0	0.7	1.0	3.6	25.7
SEP	I	7	1	5	7	10	15	0	2	4	9	0	0.0	0.1	0.5	2.5	26.9
	II	8	1	5	6	10	13	1	2	4	10	0	0.0	0.1	0.2	3.3	26.4
OCT	I	20	1	3	3	4	26	0	1	1	3	0	0.0	0.1	0.3	0.9	29.7
	II	21	1	3	2	4	25	0	1	1	4	0	0.0	0.0	0.3	0.7	30.0
NOV	I	24	0	2	2	2	29	0	0	0	1	0	0.0	0.0	0.3	1.1	28.6
	II	25	0	1	2	2	28	0	0	1	1	0	0.0	0.0	0.2	0.4	29.4
DEC	I	24	0	2	3	2	30	0	0	0	1	0	0.1	0.1	0.7	1.5	28.6
	II	25	0	2	2	2	29	0	0	1	1	0	0.0	0.0	0.1	0.5	30.4
ANNUAL TOTAL OR MEAN	I	204	3	41	46	71	282	0	8	18	56	1	[illegible]	1.5	4.1	22.6	336.3
	II	215	3	32	42	73	274	1	8	22	59	1	0.0	1.2	3.1	19.9	340.8
NUMBER OF YEARS	I	28					28						28				
	II	27					27						27				

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CLAUSE NO.	PROJECT INFORMATION

CLARIFIED WATER ANALYSIS

Table-3

S.No	Constituent	As	mg/l (except pH & turbidity)
1.	Calcium	$CaCO_3$	131
2.	Magnesium	$CaCO_3$	52
3.	Sodium + Potassium	$CaCO_3$	65
4.	Total Cations	$CaCO_3$	248
5.	Chloride	$CaCO_3$	20
6.	Sulphate	$CaCO_3$	93
7.	Nitrate	$CaCO_3$	10
8.	Alkalinity	$CaCO_3$	125
9.	Total Anions	$CaCO_3$	248
10.	Iron(total)	Fe	0.3
11.	Total Silica	SiO_2	22
12.	pH value	---	7.0-8.2
13.	Turbidity	NTU	10

Note: Clarified water is used for CW system as make up & the CW system is expected to operate at about 5.0 – 5.5 Cycles of Concentration (COC) with suitable chemical treatment program using acid, scale & corrosion inhibitor dozing. As CW blow down water is tapped from CW system, the water quality of CW blow down shall accordingly be arrived by the bidder.

Table-4

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

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

SECTION: I

SUB SECTION: C

TECHNICAL SPECIFICATIONS

SECTION: I

SUB-SECTION: C 1

SPECIFIC TECHNICAL REQUIREMENT

	3X660 MW NABINAGAR TPP (FGD SYSTEM PACKAGE) HVAC SYSTEM SPECIFIC TECHNICAL REQUIREMENT	SPECIFICATION No: PE-TS-457-(571-13000-A)-A001
		SECTION : I
		SUB-SECTION : C 1
		REV. 00
		SHEET 2 OF 17

1. FUNCTION

The purpose of the system is to provide HVAC system for different areas of 3X660 MW **NABINAGAR** TPP (FGD SYSTEM PACKAGE) under the scope of this tender.

2. SYSTEM DESCRIPTION

2.1 AC SYSTEM

AC –Plant

AC plant, in FGD control room building is provided to cater the air conditioning requirements of the control room for FGD control room building.

The air conditioning plant shall comprise of **4 x 50%** Air cooled condensing units (D-X type) type air conditioners with AHUs of suitable capacity with **4x50%** configuration and other accessories as per the system/specification requirement. These AHU shall be located in AHU rooms located adjacent to / above the air-conditioned areas. The conditioned air from AHUs is distributed to the air-conditioned areas by galvanised sheet steel ducting and extruded Aluminium grilles / diffusers with volume control dampers and supporting frames.

Controls for the AC & Ventilation (common) shall be DCS based.

For balance offsite areas, Split Type Air Conditioners shall be provided as enumerated below:

Split type air conditioners (air cooled) shall be provided to cater to the air conditioning requirements of auxiliary areas / buildings. Local isolator / MCB shall be provided with split unit's / Cassette units.

Hand operated remote and other accessories as specified. Local Distribution Boards containing Switch / MCB shall be provided for Split Air Conditioners. Each split unit shall also be provided with suitable rating stabiliser.

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

Capacity of Split AC	Single phase supply feeder
1.5 TR	32 Amp
2 TR	

2.2 VENTILATION SYSTEM

2.2.1 The Ventilation System is provided within the FGD control room building by MODULAR UAF.

2.2.2 Battery and Battery charger room through exhaust fans and intake louvers.

Please refer to relevant clauses of customer technical specifications section C-2 for other detail of system description.

3. **DESIGN CRITERIA**

3.1 The outside design conditions considered are as follows: -

	Summer	Monsoon	Winter
DBT (°C)	45.0	34	5.0
WBT (°C)	25.0	28	2.0

3.2 AC system: -

The inside design conditions for Air conditioned area to be maintained are as follows: -

- Temperature 24°C ± 1^0C & RH 50% ± 5%

A minimum design margin of 10% shall be considered while designing the AC Plant capacity for each area.

Following safety factor to considered while designing the AC system

- Minimum 12.5% in RSH
- Minimum 10% in RLH
- 10% margin on dehumidified CFM

For winter heating load calculation, 50% of combined light load and eqpt. / panel load as available in the room shall be considered.

3.3 Ventilation System: -

The inside design conditions for Ventilated area to be maintained are as follows: -

- In the areas ventilated by evaporative cooling units, the inside dry bulb temperature shall be restricted to 3°C less than the summer ambient temperature (DB).
- In dry type forced (mechanical) ventilation system, the inside temperature shall be restricted about 3°C higher than the summer ambient (outside) temperature (DB).

The ventilation philosophy in various areas shall be as under

S.No.	Area	Type of Ventilation	ACPH
1.	FGD control room building	Ventilation with modular UAF. Motorized Fire dampers will be provided in the supply air ducting of Cable Spreader room/MCC	8
2.	General areas, like pump house, building etc.	Combination of Supply and exhaust fan	20
3.	MCC / Switchgear rooms. etc.	Supply fan & back draft dampers	30
4.	Battery rooms & other areas where gaseous fumes/ vapors are generated	Combination of intake louvers & Exhaust air/Roof extractor fans.	30

In addition to above, mechanical ventilation for other auxiliary buildings shall also be provided.

3.4 All equipment shall be designed for continuous duty.

3.5 For other design parameters refer to section C2-A, customer specifications.

3. SYSTEM CAPACITY AND CONFIURATION:

a) For AC Plant: -

4x50 % (1W + 1S, minimum **35 TR** Actual capacity) DX- type air cooled condensing unit shall be provided.

b) For Ventilation system: -

2 nos. each of minimum **80,000 CMH** capacity (both working) MODULAR TYPE UAF shall be provided.

4. LAYOUT CONSIDERATIONS:

a) AC PLANT

I. Air cooled DX-type condensing units for AC Plant shall be housed at the roof of FGD control room building.

II. The AHUs for this AC Plant would be located inside AHU room located on the roof of FGD Control Room.

III. 1 T Capacity Chain pulley block with/without Monorail arrangement shall be provided for the AHU for maintenance purpose.

b) Ventilation system

I. MODULAR UAF shall be placed at the roof of FGD control room building.

II. MODULAR UAF shall be placed in open, exposed to ambient conditions and no masonry room shall be provided. Both pump and fan should be within the casing.

III. The exhaust air from battery room shall be taken out through MS duct having epoxy coating, if required and the air shall be released above roof of the building.

For other design parameters refer to section C2-A, customer specifications

5. EQUIPMENT DETAILS:

6.1 AC EQUIPMENT DETAILS

6.1.1 Air cooled condensing unit

Refer to relevant clauses of section C2-A, customer specifications

6.1.2 AIR HANDLING UNIT (DOUBLE SKIN TYPE)

a) Motors shall be installed inside the AHU.

b) Accessories, valves, controls and instruments etc. shall be provided as per customer approved PID

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

d) Serrated rubber pads for vibration isolation

e) For other details please refer to relevant clauses of section C2-A, customer specifications.

6.1.3 STRIP HEATER PACKAGE AND HUMIDIFICATION PACKAGE

a) One set of electrical strip heater package of suitable capacity shall be provided in supply air duct. Heater package shall be connected with thermostat / Humidistat which will be provided in return air path inside AHU Room.

Temp element shall also be provided and the same shall be hooked with DCS system. RH and temp sensor shall be provided and the same shall be hooked with DCS system.

b) One No. pan humidifier comprising heater, humidistat, water tank, low level switch over flow, draining, make up connection, float valves etc. for each AHU Room.

For other details please refer to relevant clause of section C2-A, customer specifications

6.1.4 Thermal and acoustic Insulation
Please refer to relevant clause of section C2-A, customer specifications.

6.2 VENTILATION EQUIPMENT DETAILS

6.2.1 MODULAR UAF

Each MODULAR UAF shall comprise of:

a) Centrifugal fan and pump.
b) Pump along with fan and other accessories shall be housed in sheet metal body as per Customer technical specification section C-2A
c) Please refer to relevant clauses of Customer technical specification section C-2A for MODULAR UAF construction.

6.2.2 CENTRIFUGAL FLOW FAN UNITS

a) Please refer to relevant clauses of Customer technical specification section C-2A for centrifugal fan.

6.2.3 WALL MOUNTED AXIAL FLOW FAN

a) Adjustable damper, vibration isolators, nuts and bolts, back draft dampers etc. Shall be provided.
b) These fans shall cater to the areas as indicated in the fan schedule of ventilation system

c) Please refer to relevant clauses of Customer technical specification section C-2A for detail construction of axial flow fan.

6.2.4 ROOF EXTRACTOR UNIT

a) Each roof extractor unit shall be complete with foundation bolts including screen at bottom.
b) Please refer to relevant clauses of Customer technical specification section C-2A for detail construction of RE Unit.

6.2.5 INSULATION

a) Thermal insulation shall be provided for the duct exposed to sun / rain only.
b) Please also refer to other relevant clauses of Customer technical specification section C-2A for detail of insulation.

6.2.6 WATER PUMP SETS

Each circulating water pump set for MODULAR UAF shall comprise of the following

a) Pump (as per the specification) of adequate capacity to match the system requirement MODULAR UAF spraying arrangement.
b) One no. adequately sized TEFC sq. cage induction motor suitable for 415V, 3 phase, 50 Hz AC supply.
c) One no. Pot type strainer at inlet complete with screen, drain arrangement etc.
d) 150 mm dia. Dial Type pressure gauges one each at suction & discharge side of the pump set.
e) One no. non-return (check) valve at discharge side of pump set.
f) One set of base plate, coupling, coupling guard, anti-vibration mountings, foundation bolts etc.
g) Rain protection canopy for the pumps and motors, if located at outdoor shall be provided.
h) Please also refer to other relevant clauses of Customer technical specification section C-2A for detail construction of water pump.

6.3 COMMON FOR BOTH AC AND VENTILATION SYSTEM

6.3.1 SHEET METAL WORK

a) Air distribution would be done through ducting system, grilles and diffusers. All ducting shall be designed on equal friction method and fabricated as per IS: 655
b) Supply air diffusers / grilles (Frame and Louvers of Diffuser/Grilles shall be of extruded aluminium of 1.2 mm thick section, duly powder coated) with volume control dampers for AC and Ventilation System. Return air Diffusers will have no Volume Control Damper.
c) For other details please refer to relevant clauses of section C2-A, customer specifications

6.3.2 FIRE DAMPERS

a) Motorized fire damper shall be installed at supply and return air duct at suitable locations where duct pass through wall & floors for ease of isolation, maintenance and as well as for emergency operation. Fire damper in the supply and return air duct shall close on receiving fire signal from fire protection system and shall also be

possible manually from remote control panel. Necessary arrangement shall be incorporated in the duct for providing duct mounted multi- sensor detectors in the return air duct for all air conditioned areas. Also respective Air Handling Units / Modular UAFs shall trip on receiving fire signal from fire protection system.

b) For fire damper refer to relevant clauses of section C2-A, customer specifications.

6.3.3 PIPING VALVES ETC

a) Refer to relevant clauses of section C2-A, customer specifications

6. ELECTRICAL ITEMS:

Refer to relevant clauses of section C2-A, customer specifications and section C-3, electrical portion of specifications.

7. CONTROL PHILOSPHY

A DCS based control system shall be provided for AC & Ventilation system. The DCS based control system shall cover the followings.

- AC system for FGD control room building.
- MODULAR UAF unit for FGD control room building.
- Refer to clause of section, C-4 of specification (C&I Specification for HVAC).

8.1 SAFETY CONTROLS

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

a) High discharge pressure cut-out (HP) as applicable
b) Low suction pressure cut out (LP) as applicable
c) Oil pressure cut-out (OP) as applicable
d) Anti-freeze thermostat (AFT) as applicable
e) Any other essential safety control as per the OEM

8.2 OPERATING CONTROL

All operating control as necessary shall be provided. However following minimum control features / hardware shall be provided:-

a) Automatic capacity control system as applicable.
b) Automatic unloaded starting device
c) Operating Thermostat
d) Unloading solenoid valves (if applicable)
e) 3 way flow control valve at the AHU's (if applicable)
f) Operation / Sequence Interlock of the Air conditioning system shall be as under:

I. Condenser fan is started.

II. The Air Handling Unit is started.

III. Chilling unit is started

8.3 INTERFACE WITH DCS

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

a) Temperature & Humidity.
b) AC Plant On / Off Status.
c) AHU Run / Trip.
d) General AC Plant Warning.

8.4 INDICATIONS PROVIDED FOR MODULAR UAF IN LOCAL CONTROL PANEL

FAN RUNNING

FAN STOP

PUMP - RUNNING

PUMP - STOP

FAN MOTOR OVERLOAD.

PUMP - MOTOR OVERLOAD.

The water sump of each modular Unitary Air Filtration Units shall be provided with a level transmitter which will initiate an alarm and will trip the pump sets, in case the water level falls below the predetermined level.

8. SPECIFIC REQUIREMENT

- Efficiency of centrifugal fan shall not be less than 70%. Pump selected should have the maximum available efficiency for given flow and head chosen.
- All ventilation system shall operate on 100% fresh air.
- MODULAR UAF shall have minimum 70% saturation efficiency.
- Ventilation ducts shall be provided with motorized type fire dampers at the supply duct in electrical area like MCC / Switch gear room/ cable spreader room, as well as Electrical areas which will close in case of fire.
- The fire damper shall close the air flow inside the duct on receiving fire alarm signal from FPS. Also respective fan shall trip once the fire damper is closed.
- Air Velocity through different system equipment should be maintained as the specification.
- Roof Exhausters and wall mounted Exhaust Fan motors shall be designed for a minimum 55-degree C ambient while the supply air fan motors shall be designed for a min.50-degree C.
- All fans shall be selected with non-overloading characteristics as far as practicable and the respective drive motor shall have a rating more than the limit load of the fan or at least 20% higher than the brake horse power, which is higher.
- Design margin shall be maintained as follows:

- For Pump a) Head-10% b) Flow-10%

- RE / wall mounted fans shall be selected so as to have motor rating and wall / slab opening as under. Feeder suitable for following ratings only shall be provided by BHEL.

1.	Roof extractor units with 15 mmwc static pressure.		
	Capacity	Motor rating	Roof / Slab opening
a.	40,000 CMH	5.5 KW	1320mm
b.	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.	4,000 CMH	0.75 KW	600mmx600mm

e.	2,000 CMH	0.55 KW	500mmx500mm
5	Axial flow exhaust fans with 10 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	15,000 CMH	1.1 KW	900mmx900mm
b.	10,000 CMH	0.75 KW	800mmx800mm
c.	7,500 CMH	0.55 KW	700mmx700mm
d.	6,000 CMH	0.55 KW	600mmx600mm
e.	4,000 CMH	0.55 KW	600mmx600mm
f.	2,000 CMH	0.37 KW	500mmx500mm
6	Exhaust fan (propeller type) with 5 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	1000 CMH	100 W	330 mm circular

9. MATERIALS OF CONSTRUCTION

10.1 CENTRIFUGAL FAN

- Fan Casing (side plates & stiffeners): Mild Steel Sheets with spray galvanized to IS: 2062 Gr.B / IS: 1079 /Eq. The minimum thickness of casing shall be 3.00 mm.
- Impeller hub: Mild Steel
- Impeller back plate blade & shroud: Mild Steel to IS: 2062 Gr.B.
- Shaft: EN - 8 or eqv.
- Shaft sleeve: EN - 8 or eqv.
- Flexible connection at outlet/inlet: Fire resistant type plastic impregnated canvas with M.S. flange and cleats (3 mm thick).
- V Belt (matched sets): ISI marked (Reinforced rubber section to (IS: 4776)
- Bolts & nuts: Galvanized / MS (Epoxy painted).
- Vibration isolating cushy foot mountings, foundation bolts and nuts etc.
- Please refer to relevant clauses of Customer technical specification section C-2A for MOC of centrifugal fan.

10.2 AXIAL FAN

- Hub: As per manufacturer std. (AL- LM6)
- Neoprene rubber pads: As required.
- Supporting frame for mounting: Required.
- Protective screen at inlet: Yes (Min 14 SWG Galvanized wire knitted in 1" square mesh).
- Mounting flange on casing: At inlet and outlet.
- Painting / protecting coating – As per clause no. 8.00.00, Section C-2A
- Please refer to relevant clauses of Customer technical specification section C-2A for MOC of axial flow fan.

10.3 ROOF EXTRACTOR UNIT

- Please refer to relevant clauses of Customer technical specification section C-2A for MOC of RE Unit.

10.4 Modular Unitary Air Filtration

- Piping: MS Heavy class Galvanised to IS: 1239 Part I / IS 3589 depending on size.
- Please refer to relevant clauses of Customer technical specification section C-2A for MOC of pipe.

10.5 Valves:

- Valves shall have full sizes port and suitable for horizontal and as well as vertical installation.
- Valves for regulating duty shall be of globe type suitable for controlling throughout its lift.
- Gate, Globe and stop check valves shall have bonnet back seat to facilitate easy replacement of packing with the valves in service.
- All safety / relief valves shall be so constructed that the failure of any part does not obstruct the free discharge.
- Manual gear operators be provided for valves of size 200 NB and above.
- Please refer to relevant clauses of Customer technical specification section C-2A for MOC of valve.

10.6 CENTRIFUGAL PUMP

- Impeller: Bronze as per Grade IS: 318 Grade 2
- Pump shaft: SS 316
- Casing: 2% Ni Cast iron to IS: 210 GR. FG-260.
- Shaft Sleeve: SS 316.
- Bolt and nuts: M.S. (Epoxy painted / Galvanised).
- Type of seal: Mechanical
- Pump motor coupling: Pin & bush type.
- Please refer to relevant clauses of Customer technical specification section C-2A for MOC of pump.

10. GENERAL

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

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

3) All drawings and documents shall be computer based.

4) Vendor to include the Back wash arrangement of pot strainer with gate valve, piping etc for the MODULAR UAF.

5) Vendor to include level gauge & level transmitter for each MODULAR UAF tank for alarm & trip of the pumps. Also include one no. Pressure transmitter for each MODULAR UAF pump.

Temperature elements, electronic transmitters etc. are to be provided for all the cases. Acceptance of use of process actuated switches is subject to customer approval.

6) All commissioning spares & consumables including refrigerant till handing over of the equipment for trouble free operation shall be provided.

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

8) Indicative list of makes is enclosed as per Annexure-I however these makes shall be subject to Customer & BHEL approval during detail engineering Stage.

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

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

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

12) Necessary supports and structures / frames etc. as required for supporting the duct / piping / equipment's etc. as lump-sum basis is in the scope of Vendor and no unit rates shall be applicable for these items. Beam between two columns, if required, for supporting the duct, shall be provided by BHEL. Vendor shall take secondary support (angle, channel, beam, bracket etc.) from main column/ beam provided by BHEL, as required for supporting the duct. Further, necessary structure required for duct support shall be in bidder's scope on lump sum basis and no unit rate for the same shall be applicable.

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

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

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

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

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

18) Instrument for testing shall be calibrated by HVAC system supplier before taking up testing.

19) Pressure gauges shall have provision for air venting.

20) Matching sockets / stubs (weld type) for flow switches and other instruments shall be supplied (as per attached instrumentation installation diagram)

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

22) Besides the system performance as above, bidder shall guarantee major technical parameters of various equipment's as per design basis / details furnished in different section of technical specification.

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

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

- All calibrated instruments to be used for the tests at manufacturer's works/site shall be arranged by the bidder.

24) For group of motorized fire damper / motorised valves, single phase power supply shall be provided by BHEL in AHU room and near MODULAR UAF. 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.

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

26) 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 item and accessories like junction box, glands etc. shall be included by vendor in his scope.

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

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

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

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

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

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

33) Supplier to furnish drawings/ documents as per the dwg. / documents distribution as per project requirement.

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

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

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

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

38) Motorized fire damper will be installed at supply air duct in electrical areas like MCC / Switchgear room / cable spreader room etc. in FGD control building. Fire damper will close on receiving fire signal from fire protection system and shall also be possible manually from remote control panel. Also modular UAF shall trip on receiving fire signal from fire protection system.

39) All openings required in brick wall for installing the axial supply and exhaust fans, propeller fans, duct opening, louvers and damper openings etc shall be done by BHEL as per opening sizes indicated under clause number 7. Any opening requirement on account of change in size of equipment over and above the opening size indicated under clause number 7, same shall be done by vendor along with finishing of opening and painting as per finished wall. Grouting of fans along with anchor fasteners shall be done by vendor. The openings shall be finished properly. In case openings are done once the wall have been painted, repainting, to match with the existing wall paint shall also be done by the vendor. Sealing of duct opening, grouting of foundation / foundation bolts etc. including special type of grouting like GPX2 etc. are in the scope of Ventilation system vendor.

40) Flat, platform type RCC / PCC foundation shall be provided for installing modular UAF and UAF fan / pumps etc. Vendor shall fix the equipment using proper anchor fasteners to secure the equipment and obtain parameter related to vibration and noise.

41) All codes and standards shall be as per contract specifications

42) Wherever air washer is mentioned (in the complete technical specification) same shall be read as modular UAF and wherever chiller/chilling unit is mentioned (in the complete technical specification) same shall be read as air cooled condensing unit.

43) Metallic ladder to be provided by the Vendor in the AHU Room for entering duct plenum.

44) Metallic stool to be provided by the vendor for operating / accessing valves provided over man height.

11. EXCLUSIONS

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

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

b) False ceiling, drop ceiling.

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

d) Provision of drain traps / points,

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

12. CODES AND STANDARDS

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

IS-659 : Safety code for air-conditioning

IS-660 : Safety code for mechanical refrigeration

ASHRAE-23 : Standard method of testing and rating [67 Standards] air conditioner.

ARI-450-6 : Standards for water cooled refrigerant Condenser.

ASME Sec. VII : Unfired pressure vessels

IS-4503 : Shell and tube type heat exchanger.

ASHRAE 22-72 : Method of testing for rating water cooled refrigerant condenser.

ASHRAE-15-2007 : Safe Standard for Refrigeration System

ASHRAE-30-1995 : Method of testing liquid chilling packages

ANSI-8-31.5 : Refrigeration piping.

ANSI-8-9.1 : Safety code for mechanical refrigeration.

AR1-410 : Standard for air cooling and air heating coils.

AR1-210 : Standard for unitary air conditioning equipment.

IS-3588 : Specification for electrical axial flow fans.

AMCA-210 : Methods of performance test for fans.

BS-2831 : Methods of test for air filters used in AC and general ventilation.

IS-4671 : Expanded polystyrene for thermal insulation purpose.

IS-702 : Industrial bitumen

IS-1239 : Heavy class Pipes for sizes up to 150 mm dia.

IS-8188 : For Water conditioning

IS-325 : 3 phase induction motors

IS-4029 : Guide line for testing 3 phase induction motor

IS-210 : Specification grey iron casting

IS-2062 : Structural steel

AMCA - Bulletin : Standard code of testing centrifugal and axial No. 210 flow fans
IS-2825 : Code of practice for welding mild steel

IS-2676 : Dimensions for wrought aluminium and aluminium alloy sheets and strips.

ASHRAE Code : For various filter

ASHRAE-62-2004 : Ventilation rates

IS-655 : Specification for metal air ducts

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

Material Handling Equipments

1.0 MANUAL HOIST (CHAIN PULLEY BLOCK)

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

DESIGN CRITERIA

All necessary lifting equipment and hoists (hooks and provisions for chain blocks to be provided for repair work where loads exceed 50 kg, hoists to be provided for repair work where loads exceed 500 kg)
i.e. for 50 kg to < 500kg - hooks and provisions for chain blocks to be provided
for 500 kg to <= 2000 kg – Chain pulley block with travelling trolley

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

For hand operated hoists, the hoists shall be suitable for operation from floor level. Hand chain shall be provided for long travel of trolley and the Hoisting mechanism.

MINIMUM LIFTING REQUIREMENT

S.N.	AREA DESCRIPTION	QTY(nos)	CAPACITY (T)	MINIMUM LIFT	TYPE
1					

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

2.0 SCOPE OF SUPPLIES

Equipment and services to be furnished by the bidder for the MANUAL HOIST with accessories as per the details given in the technical specification and data sheet A. Any equipment / accessories not specified in the specification but required to make the MANUAL HOIST complete and efficient operation shall also be under the bidder's scope of work.
Compliance with this specification shall not relieve the bidder of the responsibility of furnishing material and workmanship to meet the specified working/duty conditions.

3.0 Inspection and Testing

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

4.0 Runway beam

Shall be supplied by civil contractor

5.0 PAINTING SPECIFICATION

As per details specified elsewhere in technical specification/ Manufacturer's standard.

6.0 PACKING

As per details specified elsewhere in technical specification.

7.0 DEMONSTRATION TEST

Hoist along with its accessories shall be demonstrated for the rated capacity for the service conditions specified as per QAP approved during detail engineering.

Proof load test shall be carried out as per IS:3832.

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

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

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

8.0 MAKE OF CHAIN PULLEY BLOCK

Make will be as per list specified in the specification. Any other make will be acceptable only if approved by the purchaser/ end client.

9.0 TESTING AT SITE

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

MANUAL HOIST (CHAIN PULLEY BLOCK):

Sl.no	DESCRIPTION	TECHNICAL PARTICULARS
1.0	**Type**	Hand operated chain pulley block (with/ without travelling trolley)
2.0	**Scope (Qty., Capacity, Lift, Travel Length)**	As per specification and layout requirement
3.0	**Type of service**	As per specification & layout requirement (Indoor/ Outdoor)

4.0	**Design Ambient temperature**	50 Deg C
5.0	**Design standards**	IS: 3832
6.0	**Duty class**	Class II duty equivalent (Suitable for power plant operation)
7.0	**Hoisting Mechanism**	
7.1	Type	Hand operated gear transmission
7.2	Gears / pinion	
i)	Type	Spur / Helical
ii)	Material	Alloy steel / carbon steel / high graded cast iron
iii)	Type of bearing used	Antifriction ball bearing / Roller
7.3	Load Chain	
i)	Type	Link type
ii)	Material	As per IS:6216 grade 80
iii)	Conforms to (Std./Code):	IS:6216
7.4	Hand Chain	
i)	Type	Link type
ii)	Material	Mild steel (grade 30 pitched and polished) as per IS 2429 Part I / II
7.5	Load Hook	
i)	Type of load hook	Plain shank- Trapezoidal section with safety latch.
ii)	Load hooks conforms to:	IS: 8610 & with antifriction bearing
iii)	Type of hook suspension	Swiveling
iv)	Type of make of bearing	Thrust ball bearing of hook suspension
7.6	Sprockets	
i)	Type of bearings used	Antifriction ball bearing / Roller
7.7	Load chain wheel	
i)	Material	As per IS 3832
7.8	Hoisting effort	Shall not exceed 30 kg
8.0	**Trolley & Bridge Drive**	
8.1	Trolley	
i)	Type	Geared (Manually operated)
ii)	Material of frame	Rolled structural steel (IS:2062 Grade A or B)
8.2	Drive Chain	

i)	Type	Link type
ii)	Material	Steel Gr.30
8.3	Trolley Wheel	
i)	Number of pairs of wheel in each trolley/bridge	Two/four
ii)	Flange	Single flanged
iii)	Wheel material	As per IS 3832
iv)	Type of bearings need	Antifriction
8.4	Gears/ Pinions	
i)	Type	Spur / Helical
ii)	Material	Alloy/ Carbon steel
iii)	Type of bearings used	Antifriction
8.5	Hand chain wheel	Wheels shall be with flanges, suitable local brake shall be provided as per IS:3832 to arrest and sustain loads in all working positions
i)	Material	Cast steel as per IS 3832,
8.6	Trolley effort	Shall not be more than 30 kg
8.7	The velocity rates, effort on chain required to raise the safe working load and travel and speed shall be within the limit specified in IS:3832.	
9.0	**Method of lubrications (Bearings, Gearing & Pinions, Sprockets)**	Grease
10.0	**Brakes**	Ratchet and pawl arrangement along with screw and friction disc type

12.0 DRAWING/DOCUMENT SUBMISSION

The successful bidder shall submit the drawings / documents as listed in Section –I, Sub-Section-E during detail engineering for customer's approval /information:

MANUFACTURER'S NAME & ADDRESS :	**MANUFACTURING QUALITY PLAN** **ITEM :** Chain Pulley Block **QP No.:** PE-V0-457-571-13000-A-A102 **REV**.: , **Date.:** , **PAGE**: 1 OF 4	**PROJECT: 3X660MW NABINAGAR STPP (FGD SYSTEM PACKAGE)** **PACKAGE: CHAIN PULLEY BLOCK**

Sr. No.	COMPONENT / OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
					M	C/N				M	C	N	
1.	2.	3.	4.	5.	6.		7.	8.	9.	10.			11.
1	**RAW MATERIAL & B/OUT ITEMS:**												
1.1	HOOKS	CHEMICAL & MECH	MA	LAB ANALYSIS	ONE SAMPLE PER HEAT		MATERIAL SPECIFICATION AS PER APPROVED DRAWINGS.		MTC. ✓	P	V	V	
		MARK & IDENTIFICATION	MA	VISUAL	100%		HOOK TC FROM COMPETENT AUTHORITY		TC ✓	P	V	V	
		INTERNAL DEFECTS	MA	UT	100%		ASTM A-388 (REFER NOTE I)		IR ✓	P	V	V	
		PROOF LOAD TEST	MA	REVIEW	100%		IS 15560		TC ✓	P	V	V	
		NDT AFTER PROOF LOAD TEST	MA	DPT	100%		ASTM E-165	NO RELEVANT INDICATTION	TC ✓	P	V	V	
1.2	LOAD CHAIN	- DIMENSIONS	MA	MEASUREMENT	100%		APPD. DRGS	APPD. DRGS.	IR ✓	P	V	V	
		- BREAKING STR & % ELONGATION	MA	-TENSILE TEST	1/LOT		-DO-	-DO-	MTC ✓	P	V	V	
		- PROOF LOAD -HEAT TREATMENT	MA	-TENSILE TEST	100%		-DO-	-DO-	MTC ✓	P	V	V	
			MA	REVIEW	100%		-DO-	-DO-	HT CHRT ✓	P	V	V	
		-GRADE	MA	REVIEW	1/BATCH		-DO-	-DO-	MTC ✓	P	V	V	

	LEGEND:	FOR CUSTOMER USE	
MANUFACTURER / CONTRACTOR SUB-CONTRACTOR	** M : MANUFACTURER / SUB-SUPPLIER C : BHEL / NOMINATED INSPECTION AGENCY. N : CUSTOMER/ NOMINATED INSPECTION AGENCY. INDICATE "P" PERFORM "W" WITNESS AND "V" VERIFICATION		
SIGNATURE		REVIEWED BY	NAME & SIGN OF APPROVING AUTHORITY & SEAL

BHEL	MANUFACTURER'S NAME & ADDRESS :	**MANUFACTURING QUALITY PLAN** **ITEM :** Chain Pulley Block **QP No.:** PE-V0-457-571-13000-A-A102 **REV**.: , **Date.:** , **PAGE**: 2 OF 4	**PROJECT: 3X660MW NABINAGAR STPP (FGD SYSTEM PACKAGE)** **PACKAGE: CHAIN PULLEY BLOCK**

Sr. No.	COMPONENT / OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C/N					M	C	N	
1.	2.	3.	4.	5.	6.		7.	8.	9.		10.			11.
1.3	RAW MATL. (BAR /FORGING) FOR GEAR/ RATCHET PAWL / RATCHET WHEEL & PLATES FOR FABRICATION	CHEMICAL COMPOSITION	MA	Review	ONE SAMPLE PER HEAT		Material specification as per approved drawings.		MFR'S TC	✓	P	V	V	TC or inspection report for components shall be given. For rounds ≥40mm and plates ≥20.
		MECHANICAL	MA	Review						✓	P	V	V	
		INTERNAL DEFECTS	MA	UT	100%		ASTM A-388 REFER NOTE 1		IR	✓	P	V	V	
1.4.	LOAD CHAIN WHEELS	- CHEMICAL & MECHANICAL PROPERTIES	MA	CHEMICAL MECHANICAL PROPERTIES	ONE SAMPLE PER LOT		APPD. DRG.	APPD. DRG.	MTC	✓	P	V	V	
1.5	BEARINGS	MAKE, TYPE, CATALOUGE NO.	MA	VISUAL	RANDOM		APP DRG / MFR"S CATALOGUE	APP DRG / MFR"S CATALOGUE	IR	✓	P	V	V	
1.6	HAND CHAIN WHEEL	CHEMICAL MECHANICAL PROPERTIES	MA	CHEMICAL MECHANICAL PROPERTIES	ONE SAMPLE PER LOT		AS PER DRAWING	AS PER DRAWING	MTC	✓	P	V	V	
1.7	HAND CHAIN	GRADE/ DIMENSION	MA	GRADE DIMENSION	100%		AS PER DRAWING	AS PER DRAWING	MTC	✓	P	V	V	

MANUFACTURER / CONTRACTOR SUB-CONTRACTOR SIGNATURE	LEGEND: ** M : MANUFACTURER / SUB-SUPPLIER C : BHEL / NOMINATED INSPECTION AGENCY. N : CUSTOMER/ NOMINATED INSPECTION AGENCY. INDICATE "P" PERFORM "W" WITNESS AND "V" VERIFICATION	FOR CUSTOMER USE REVIEWED BY	NAME & SIGN OF APPROVING AUTHORITY & SEAL

MANUFACTURER'S NAME & ADDRESS :	**MANUFACTURING QUALITY PLAN** **ITEM :** Chain Pulley Block **QP No.:** PE-V0-457-571-13000-A-A102 **REV**.: , **Date.:** , **PAGE**: 3 OF 4	**PROJECT: 3X660MW NABINAGAR STPP (FGD SYSTEM PACKAGE)** **PACKAGE: CHAIN PULLEY BLOCK**

Sr. No.	COMPONENT / OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C/N					M	C	N	
1.	2.	3.	4.	5.	6.		7.	8.	9.		10.			11.
1.8	TROLLEY GEARS, PINION,WHEELS, AXLE	CHEMICAL & MECHANICAL	MA	LAB ANALYSIS,	100%		APPVD DRGS	APPVD DRGS	IR/TC	✓	P	V	V	
2	**IN PROCESS**													
2.1	RATCHET PAWL / RATCHET WHEEL	-HARDNESS	MA	HARDNESS	100%		IS:3832/ APPD DRG.	IS:3832/ APPD. DRG.	IR	✓	P	V	V	
		-SURFACE CRACK	MA	DPT	100 %		ASTM E165	NO DEFECT	IR	✓	P	V	V	
2.2	GEARS AND PINIONS AFTER MACHINING	HEAT TREATMENT	MA	HT CHART	100%		IS 1875/IS 4367/IS 3832		IR	✓	P	V	V	
		SURFACE HARDNESS	MA	HARDNESS	10%		--DO--		IR	✓	P	V	V	
		SURFACE CRACK	MA	DPT FOR SURFACE CRACK	100%		ASTM E 165	NO DEFECT	IR	✓	P	V	V	
		DIMENSION	MA	MEASURE	10%			IS 3832	IR	✓	P	V	V	
3.0	**FINAL INSPECTION**													
3.1	COMPLETE ASSEMBLY	OVERALL DIMENSION	CR	MEASUREMENT	100 %		IS:3832 /APPD DRG	IS:3832 /APPD DRG	IR	✓	P	W	V	
		ENDURNACE TYPE TEST	MA	TYPE TEST	1 PER SIZE		IS 3832	IS 3832	TC	✓	P	V	V	
		OPERATIONAL PROOF LOAD & LIGHT LOAD TEST	CR	LOAD TEST	100%		-DO-	-DO-	IR	✓	P	W	V	
		HEIGHT OF LIFT	MA	VISUAL	100 %		-DO-	-DO-	IR	✓	P	W	V	

	LEGEND:	FOR CUSTOMER USE	
MANUFACTURER / CONTRACTOR SUB-CONTRACTOR	** M : MANUFACTURER / SUB-SUPPLIER C : BHEL / NOMINATED INSPECTION AGENCY. N : CUSTOMER/ NOMINATED INSPECTION AGENCY. INDICATE "P" PERFORM "W" WITNESS AND "V" VERIFICATION		
SIGNATURE		REVIEWED BY	NAME & SIGN OF APPROVING AUTHORITY & SEAL

MANUFACTURER'S NAME & ADDRESS :	**MANUFACTURING QUALITY PLAN** **ITEM :** Chain Pulley Block **QP No.:** PE-V0-457-571-13000-A-A102 **REV**.: , **Date.:** , **PAGE**: 4 OF 4	**PROJECT: 3X660MW NABINAGAR STPP (FGD SYSTEM PACKAGE)** **PACKAGE: CHAIN PULLEY BLOCK**

Sr. No.	COMPONENT / OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
					M	C/N				M	C	N	
1.	2.	3.	4.	5.	6.		7.	8.	9.	10.			11.
		SWIVELING OF HOOK	MA	VISUAL	100%		APPROVED DRG	APPROVED DRG	IR ✓	P	W	V	
		EFFORT	MA	PULL ON CHAIN	100%		-DO-	-DO-	IR ✓	P	W	V	
3.2	PAINTING	-CLEANING	MA	VISUAL	AT RANDOM		APPROVED DRAWING/ **SPECIFICATION**	APPROVED DRAWING/ **SPECIFICATION**	IR	P	---	---	
		- SHADE & DFT OF PAINT	MI	VISUAL	AT RANDOM				IR	p	W	---	
3.3	NAME PLATE	VERIFICATION	MA	VISUAL	100%				IR	P	V	---	
3.4	PACKING	-VERIFICATION	MI	VISUAL	100%		SPECS.	SPECS.	IR	P	---	---	
3.5	REVIEW OF QA DOCUMENTATION	VERIFICATION	MA	VISUAL	100%		APPD. QP	APPD. QP	✓	V	V	V	

CR – CRITICAL, MA – MAJOR , MI – MINOR

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

	LEGEND:	FOR CUSTOMER USE	
MANUFACTURER / CONTRACTOR SUB-CONTRACTOR	** M : MANUFACTURER / SUB-SUPPLIER C : BHEL / NOMINATED INSPECTION AGENCY. N : CUSTOMER/ NOMINATED INSPECTION AGENCY. INDICATE "P" PERFORM "W" WITNESS AND "V" VERIFICATION		
SIGNATURE		REVIEWED BY	NAME & SIGN OF APPROVING AUTHORITY & SEAL

	3X660 MW NABINAGAR TPP (FGD SYSTEM PACKAGE) HVAC SYSTEM O&M SERVICES	SPECIFICATION No: PE-TS-457-(571-13000-A)-A001
		SECTION : I
		SUB-SECTION : C 1
		REV. 00
		SHEET 1 OF 5

OPERATION AND MAINTENANCE SERVICES FOR HVAC SYSTEM

	3X660 MW NABINAGAR TPP (FGD SYSTEM PACKAGE) HVAC SYSTEM O&M SERVICES	SPECIFICATION No: PE-TS-457-(571-13000-A)-A001
		SECTION : I
		SUB-SECTION : C 1
		REV. 00
		SHEET 2 OF 5

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 of HVAC System 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 unauthorised part and abridge the qualified person without any commercial implication to BHEL.

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

For the purpose of Operation of HVAC System, One-day shall be considered as 24 hours i.e. 3 shifts of 8 hours each. The HVAC 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 by Bidder can be increased or decreased as per requirement and payment in such case shall be made on pro-rata basis.

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 HVAC 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 be deemed as complete HVAC System.

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

i. One qualified and experienced AC 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 HVAC System. Under normal circumstances one shift shall not be more than 8 hours.

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 HVAC System Operator in day to day operation of HVAC System and accessories and shall assist him for keeping HVAC System equipment's in neat

and tidy condition. Under normal circumstances one shift shall not be more than 8 hours

1.1 Responsibility of HVAC System Operator

i. HVAC System operator shall be responsible for proper sequential operation of HVAC System (AC and Ventilation System) including operation of standby equipment 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 HVAC 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 action irrespective of time of occurrence of malfunctioning / abnormality in the system. A log book of all such outrages shall be maintained by HVAC system operator, which shall be shared with BHEL site engineer on periodic basis.

ii. HVAC System operator shall take hourly readings of all the parameters of HVAC System / Equipment's including reading on main electrical panel of HVAC System. Temperature & RH readings inside all AC areas shall be taken at least once in a day. All the readings shall be recorded in a logbook register.

1.2 Responsibility of Helper.

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

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

1.3 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.

1.4 All the necessary tools and other materials, required for operation of HVAC System shall be kept by vendor under the control of HVAC System operator. Required testing instruments like refrigerant leak detector, Multi Meter (for Electrical portion of HVAC System), Sling pshycrometer, Line Tester, Tool Kit, Torch etc. should also be always available with Plant Operator.

1.5 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 A/C Operator or helper

does not turn up due to any reasons, the earlier duty person shall continue to make sure that HVAC System never remains unattended.

2.0 Maintenance of HVAC 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 plant at regular interval including cleaning of AHU filters etc., Strainer, UAF Tanks etc.

c) Attending to complaints.

d) Replacement of worn out or defective components

e) Replacing of refrigerant gas and oil as and when required.

No consumable or any other items of HVAC 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 HVAC 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 HVAC 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 HVAC 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 HVAC 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 compressors, evaporators, condensers, pumps, AHU's, piping / ducting works, valves etc. shall be done by vendor once in a year.

vi. Painting of all equipment’s including base frames & accessories like piping, electrical panel boards etc. shall be done once in two years.

vii. In case any repair/services of particular equipment of system like chiller unit 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.

viii. Vendor shall arrange and maintain separate logbook register for services / maintenance of HVAC 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.

ix. Vendor shall arrange and maintain sufficient stock of spares and consumable at site (HVAC room). 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.

x. 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.

xi. 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.

xii. 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 HVAC System equipment's etc.

xiii. All the safety controls of AC Plant such as HP, LP, OP, Water pressure switch, inter locking etc. shall be positively checked at least once a month and same shall be recorded by vendor engineer

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

xv. 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 AC system

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

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

SECTION: I

SUB-SECTION: C 2

CUSTOMER SPECIFICATIONS

SECTION: I

SUB-SECTION: C 2A

CUSTOMER SPECIFICATIONS
TECHNICAL REQUIREMENT

CLAUSE NO.	SCOPE OF SUPPLY & SERVICES

1.00.00 **AIR CONDITIONING SYSTEM**

a) **General**

The scope includes Engineering, Supply, Construction, Erection, Testing and Commissioning for Complete Air conditioning system consisting of D-X units with refrigerant piping & valves, Air handling units, Hi-wall split air conditioner /Cassette Air conditioners, Packaged Air Conditioners, Fresh air fans, air distribution system (ducting, filters, isolation dampers, motorized fire dampers, diffusers, grills, volume control dampers, etc.) etc., along with all electrical equipment and instrumentation as required for all the buildings which are in the scope of the bidder, as detailed out in Part-B of Section-VI.

b) **Air-conditioning system for F.G.D Control Room Building**

Air cooled condensing units (D-X type) type air conditioners with AHU of suitable capacity with 100 % redundancy (as per actual heat load calculation) shall be provided .

c) SO2 analyzer room (if required) and other air conditioned offices/areas covered under this package shall be provided with Ductable/Non ductable Split air conditioners etc. as per Design criteria specified in Chapter Salient Design Data. Non ductable 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.

d) Supply of Mandatory spares as specified.

e) Any additional items required to make the system complete.

f) 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 acceptable to the Employer. 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.

h) Apart from the above, any area/building which are in the scope of the bidder and require air conditioning, the same shall be provided with air conditioning system, as detailed out in Part-B of Technical Specification.

CLAUSE NO.	SCOPE OF SUPPLY & SERVICES
1.02.00	**Redundancies of equipments:** 100% standby unit shall be kept for FGD control room, SO2 analyzer room (if required) and other air conditioned offices/areas.
2.00.00	**VENTILATION SYSTEM** a) **General** The scope includes Engineering, Supply, Construction, Erection, Testing and Commissioning for Complete Ventilation system consisting of Modular type Unitary air filteration Units, Supply air fans, water pumps, exhaust air fans, louvers, filters, ducting, diffusers, piping, instrumentation etc., for all the buildings which are in the scope of the bidder, as detailed out in Part-B of Section-VI. b) **Non-A/C areas of F.G.D Control Room Building** **Minimum** One (1) nos. of Evaporative type Unitary Air Filtration (UAF) unit (of metallic construction- modular type) of suitable capacity with all accessories, DIDW centrifugal fan (1 x 100%), circulating water pump (1 x 100%), etc. as detailed out in technical specification shall be provided. c) **Miscellaneous areas:** All other areas like Limestone Grinding system building, Gypsum dewatering building, Recirculation pump & Oxidation blower/compressor building etc & all other non-air conditioned areas covered under this package shall be ventilated by a combination of supply/exhaust fans and fresh air in-take / back draft louvers. For ventilation of Battery rooms and Oil rooms, fans with flame proof motor shall be used. Further, toilets shall be provided with propeller type exhaust air fans. d) Supply of Mandatory spares as specified. e) Any additional items required to make the system complete. f) For Ventilation system, the Bidder shall provide all Instrumentation systems, accessories and associated equipment, which are included in Bidder's scope, in a fully operational condition acceptable to the Employer. The Contractor shall also provide all material, equipment and services which may not be specifically stated in the specifications but are required for completeness of the equipment/systems furnished by the Contractor and for meeting the intent and requirements of these specifications.

CLAUSE NO.	SCOPE OF SUPPLY & SERVICES
3.00.00	
4.00.00	**General** ii. Set of commissioning spares as may be required during erection and commissioning. iii. One (1) set Special tools and tackles required for maintenance of all the Mechanical, Electrical and C & I equipment under the scope of bidder. iv. All steel / cast iron inserts, plates, bolts, nuts, sleeves, metallic-fasteners etc. to be grouted in concrete work and used to hold/ support the equipment/piping / ducting being supplied and erected under this specifications. v. Any additional items required to make the system complete. vi. Initial charge of all lubricants and grease, etc. Further, all consumables required for PG tests shall also be in Bidder's scope of supply. Grouting, dressing and final finishing of all foundations of various equipment, etc.

CLAUSE NO.	SCOPE OF SUPPLY & SERVICES
	vii. Repairing and making good/ sealing of cutouts / openings in floors, roofs and walls, for executing the works under this system and making them water tight as directed by the engineer. Corrosion protection painting for all equipment / items by Bidder as detailed in relevant clauses of technical specification.

CLAUSE NO.	SALIENT DESIGN DATA
7.00.00	**AIR CONDITIONING SYSTEM**
	GENERAL REQUIREMENTS 1. All equipments shall be located indoor unless otherwise agreed to by the Employer. The equipment and layout shall generally be in accordance with the General Layout Plant drawings. 2. The layout of all equipment and accessories shall be developed in a way to facilitate easy accessibility and maintenance of all equipments. 3. Each equipment shall be provided with suitable lifting arrangement, e.g. Lifting lugs, eye bolts, etc to facilitate maintenance.
7.01.00	**DESIGN PHILOSOPHY FOR AIR CONDITIONING** 1. Design ambient conditions for all air conditioning system shall be as per **Appendix-A** 2. All equipments of Air Conditioning system shall be designed for continuous duty. 3. All air conditioned areas 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 FGD Control Room etc. shall be 0.45 M^3/minutes/person or 1.5 air change per hour whichever is greater. Fresh air fan capacity shall be minimum 10% of the total CMH value of working indoor units. 5. Lighting load shall be minimum 2 Watts/Sq. feet. 6. The occupancy for general area shall be minimum one person per 10 Sq. M and for conference room the same shall be one per 3 Sq.M. In the equipment rooms etc, the occupancy may be one person per 25 Sq.M (Minimum). 7. In Air conditioning system for FGD Control Room, return air shall be routed back to AHU room through plenum space. 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 & floors. Operation of these dampers shall be interlocked with the fire alarm system and shall also be possible to operate manually from

CLAUSE NO.	SALIENT DESIGN DATA
	the remote control panel. Required electrical contacts in control panel of A/C plant and further wiring upto fire alarm panels shall be done by Bidder. 9. Soft water make up (if required) for complete air conditioning system shall be provided by the bidder in-line with terminal point specified in technical specification. 10. Coil face area of Air Handling units shall be designed considering a face velocity of not more than 2.5 m/sec. 11. 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. 12. Requirement of Underdeck Insulation (for A/C area) Underdeck insulation of 50 mm nominal thickness of glass wool (32 Kg/cu.m) or rock wool (48 Kg/cu.m) 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 A/C area or exposed to Atmosphere. 13. AHU's shall be provided with two stage of filteration i.e. pre and fine filter. All fresh air supply shall also be filtered using pre and fine filter. 14. A minimum design margin of ten (10) % shall be considered in design of A/C Plant Capacity for each area. 15. For areas, where A/C load is of the order of 25-60 TR, Direct Expansion (D-X) type Condensing unit (with AHU) shall be provided depending on the availability of space/ layout etc. For areas, where A/C load is of the order of 15-25TR, 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 15 TR rating shall be served with Hi-wall Split/Cassette air conditioner units as per requirement. 16. Insulation for supply and return air ducts: Supply and return ducts shall be insulated. All types of Insulation used for HVAC application shall be CFC/HCFC free.
7.02.00	**REDUNDANCY OF EQUIPMENTS**
7.02.01	Redundancy of various A/C system equipments shall be as follows: **a) FGD Control Room Building** i) Air Cooled condensing units Air conditioners: 2X100% ii) AHU (with VVVFD): 2 X 100%

CLAUSE NO.	SALIENT DESIGN DATA
	b) 100% standby shall be provided for area served by Cassette / Hi-wall Split /Ductable split AC/Package type air conditioners for all other control rooms covered in the scope of this package. c) Fresh air fans shall be 1 x 100 % Capacity for each AHU room.
7.03.00	**DESIGN PHILOSOPHY – Ventilation System**
	1. 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 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 :** Dry bulb temperature during summer = 45 Deg C. 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.
	3. All ventilation systems shall operate on 100% fresh air. All mechanically ventilated areas shall be positively ventilated by means of supply air fans fitted with filters and exhaust fans for ventilation of heat generating areas combination of supply air fans with exhaust air fans shall be provided. MCC / switchgear and cable gallery areas shall be provided with gravity operated back draft dampers in association with supply air fans in order to maintain positive pressure. Battery rooms and other fumes/odour generating areas shall be negatively ventilated by means of exhaust air fans / roof exhausters and intake louvers. All other areas like pump house, Blower/compressor house (if any), etc shall be positively ventilated by a combination of supply air fan and exhaust air fan. Supply air fan catering for electrical areas (MCC & Switchgear rooms) shall be provided with pre-filters and fine filters and for other areas shall be provided with pre-filter only. For Positive ventilation CFM of exhaust air shall be 60% of CFM required for supply air. Similarly for

CLAUSE NO.	SALIENT DESIGN DATA

negatively ventilated area, CFM of supply shall be 60% of total CFM exhaust.

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

5. The supply air ducts of evaporative type ventilation system entering into switchgear room, cable galleries etc. shall be provided with automatic (motorised) fire dampers (of 90 minutes fire rating). 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 in control panel of A/C plant and further wiring upto fire alarm panels shall be done by Bidder.

6. Circulating water Capacity for Air washer units 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. 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.

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

CLAUSE NO.	SALIENT DESIGN DATA	एनटीपीसी NTPC

Appendix-A

Outside Design Ambient condition to be considered for Air Conditioning system and ventilation System for various project/station are as under.

Location	Season	Dry Bulb Temp. (Deg. C)	Wet Bulb Temp. (Deg. C)
Kudgi Stg-I (3x800)	Summer	42.0	21.6
	Monsoon	32.6	26.6
	Winter	16.2	12.4
LARA Stg-I (2x800)	Summer	44.0	25.5
	Monsoon	31.0	27.7
	Winter	12.2	6.6
Gadarwara Stg-I (2x800)	Summer	44.0	25.5
	Monsoon	31.0	27.0
	Winter	12.2	6.6
Darlipalli Stg-I (2x800)	Summer	43.0	27.0
	Monsoon	34.0	28.0
	Winter	11.0	5.0
Mouda Stg-II (2x660)	Summer	43.5	25.5
	Monsoon	38.0	27.5
	Winter	15.0	10.0
Solapur	Summer	43.5	25.5

CLAUSE NO.	SALIENT DESIGN DATA		
STg-I (2x660)	Monsoon	38.0	27.5
	Winter	15.0	10.0
Tanda-II STG-II (2x660)	Summer	44.0	23.5
	Monsoon	34.0	28.5
	Winter	8.0	7.0
Nabinagar JV STG-I (2x660)	Summer	45.0	25.0
	Monsoon	34.0	28.0
	Winter	5.0	2.0
Meja JV STG-I (2x660)	Summer	44.0	23.5
	Monsoon	34.0	28.5
	Winter	8.0	7.0
Barh Stg-I (3x660)	Summer	43.0	27.5
	Monsoon	38.0	29.5
	Winter	7.0	5.8
Nabinagar JV (RLY) Stg-I (4x250)	Summer	45.0	25.0
	Monsoon	38.0	28.0
	Winter	5.0	2.0
Rihand STG-II&III (2x500)	Summer	43.9	25.6
	Monsoon	35	28.9

SUB-SECTION-I-M2

AIR CONDITIONING & VENTILATION SYSTEM

CLAUSE NO.	TECHNICAL REQUIREMENTS
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 Design, Engineering, Supply, Construction, Erection, and Testing & Commissioning of all the equipments & works listed here shall be on the basis of single point responsibility in bidder's scope of work for satisfactory completion of the system in all respect.
2.00.00	**AREAS TO BE AIR CONDITIONED**
2.01.00	The areas to be air-conditioned shall be as follows: a) Air cooled condensing units (D-X type) type air conditioners with AHU of suitable capacity with 100 % redundancy (as per actual heat load calculation) shall be provided for each FGD Control room building b) Cassette and Hi-wall Air-conditioners for Other auxiliary control room /control room buildings not listed above but covered in the scope of Bidder.
3.00.00	**AREAS TO BE VENTILATED**
3.01.00	(i) Unitary Air Filtration (UAF) units of min. capacity as mentioned in BOQ shall be provided for Non-Air Conditioned areas of FGD control building (e.g. Switchgear Rooms, Cable galleries etc.) (ii) Mechanical Ventilation (using Roof extractors/ Supply and/or Exhaust fans) shall be provided for various other areas/buildings in the scope of bidder as under: a) Grinding system building b) Gypsum dewatering building c) Recirculation pump & Oxidation blower/compressor building. (iii) Toilets etc in above building (i) & (ii). Any other area not listed above but covered in the scope of Bidder. iv) For other miscellaneous areas/ buildings not listed above but covered in the scope of Bidder, mechanical type ventilation system using Supply and/or exhaust air fans/ roof exhausters shall be provided.
3.02.00	All non-air conditioned areas covered under this package shall be ventilated by a combination of supply/exhaust fans and fresh air in-take / back draft louvers as detailed below:

S.No	Area	Type of Ventilation system
(i)	General area like pump house, buildings etc	Combination of Supply air fan & Exhaust air fans
(ii)	MCCs and Switchgear room etc	Supply air fan & Back draft dampers
(iii)	Battery rooms & Oil rooms and fumes/odor generates	Combination of Supply air fan & Exhaust air fans. Motors shall be flame proof.
(iv)	Toilet/pantry etc	Propeller type exhaust air fan

4.00.00 EQUIPMENT DESCRIPTION – AIR CONDITIONING SYSTEM

4.01.00 **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, direct or through V-belt.

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.

Motor Rating : 10% more than the power required by the compressor at 50 deg C design ambient temperature.

CLAUSE NO.	TECHNICAL REQUIREMENTS
	Capacity : Minimum capacity shall be suitable for the identified/selected at evaporating temperature and condensing temperature and shall be indicated.
4.02.00	**Air Handling Unit (AHU)**
4.02.01	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 shall be provided.
4.02.02	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.
4.02.03	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.
4.02.04	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.
4.02.05	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.
4.02.06	**Centrifugal fan for AHU** 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

CLAUSE NO.	TECHNICAL REQUIREMENTS

	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 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.

4.02.07 **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. Further, wherever return air is led back directly to AHU room, no mixing box is required.

4.02.08 **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.

4.03.00 HI-WALL SPLIT/CASSETTE AIR-CONDITIONERS

4.03.01 Hi-wall Split/cassette air conditioners shall in general consist of the following:

i) Casing

ii) Hermetically sealed rotary/scroll Compressor

iii) Condenser and condenser cooling fan

iv) Evaporator along with fan

v) Cooling coil

vi) Filters

CLAUSE NO.	TECHNICAL REQUIREMENTS
	vii) Piping, valves, refrigerant strainer, etc. viii) Controls, instruments, control panel/starter panels. ix) Vibration isolator pads, etc as required. x) Refrigerant as per manufacturer practice.
4.03.02	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.
4.04.00	**SPLIT/PACKAGED AIR CONDITIONERS**
4.04.01	Split/packaged air conditioners shall in general consist of following: I. Casing II. Compressor III. Condenser IV. Evaporator and condenser cooling fan V. Cooling Coil VI. Filters VII. Piping, Valves, refrigerant strainer etc. VIII. Control, instruments, control panel/starter panels. IX. Vibration isolator pads, ducting (if applicable) etc as required.
5.00.00	**EQUIPMENT DESCRIPTION - VENTILATION SYSTEM**
5.01.00	**Unitary Air Filtration**
5.01.01	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.
5.01.02	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/cub. Mtr. Density in between. Frame work for section shall be joined together with soft

CLAUSE NO.	TECHNICAL REQUIREMENTS
	rubber gasket in between to make the joints air tight. The entire fan section shall be mounted on rolled formed GSS channel frame work.
5.01.03	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.
5.01.04	The distribution plate shall be fabricated out of 18G galvanized steel sheets & galvanized steel angle supports with minimum 50% free area.
5.01.05	Unitary air filtration shall be one-bank construction. All header and stand pipes shall be galvanised. Cat walks of suitable width shall be provided for maintenance of nozzle, filter etc.
5.01.06	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 atomised spray and shall be properly spaced to give a uniform coverage of the air washer section. The pressure drop through the nozzle should be in the range of 1.4 to 2.4 Kg/cm2.
5.01.07	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 stabilised using Titanium di-oxide and shall withstand the weathering test as per IS:4892 for 500 hrs. Type test report of the compound testing carried out in any reputed laboratory shall be submitted for approval. All supports, tie rods and space bar shall be of either galvanised steel or PVC construction and shall be complete with suitable drip tray and drain pipe.
5.01.08	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.
5.01.09	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.
5.01.10	The specification for centrifugal fans shall generally be as indicated below. However, the fan shall be of DIDW type for UAF unit.
5.01.11	Saturation efficiency of Unitary Air Filtration units shall be minimum 60%.
5.02.00	**Centrifugal Fan**
5.02.01	The casing shall be of welded construction fabricated with heavy gauge galvanised sheet steel or MS sheet with spray galvanization (**minimum** 60 micron DFT). The minimum thickness of casing shall be 3 mm. It shall be rigidly reinforced and supported by structural angles. The seams shall be permanently sealed air-tight. Split casings shall be provided on larger sizes of fans. Casing drain with valves shall be provided wherever required. 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

CLAUSE NO.	TECHNICAL REQUIREMENTS
	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.
5.02.02	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.
5.02.03	Inlet guard shall be spun to have a smooth contour. Inlet screen, if provided, shall be of galvanised wire mesh of 25 mm square.
5.02.04	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.
5.02.05	The first critical speed of the rotating assembly shall be at least 25% above the opening speed.
5.02.06	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.
5.03.0	**Roof Ventilators (If applicable)**
5.03.01	The roof extractors shall be "COWL" type.
5.03.02	Impeller shall be of axial flow type, cast Aluminium 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.
5.03.03	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.
5.03.04	The speed of the fan be limited as per limitation given above for axial fans.
5.03.05	All accessories rain protection exhaust hood, transformation piece, vibration isolators, steel supports vibration isolators, bird screen, etc. as required shall be provided.
5.03.06	The vibration level for fans shall be as per ISO: 14694.
5.04.00	**Centrifugal Pumps**
	a) Type : Horizontal Centrifugal, Axially or radial split type casing pump or end suction, top discharge horizontal centrifugal pump
	b) Impeller : Closed type
	c) Material of Construction
	i) Casing : 2% Ni Cast Iron : IS:210 Gr. FG-260

	ii) Impeller	:	Bronze IS:318 Gr-2
	iii) Wearing rings	:	Bronze
	iv) Shaft	:	SS 316
	v) Shaft sleeve	:	SS 316
	vi) Lantern ring	:	Brass / Bronze
	vii) Packing	:	Asbestos free
	viii) Base Plate	:	Carbon steel as per IS:2062
	ix) Speed	:	Maximum 1500 rpm
	x) Other requirements	:	To refer to **Annexure-I** titled "Horizontal Pumps" of this sub section.

5.05.0 Axial Fans

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

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

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

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

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

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

6.00.00 BALANCE EQUIPMENT SPECIFICATION

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

a)	Piping for Chilled and Condenser water lines	:	Heavy grade-IS:1239 or Equivalent upto150 NB and IS:3589 or Equivalent for pipes beyond 200 NB with thickness as indicated in **Annexure-II**
b)	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).
c)	Drain piping	:	Same as (a) above & galvanized as per IS:4736.

	d) 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
6.02.00	**VALVES**
6.02.01	Valves shall have full sizes port and suitable for horizontal and as well as vertical installation.
6.02.02	Valves for regulating duty shall be of globe type suitable for controlling throughout its lift.
6.02.03	All safety /relief valves shall be so constructed that the failure of any part does not obstruct the free discharge.
6.02.04	Valves shall be furnished with back seating arrangement for repacking while working under full working pressure.
6.02.05	Manual gear operators be provided for valves of size 200 NB and above.
6.02.06	All valves shall be supplied with companion flanges, nut, bolts & washers, etc.
6.02.07	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.
6.02.08	Gate valves shall be of Cast Iron body (confirming to IS:210 Gr FG 220/equivalent) for sizes 65 NB and above conforming to fIS :14846. Gun Metal construction for sizes less than 65NB shall be as per IS:778. Butterfly valves shall conform to latest revision of BS:5155 or equivalent standard of required class/rating.
6.03.00	**AIR FILTERS**
6.03.01	**Pre Filter** 1) Type : Flange / Cassette 2) 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.

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 suction of each Fresh air fan

6.03.02 **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.

6.04.00 **LOW PRESSURE AIR DISTRIBUTION SYSTEM**

6.04.01 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). GI Sheets should be galvanized and galvanizing shall be of 275 gms/sq.m. (total coating on both sides) both for site fabricated and factory fabricated ducts.

6.04.02 **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

6.04.03 **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

CLAUSE NO.	TECHNICAL REQUIREMENTS
6.04.04	**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**. 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 with provision of necessary auxiliary or special steel members or by hooks or can be provided 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. Where ever ducts are running outside the building and or at locations where it is not possible to support the ducts from ceiling/floor due to non-availability of the same, the base steel frame/truss work and other auxiliary steel members, hooks, rods, etc. for supporting the duct work shall also 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 asbestos/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.
6.04.05	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.

6.04.06 **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

6.05.00 Diffusers, Grills & Dampers :

6.05.01 Supply air diffusers/grills with factory fitted volume control dampers be provided for all air-conditioned areas.

6.05.02 Return air diffusers of air-conditioned areas shall be without volume control dampers.

6.05.03 The diffusers/grills shall be of extruded Aluminum of minimum 1.2 mm thick with powder coating. The colour of power coating shall be as per the interior décor.

CLAUSE NO.	TECHNICAL REQUIREMENTS
6.05.04	Supply air grills shall be of double deflection type and return air grills shall be of single deflection type.
6.05.05	All volume control (VC) damper shall be operated by a key from the front of the grills/diffusers and shall be of GI sheet.
6.05.06	The thickness of VC dampers shall be of minimum 20 gauge and thickness of louvers shall be of minimum 22 gauge.
6.05.07	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.
6.05.08	Fire dampers shall be motor operated type and shall have fire rating of minimum 90 minutes.
6.05.09	All plenum chambers of connections to fans, dampers etc shall be constructed in 18 gauge GS sheet and supported on MS angle frames.
6.05.10	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.
6.06.0	**Thermal and Acoustic Insulation**
6.06.01	**A) <u>Application with Glass Wool / Rockwool</u>** (i) All surfaces to be insulated both thermally and acoustically shall be thoroughly cleaned, dried and an adhesive (CPRX compound of Shalimar Tar Products / Loid bond 83 or Equivalent) be applied @ 1.5 Kg /Sqm on the surface. (ii) Insulation material (either expanded polystyrene foam or Glass Wool/ Glass fiber / Rockwool) shall be struck to the surface. All the joints shall be sealed with bitumen. (iii) Insulation mass to be covered with 500 gauge polythene sheet with 50 mm overlaps and sealing all joints on hot side or alternatively aluminum foil can be used which can come as lamination over insulation. (iv) Insulation Finish of types specified under shall be provided thereafter.. **B) <u>Application with Nitrile Rubber</u>** (i) All surfaces to be insulated shall be properly cleaned. (ii) A suitable adhesive such as SR 998 or equivalent shall be applied over the surfaces to be insulated and insulation material surfaces. (iii) Insulating material shall than be pasted onto the surfaces in a manner to avoid stretching and any air entrapment within. (iv) 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) <u>Application with Polyurethane Foam & Polyisocyanurate Foam</u>** i) All surfaces to be insulated shall be cleaned.

ii) 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.

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

iv) 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.

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

6.06.02 Type of Insulation & Finish

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.

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

6.06.03 **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 50^{o}C 0.043 at 50^{o}C	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 50^{o}C	144
Closed Cell Elastomeric Nitrile Rubber		0.036 at 20^{o}C	40 – 60
Polyurethane Foam Polyisocyanurate Foam	IS12436	0.03 at 50 ^{o}C 0.03 at 50 ^{o}C	34 $\pm$ 2 34 $\pm$ 2
Note : Insulation used for HVAC application shall be CFC/HCFC free			

6.06.04 **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.
6.06.05		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.

CLAUSE NO.	TECHNICAL REQUIREMENTS
6.06.06	**ACOUSTIC INSULATION** a) All ducts up to a distance of 5 meters from AHU 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.
7.00.00	**PLANT CONTROL**
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	Contractor shall provide microprocessor/PLC/GIU based control system for control and monitoring of air conditioning and ventilation system as per manufacturer's standard practice. Control and monitoring of air conditioning and ventilation system from FGD ~~and ZLD~~ (as provided) control system is also acceptable.
7.03.00	**Air Handling Unit** a) Humidity sensor and gyserstat located in the return air duct shall actuate the PAN humidifier to obtain the desired degree of humidification. b) 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. c) 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) d) AHU shall be started either locally or from the main control room of AC system by means of Remote / Manual selection facility. e) The closure of fire dampers, automatic tripping of AHU fans and fresh air fans shall be interlocked with Fire Detection System.
7.05.00	**Cassette /Hi-wall Split Air Conditioners** Control and interlocks for these type of units shall be as per manufacturer's standard practice.
7.06.00	**Miscellaneous Control Requirements** a) The fans (both supply and exhaust fans) associated with mechanical ventilation system shall be operated locally.

CLAUSE NO.	TECHNICAL REQUIREMENTS
	b) Relative humidity and temperature measurement of all control rooms and all major air-conditioned areas shall made be available in FGD and ZLD (as provided) control system
8.00.00	**PAINTING:**
8.01.00	All the Equipments shall be protected against external corrosion by providing suitable painting.
8.02.00	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.
8.03.00	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.
8.04.00	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.
8.05.00	For centrifugal fans - Casing shall have hot dip/ spray galvanization (**minimum** 60 micron DFT).
8.06.00	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 colour with glossy finish of minimum thickness of 25 microns.
9.00.00	**CODES & STANDARDS**
9.01.00	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.
9.02.00	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.

Annexure –I

GENERAL SPECIFICATION FOR HORIZONTAL PUMPS

1) **SCOPE**

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

2) **CODES AND STANDARDS**

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

3) List of Applicable Standards.

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

IS : 5120 : Technical requirements of 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.

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

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

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

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

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

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

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

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

5) **DESIGN CONSTRUCTION**

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

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b) **Pump Casing**

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

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

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.

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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.

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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 minimize misalignment caused by mechanical forces such as normal piping strain, internal differential thermal expansion and hydraulic piping thrust. Suitable drain troughs and drip lip shall be provided.

m) **Assembly and Dismantling**

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

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

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

ANNEXURE-II

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

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

SECTION: I

SUB-SECTION: C 2B

CUSTOMER SPECIFICATIONS
PROJECT SPECIFIC GENERAL REQUIREMENTS

PART - C

GENERAL TECHNICAL REQUIREMENTS

GENERAL TECHNICAL REQUIREMENTS

PART - C

CONTENTS

CLAUSE NO.	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 **BASE OFFER & ALTERNATE PROPOSALS**

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

4.00.00 **COMPLETENESS OF FACILITIES**

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

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS
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	**RULES, REGULATIONS, 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, NTPC rules/codes of practices as well as of the locality where they will be installed, including the following: a) Indian Electricity Act b) Indian Electricity Rules c) Indian Explosives Act d) Indian Factories Act and State Factories Act e) Indian Boiler Regulations (IBR) f) Regulations of the Central Pollution Control Board, India g) Regulations of the Ministry of Environment & Forest (MoEF), Government of India h) Pollution Control Regulations of Department of Environment, Government of India i) State Pollution Control Board. (j.) Rules for Electrical installation by Tariff Advisory Committee (TAC). (k.) Building and other construction workers (Regulation of Employment and Conditions of services) Act, 1996 (l.) Building and other construction workers (Regulation of Employment and Conditions of services) Central Rules, 1998 (m.) Explosive Rules, 1983 (n.) Petroleum Act, 1984 (o.) Petroleum Rules, 1976,

	(p.) Gas Cylinder Rules, 1981
	(q.) Static and Mobile Pressure Vessels (Unified) Rules, 1981
	(r.) Workmen's Compensation Act, 1923
	(s.) Workmen's Compensation Rules, 1924
	(t.) NTPC Safety Rules for Construction and Erection
	(u.) NTPC Safety Policy
	(v.) Any other statutory codes / standards / regulations, as may be applicable.
5.02.00	Unless covered otherwise in the specifications, the latest editions (as applicable as on date of bid opening), of the codes and standards given below shall also apply:
	a) Bureau of Indian standards (BIS)
	b) Japanese Industrial Standards (JIS)
	c) American National Standards Institute (ANSI)
	d) American Society of Testing and Materials (ASTM)
	e) American Society of Mechanical Engineers (ASME)
	f) American Petroleum Institute (API)
	g) Standards of the Hydraulic Institute, U.S.A.
	h) International Organisation for Standardisation (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)

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS
	p) IEEE standard q) JEC standard
5.03.00	Other International/ National standards such as DIN, JIS, VDI, EN, 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	Not used.
5.05.00	In the event of any conflict between the codes and standards referred to in the above clauses and the requirement of this specification, the requirement of Technical Specification shall govern.
5.06.00	Two (2) English language copies of all national and international codes and/or standards used in the design of the plant, equipment, civil, structural and architectural works shall be provided by the Contractor to the Employer within two calendar months from the date of the Notification of Award.
5.07.00	In case of any change in codes, standards & regulations between the date of bid opening and the date when vendors proceed with fabrication, the Employer shall have the option to incorporate the changed requirements or to retain the original standard. It shall be the responsibility of the Contractor to bring to the notice of the Employer such changes and advise Employer of the resulting effect.
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 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.

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS
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 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 a contract inclusive of the scope as indicated elsewhere in the specification. Each of the plant and equipment shall be fully integrated, engineered and designed to perform in accordance with the technical specification. All engineering and technical services required to ensure a completely

engineered plant shall be provided in respect of mechanical, electrical, control & instrumentation, civil & structural works as per the scope.

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

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

A comprehensive engg 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) Optimisation studies including thermal cycle optimisation.

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) Operation Philosophy and the control philosophy of the equipments/system covered under the scope.

ix) General Layout plan of the FGD System 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 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 FGD System.

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) Performance curves for Absorber

v) Piping isometric, composite layout and fabrication drawings.

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

vii) Technical data sheets for all bought out and manufactured items. Contractor shall use the 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 etc. as per criteria specified elsewhere in specification.

ix) Absorber sizing calculations. Absorber performance data.

x) Mass Balance Diagram

xi) Characteristic Curves/ Performance Correction Curves.

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

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

xiv) Protection system diagrams and relay settings.

xv) Cables schedules and interconnection diagrams.

xvii) Cable routing plan.

xviii) Instrument schedule, measuring point list, I/O list, Interconnection & wiring diagram, functional write-ups, and 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

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

xxiii) Detailed Control system manuals.

xxiv) Detailed flow chart for digital control system.

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

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) Maintenance schedule for Absorber & auxiliaries clearly indicating interval, duration if shutdown required, manhours required and tools & tackles required for maintenance.

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

8.03.02 **INSTRUCTION MANUALS**

The Contractor shall make first submission of instruction manual for all the equipments covered under the Contract as per agreed engineering information schedule. 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 atleast three (3) months prior to the commencement of erection activities of particular equipment/system. The erection manual should contain the following as a minimum.

a) Erection strategy.

b) Sequence of erection.

c) Erection instructions.

d) Critical checks and permissible deviation/tolerances.

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

f) Bill of Materials

g) Procedure for erection 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 is to be given by the supplier of the Main equipment by taking into account the operating instruction given by the associated suppliers).

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

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

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

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

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

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

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

(b) Limiting values of all protection settings.

(c) Various settings of annunciation/interlocks provided.

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

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

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

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

(h) Equipment isolating procedures.

(i) Trouble shooting with causes and remedial measures.

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

(k) Routine Operational Checks, Recommended Logs and Records

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

(m) Preservation procedure on long shut down.

(n) System/plant commissioning procedure.

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

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

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

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

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

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

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

(g) Long term maintenance schedules

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

(i) List of lubricants with their Indian equivalent, Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at

longer intervals to ensure trouble free operation and quantity required for complete replacement.

(j) Tolerance for fitment of various components.

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

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

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

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

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

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

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

8.03.03 **PLANT HANDBOOK AND PROJECT COMPLETION REPORT**

8.03.03.01 **PLANT HANDBOOK**

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

i) Design and performance data.

ii) Process & Instrumentation diagrams.

iii) Single line diagrams.

iv) Sequence & Protection Interlock Schemes.

v) Alarm and trip values.

vi) Performance Curves.

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

viii) Important Do's & Don't's

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

8.03.03.02 **PROJECT COMPLETION REPORT**

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

8.03.04 **DRAWINGS**

a) i) All the FGD plant layouts shall be made in computerised 3D modelling system. The Employer reserves the right to review the 3D model at different stages during the progress of engineering. The layout drawings submitted for Employer's review shall be fully dimensioned and extracted from 3D model after interference check.

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

Similarly, the vendor can download the drawings/documents, approved/ commented by NTPC, through above site.

The soft copies of identified drawings/documents shall be in pdf format, whereas the attachments/reply to the submitted document(s) can be in .doc, .xls, .pdf, .dwg or .std formats.

iii) Final copies of the approved drawings along with requisite number of hard copies shall be submitted as per **Annexure-VI** of Part-C.

iv) Contractor shall prepare the model of all the facilities located in FLUE GAS DESULPHURISATION (FGD) SYSTEM PACKAGE (including all

facilities), and any other facility in an integrated & intelligent 3D software solution using rule-based, data centric 3D Design software with equipment drawings, data sheets, intelligent P&ID correlated with intelligent 3D Model, BOQ, schematics and logic diagrams etc. attached to the respective equipment / systems in the aforesaid 3D model. Contractor shall make a presentation on 3D model every 3 months from LOA to enable NTPC to review the progress of engineering. After the completion of engineering the corresponding complete 3D review model shall be handed over to the employer for its reference.

Contractor shall provide 3D model (which shall include visual interference check, walk-through animation, video simulation for major equipment placement and removal, visual effect, photo realism etc), which is extracted from intelligent 3D model, for employer's review as & when desired by employer. However, all piping layouts, equipment layouts, floor plans, ducting layout (Air/flue gas, A/C, Ventilation etc.), General Arrangement drawings of major buildings, structural arrangement drawings and RCC layout drawings shall necessarily be extracted from the aforesaid 3D model and submitted for employer's review along with the 3D review model to enable NTPC to review and approve these drawings.

b) All documents/text information shall be in latest version of MS Office / MS Excel / PDF FORMAT as applicable.

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

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

e) The drawings submitted by the Contractor (or their subvendors) shall bear Employer's drawing number in addition to contractor's (their sub-vendor's) own drawing number. Employer's drawing numbering system shall be made available to the successful bidder so as to enable him to assign Employer's drawing numbers to the drawings to be submitted by him during the course of execution of the Contract.

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

Similarly, all the drawings/ documents submitted by the Contractor during detailed engineering stage shall be marked "FOR APPROVAL" or "FOR INFORMATION" prior to submission. Further, space shall be identified on each drawing for Approval stamp and electronic signature.

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

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

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

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

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

j) As Built Drawings

After final acceptance of individual equipment / system by the Employer, the Contractor will update all original drawings and documents for the equipment / system to "as built" conditions and submit no. of copies as per **Annexure VI**.

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

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

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

n) The Contractor shall submit drawings in line with the suggestive MDL covered in Part-B, Section-VI of Technical Specification and which shall be duly integrated with approved PERT network.

8.04.00 **ENGINEERING INFORMATION SUBMISSION SCHEDULE**

Prior to the award of Contract, a Detailed Engineering Information Submission Scheduler/Master Drawing List duly integrated with approved PERT network shall be tied up with the Employer. For this, the bidder shall furnish a detailed list of engineering information alongwith the proposed submission schedule. This list would be a comprehensive one including all engineering data / drawings / information for all bought out items and manufactured items. The information shall be categorized into the following parts.

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

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

The Master Drawing List (MDL) shall be updated periodically and submitted to the employer, highlighting the changes made in MDL.

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

8.05.00 **ENGINEERING PROGRESS AND EXCEPTION REPORT**

8.05.01 The Contractor shall submit every month an Engineering progress and Exception Report giving the status of each engineering information including

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

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

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

8.06.00 Engineering Co-ordination Procedure

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

NTPC Engineering Coordinator (NTPC EC):

Name :

Designation :

Address :

a) Postal :

b) Telegraphic / e-Mail :

c) FAX : TELEPHONE :

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

Name :

Designation :

Address :

a) Postal :

b) Telegraphic / e-Mail :

c) FAX : TELEPHONE :

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

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

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

b) The 'Master drawings list' indicating titles, Drawing Number, Date of submission and approval etc. shall be finalised mutually between Contractor and Employer before the award of contract. This list shall be updated if required at suitable interval during detailed engineering.

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

d) Employer and contractor shall follow their own numbering systems for the drawings. However, Employer shall intimate the contractor, NTPC drawing number on receipt of the first submission of each drawing. Vendor,

thereafter, shall indicate NTPC's drawing number in subsequent Submission, in the space provided for this purpose in title plate, in addition to his own drawing number.

e) The contractor shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data / drawings at site which are needed as an input to the engineering. The contractor shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Employer's scope and submit all necessary drawings/ documents for the same.

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

g) The Contractor shall submit adequate prints of drawing / data / document for Employer's review and approval. The drawings submitted by the Contractor/vendor shall be reviewed by NTPC and their comments shall be forwarded within four (4) weeks of receipt of drawings. Upon review of each drawing, depending on the correctness and completeness of the drawing, the same will be categorized and approval accorded in one of the following categories :

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

h) Contractor shall resubmit the drawings approved under Category II, III & IVR within three (3) weeks of receipt of comments on the drawings, incorporating all comments. Every revision of the drawing shall bear a revision index wherein such revisions shall be highlighted in the form of description or marked up in the drawing identifying the same with relevant revision Number enclosed in a triangle (eg. 1, 2, 3 etc). Contractor shall not make any changes in the portions of the drawing other than those commented. If changes are required to be made in the portions already approved, the

Contractor shall resubmit the drawing identifying the changes for Employer's review and approval. **Drawings resubmitted shall show clearly the portions where the same are revised marking the relevant revision numbers and Employer shall review only such revised portion of documents.**

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

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

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

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

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

9.00.00 **TECHNICAL CO-ORDINATION MEETING**

9.01.00 The Contractor shall be called upon to organise and attend monthly Design/ Technical Co-ordination Meetings (TCMs) with the Employer/Employer's representatives and other Contractors of the Employer during the period of contract. The Contractor shall attend such meetings at his own cost at NEW DELHI / NOIDA or at mutually agreed venue as and when required and fully co-operate with such persons and agencies involved during the discussions.

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

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS
9.02.01	The Contractor shall ensure availability of the concerned experts / consultants/ personnel who are empowered to take necessary decisions during these meetings. The Contractor shall be equipped with necessary tools and facilities so that the drawings/documents can be resubmitted after incorporating necessary changes and approved during the meeting itself.
9.02.02	Should any drawing remain unapproved for more than six (6) weeks after it's first submission ,this shall be brought out in the monthly Engineering Progress and Exception Report with reasons thereof.
9.03.0	Any delays arising out of failure by the Contractor to incorporate Employer's comments and resubmit the same during the TCM shall be considered as a default and in no case shall entitle the Contractor to alter the Contract completion date.
10.00.00	**DESIGN IMPROVEMENTS** The Employer or the Contractor may propose changes in the specification of the equipment or quality thereof and if the parties agree upon any such changes the specification shall be modified accordingly. If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any changing the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.
11.00.00	**EQUIPMENT BASES** A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base, unless otherwise specifically agreed to by the Employer. Each base plate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.
12.00.00	**PROTECTIVE GUARDS** Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards shall be designed for easy installation and removal for maintenance purpose.
13.00.00	**LUBRICANTS, SERVO FLUIDS AND CHEMICALS**
13.01.00	I. All the first fills of consumables and one years topping requirement of consumables such as greases, oil, lubricants, servo fluids / control fluids, gases and essential chemicals etc. which will be required to put the equipment covered under the scope of specifications, into successful commissioning / initial operation and to establish completion of facilities shall

be supplied by the Contractor. Suitable standard lubricants as available in India are desired. Efforts should be made to limit the variety of lubricants to minimum.

Bidder shall supply a quantity not less than 10 % of the full charge or one (1) year topping requirement mentioned above (whichever is higher) of each variety of lubricants, servo fluids, gases, chemicals etc (as detailed above) which is expected to be utilized during the first year of operation. The additional quantity shall be supplied in separate container.

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

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

14.00.00 **LUBRICATION**

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

15.00.00 **MATERIAL OF CONSTRUCTION**

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

16.00.00 **RATING PLATES, NAME PLATES & LABELS**

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

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

16.03.00	Such nameplates or labels shall be of white nonhygroscopic material with engraved black lettering or alternately, in the case of indoor circuit breakers, starters, etc. of transparent plastic material with suitably coloured lettering engraved on the back. The name plates shall be suitably fixed on both front and rear side.
16.04.00	Items of plant such as valves, which are subject to handling, shall be provided with an engraved chromium plated nameplate or label with engraving filled with enamel. The name plates for valves shall be marked in accordance with MSS standard SP-25 and ANSI B 16.34 as a minimum.
16.05.00	Hanger/ support numbers shall be marked on all pipe supports, anchors, hangers, snubbers and restraint assemblies. Each constant and variable spring support shall also have stamped upon it the designed hot and cold load which it is intended to support. Suitable scale shall also be provided to indicate load on support or hanger.
16.06.00	Valves, steam traps and strainers shall be identified by Employer's tag number of a metal tap permanently attached to non pressure parts such as the yoke by a stainless steel wire. The direction of flow shall also be marked on the body.
16.07.00	Safety and relief valves shall be provided with the following: a) Manufacturer's identification. b) Nominal inlet and outlet sizes in mm. c) Set pressure in Kg/cm^2 (abs). d) Blowdown and accumulation as percentage of set pressure. e) Certified capacity in Kg of saturated steam per hour or in case of liquid certified capacity in litres of water per minute.
16.08.00	All such plates, instruction plates, etc. shall be bilingual with Hindi inscription first, followed by English. Alternatively, two separate plates one with Hindi and the other with English inscriptions may be provided.
16.09.00	All segregated phases of conductors or bus ducts, indoor or outdoor, shall be provided with coloured phase plates to clearly identify the phase of the system.
17.00.00	**TOOLS AND TACKLES** The Contractor shall supply with the equipment one complete set of all special tools and tackles and other instruments required and other instruments for the erection, assembly, disassembly and proper maintenance of the plant and equipment and systems (including software). These special tools will also include special material handling equipment, jigs and fixtures for maintenance and calibration / readjustment,

checking and measurement aids etc. A list of such tools and tackles shall be submitted by the Bidder alongwith the offer.

The price of each tool / tackle shall be deemed to have been included in the total bid price. These tools and tackles shall be separately packed and sent to site. The Contractor shall also ensure that these tools and tackles are not used by him during erection, commissioning and initial operation. For this period the Contractor should bring his own tools and tackles. In case these tools and tackles are used by the Contractor during erection, commissioning or initial operation the same shall be refurbished repaired/replaced as required to the satisfaction of the Employer before handing over to the Employer. All the tools and tackles shall be of reputed make acceptable to the Employer.

18.00.00 **WELDING**

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

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

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

20.00.00 **PROTECTION AND PRESERVATIVE SHOP COATING**

20.01.00 **PROTECTION**

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

20.02.00 **PRESERVATIVE SHOP COATING**

All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. All surfaces which will not be easily accessible after the shop assembly, shall be treated beforehand and protected for the life of the

	equipment. All surfaces shall be thoroughly cleaned of all mill scales, oxides and other coatings and prepared in the shop. The surfaces that are to be finish-painted after installation or require corrosion protection until installation, shall be shop painted as per the requirements covered in the relevant part of the Technical Specification. Transformers and other electrical equipments, if included shall be shop finished with one or more coats of primer and two coats of high grade resistance enamel. The finished colors shall be as per manufacturer's standards, to be selected and specified by the Employer at a later date.
20.03.00	Shop primer for all steel surfaces which will be exposed to operating temperature below 95 degrees Celsius shall be selected by the Contractor after obtaining specific approval of the Employer regarding the quality of primer proposed to be applied. Special high temperature primer shall be used on surfaces exposed to temperature higher than 95 degrees Celsius and such primer shall also be subject to the approval of the Employer.
20.04.00	All other steel surfaces which are not to be painted shall be coated with suitable dust preventive compound subject to the approval of the Employer.
20.05.00	All piping shall be cleaned after shop assembly by shot blasting or other means approved by the Employer. Lube oil piping or carbon steel shall be pickled.
20.06.00	Painting for Civil structures and equipment/system covered under this package shall be done as specified under technical requirements on civil works in relevant part of this specifications.
21.00.00	**QUALITY ASSURANCE PROGRAMME**
21.01.00	To ensure that the equipment and services under the scope of contract whether manufactured or performed within the Contractor's works or at his sub-contractor's premises or at the Employer's site or at any other place of work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points, as necessary. Such programmes shall be outlined by the Contractor and shall be finally accepted by the Employer/authorised representative after discussions before the award of the contract. The QA programme shall be generally in line with ISO-9001/IS-14001. A quality assurance programme of the contractor shall generally cover the following: a) His organisation structure for the management and implementation of the proposed quality assurance programme b) Quality System Manual c) Design Control System

d) Documentation Control System

e) Qualification data for Bidder's key Personnel.

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

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

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

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

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

k) System for Quality Audits.

l) System for indication and appraisal of inspection status.

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

n) System for handling storage and delivery.

o) System for maintenance of records, and

p) Furnishing of quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component as per formats enclosed as **Annexure-I** and **Annexure-II** respectively.

22.00.00 **GENERAL REQUIREMENTS - QUALITY ASSURANCE**

22.01.00 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the contractor for some of the major items is given in the respective technical specification. This is, however, not intended to form a comprehensive programme as it is the contractor's responsibility to draw up and implement such programme duly approved by the Employer. The detailed Quality Plans for manufacturing and field activities shall be drawn up by the Bidder and will be submitted to Employer for approval. Schedule of finalisation of such quality plans will be finalised before award on enclosed format No. QS-01-QAI-P-1/F3-R0. Monthly progress reports shall be furnished.

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS
22.02.00	Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Contractor's/ Sub-contractor's/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media through C-folders, a web based system of NTPC ERP in addition to hard copy, for review and approval. After approval the same shall be submitted in compiled form on CD-ROM (As per format at Annexure-I)
22.03.00	Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Contractor's "Site Quality Control Organisation", during various stages of site activities starting from receipt of materials/equipment at site (As per format at Annexure – II).
22.04.00	The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Employer's approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved Quality Plans, Employer shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Employer's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Employer in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Employer along with technical justification for approval and dispositioning.
22.05.00	The contractor shall submit to the Employer Field Welding Schedule for field welding activities in the format enclosed at **Annexure-V.** The field welding schedule shall be submitted to the Employer along with all supporting documents, like welding procedures, heat treatment procedures, NDT procedures etc. at least ninety days before schedule start of erection work at site.
22.06.00	The contractor shall have suitable Field Quality Organization with adequate manpower at Employer's site, to effectively implement the Field Quality Plan (FQP) and Field Quality Management System for site activities. The contractor shall submit the details of proposed FQA setup (organizational structure and manpower) for employer's approval. The FQA setup shall be in place at least one month before the start of site activities.
22.07.00	No material shall be despatched from the manufacturer's works before the same is accepted, subsequent to predespatch final inspection including verification of records of all previous tests/inspections by Employer's Project Manager/Authorised representative and duly authorised for despatch by issuance of Material Despatch

	Clearance Certificate (MDCC).
22.08.00	All material used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties; chemical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details
22.09.00	All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the Employer. All welding/brazing procedures shall be submitted to the Employer or its authorised representative for approval prior to carrying out the welding/brazing.
22.10.00	All brazers, welders and welding operators employed on any part of the contract either in Contractor's/his sub-contractor's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Employer.
22.11.00	Welding procedure qualification & Welder qualification test results shall be furnished to the Employer for approval. However, where required by the Employer, tests shall be conducted in presence of Employer/authorized representative.
22.12.00	For all IBR pressure parts and high pressure piping welding, the latest applicable requirements of the IBR (Indian Boiler Regulations) shall also be essentially complied with. However, other piping system ASME B31.1 or other relevant code as applicable shall be followed. Similarly, any other statutory requirements for the equipment/systems shall also be complied with. On all back-gauged welds MPI/LPI shall be carried before seal welding
22.13.00	All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.
22.14.00	No welding shall be carried out on cast iron components for repair.
22.15.00	Unless otherwise proven and specifically agreed with the Employer, welding of dissimilar materials and high alloy materials shall be carried out at shop only.
22.16.00	All non-destructive examination shall be performed in accordance with written procedures as per International Standards. The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination) or equivalent. NDT shall be recorded in a report, which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job.

	In general all plates of thickness greater than 40mm & for pressure parts plates of thickness equal to or greater than 25mm shall be ultrasonically tested otherwise as specified in respective equipment specification. All bar stock/Forging of diameter equal to or greater than 40 mm shall be ultrasonically tested.
22.17.00	The Contractor shall list out all major items/ equipment/ components to be manufactured in house as well as procured from sub-contractors (BOI). All the sub-contractor proposed by the Contractor for procurement of major bought out items including castings, forging, semi-finished and finished components/equipment etc., list of which shall be drawn up by the Contractor and finalised with the Employer, shall be subject to Employer's approval on enclosed format No. QS-01-QAI-P-01/F3. The contractor's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified sub-contractors enclosed and shall be submitted to the Employer for approval within the period agreed at the time of pre-awards discussion and identified in "DR" category prior to any procurement. Monthly progress reports on sub-contractor detail submission / approval shall be furnished preferably on enclosed format at **Annexure-IV.** Such vendor approval shall not relieve the contractor from any obligation, duty or responsibility under the contract.
22.18.00	For components/equipment procured by the contractors for the purpose of the contract, after obtaining the written approval of the Employer, the contractor's purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the sub-contractor shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the vendor's quality control organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc. Such quality plans of the successful vendors shall be finalised with the Employer and such approved Quality Plans shall form a part of the purchase order/contract between the Contractor and sub-contractor. With in three weeks of the release of the purchase orders /contracts for such bought out items /components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the Employer on the monthly basis by the Contractor along with a report of the Purchase Order placed so far for the contract.
22.19.00	Employer reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Contractor's or their sub-contractor's quality management and control activities. The contractor shall provide all necessary assistance to enable the Employer carry out such audit and surveillance.
22.20.00	The contractor shall carry out an inspection and testing programme during manufacture in his work and that of his sub-contractor's and at site to ensure the

mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identity and acceptability of all materials parts and equipment. Contractor shall carry out all tests/inspection required to establish that the items/equipment conform to requirements of the specification and the relevant codes/standards specified in the specification, in addition to carrying out tests as per the approved quality plan.

22.21.00 Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Employer to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the Contractor in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.

22.22.00 For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.

22.23.00 Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Employer/ authorised representative.

22.24.00 **Environmental Stress Screening**

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

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

Or

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

Elevated Temperature Test Cycle

During the elevated temperature test which shall be for 48 hours, the ambient temperature shall be maintained at 50° C. The equipment shall be interconnected with devices and kept under energized conditions so as to repeatedly perform all operations it is expected to perform in actual service

with load on various components being equal to those which will be experienced in actual service.

During the elevated temperature test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components / modules shall be monitored. The temperature rise inside the cubicle should not exceed 10° C above the ambient temperature at 50° C.

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

2) **Burn in Test Cycle**

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

The period of Burn in Test Cycle shall be 120 hrs and process shall be similar to the elevated temperature test as above except that the temperature shall be reduced to the ambient temperature prevalent at that time.

During the above tests, the process I/O and other load on the system shall be simulated by simulated inputs and in the case of control systems; the process which is to be controlled shall also be simulated. Testing of individual components or modules shall not be acceptable.

During the Burn in Test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components / modules shall be monitored. The temperature rise inside the cubicle should not exceed 10° C above the ambient temperature.

22.25.00 The Contractor / Sub-contractor shall carry out routine test on 100% item at contractor / sub-contractor's works. The quantum of check / test for routine & acceptance test by employer shall be generally as per criteria / sampling plan defined in referred standards. Wherever standards have not been mentioned quantum of check / test for routine / acceptance test shall be as agreed during detailed engineering stage.

23.00.00 **QUALITY ASSURANCE DOCUMENTS**

23.01.00 The Contractor shall be required to submit the QA Documentation in two hard copies and two CD ROMs, as identified in respective quality plan with tick (✓)mark.