

**TELANGANA STATE POWER GENERATION CORPORATION
LIMITED (TSGENCO)**

5X800 MW TSGENCO YADADRI TPS

TECHNICAL SPECIFICATION

FOR

VENTILATION SYSTEM

**SPECIFICATION NO.: - PE-TS-417-554-A001
(REV 00)**



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



TITLE:
5X800 MW YADADRI TPS
TECHNICAL SPECIFICATINS FOR
VENTILATION SYSTEM

SPECIFICATION No: PE-TS-417-554-A001
SECTION
REV. 00 **DATE: APRIL 2018**
SHEET : 1 OF 2

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**TITLE:**

**5X800 MW YADADRI TPS
TECHNICAL SPECIFICATINS FOR
VENTILATION SYSTEM**

SPECIFICATION No: PE-TS-417-554-A001**SECTION****REV. 00****DATE: APRIL 2018****SHEET : 2 OF 2****SECTION - II**

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5X800 MW YADADRI TPS

**VENTILATION SYSTEM
INTENT OF SPECIFICATION**

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DATE: FEB 2020

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SECTION-I

SUB-SECTION-A

INTENT OF SPECIFICATION



5X800 MW YADADRI TPS

VENTILATION SYSTEM INTENT OF SPECIFICATION

SPECIFICATION No: PE-TS-417-554-A001

SECTION : I

Sub Section: A

REV. 00

DATE: FEB 2020

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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 **VENTILATION SYSTEM along with mandatory spares** as per details in different sections / volumes of this specification and various pre award agreements for **5X800 MW YADADRI TPS, TELANGANA**.
- 1.2 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve the contractor of the responsibility of providing such facilities to complete the supply, erection and commissioning, performance and guarantee/demonstration testing of **VENTILATION SYSTEM**.
- 1.3 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to highest standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgement is not in full accordance herewith.
- 1.4 The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing. Similarly, the extent of supply also includes all items required for completion of the system and not withstanding that they may have been omitted in drawings / specifications or schedules.
- 1.5 The general term and conditions, instructions to tenderers and other attachment referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification is subject to compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.
- 1.6 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under Vol-III of the specification **within 10 days of receipt of tender documents**. In absence of any such clarifications, in case of any contradictory requirement, the more stringent

**5X800 MW YADADRI TPS****VENTILATION SYSTEM
INTENT OF SPECIFICATION****SPECIFICATION No: PE-TS-417-554-A001****SECTION : I****Sub Section: A****REV. 00****DATE: FEB 2020****SHEET 1 OF 3**

requirement as per interpretation of Purchaser / Customer shall prevail and shall be complied by the bidder without any commercial implication on account of the same. Further in case of any missing information in the specification not brought out by the prospective bidders as part of pre-bid clarification, the same shall be furnished by Purchaser/ Customer as and when brought to their notice either by the bidder or by purchaser/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.

- 1.7 The bidder's offer shall not carry any sections like clarification, interpretations and /or assumptions.
- 1.8 Deviations, if any, should be very clearly brought out clause by clause along with cost of withdrawal in the enclosed schedule (in Vol – III); otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification. If no cost of withdrawal is given against the deviation, it will be presumed that deviation can be withdrawn without any cost to BHEL/its customer.
- 1.9 In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, Section - C shall prevail over section – D, however more stringent requirement as per the interpretation of the owner shall apply.
- 1.10 In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.
- 1.11 For definition of word like Contractor, bidder, supplier, vendor, Customer/ Purchaser Employer, consultant, please referred relevant clause



**5X800 MW YADADRI TPS
VENTILATION SYSTEM
PROJECT INFORMATION WITH WIND AND
SEISMIC DESIGN CRITERIA**

SPECIFICATION No: PE-TS-417-554-A001

SECTION : I

Sub Section : B

REV. 0

DATE: JAN 2020

SECTION: I

SUB-SECTION: B

PROJECT INFORMATION

YADADRI THERMAL POWER STATION

PROJECT INFORMATION

1	Name of the Project	YADADRI Thermal Power Station
2	Station Capacity	5X800 MW (Coal based)
3	Owner	Telangana State Power Generation Corporation Limited (TSGENCO)
4	Site Location	Site is located 7 km from the NH5.
5	Latitude	16° 42'20.40 N
6	Longitude	79° 34'41.56 E
7	Nearest Town	30 Km Miryalaguda
8	Nearest Railway Station	6.5 Km Damercherla
9	Nearest Airport	130 Kms (Vijayawada)
10	Site Conditions	
	Ambient Temperature	
	Daily minimum (average)	10°C
	Daily maximum (average)	47°C
	Design Ambient Temperature	50°C
	Ambient temperature (performance)	38°C
	Relative Humidity for design / efficiency	48-84 %
	Annual rainfall, mm	600 mm
	Plant Elevation above MSL	85 m above MSL
	Mean Wind Speed	44 m/s
	Wind Pressure	As per the latest revision of IS 875/1987
	Seismic co-efficient	Zone-III as per IS- 1893 (Part-IV)

जलवायवी सारणी
CLIMATOLOGICAL TABLE

BACK

स्टेशन : नलगोंदा
STATION : Nalgonda

अक्षांश
LAT. 17° 03'
देशांतर
LONG. 79° 16'

समुद्री तल माध्य से ऊंचाई
HEIGHT ABOVE M.S.L. 227
मीटर
METRES

प्रक्षेपों पर आधारित
BASED ON OBSERVATIONS 1975-2000

माह		स्टेशन का सतह दाब	वायु तापमान										आर्द्रता		मेघ की मात्रा		BASED ON OBSERVATIONS 1975-2000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
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MONTH		STATION LEVEL PRESSURE	MEAN				EXTREMES				HUMIDITY		CLOUD AMOUNTS		TOTAL IN WETTEST MONTH WITH YEAR								TOTAL IN DRIEST MONTH WITH YEAR				HEAVIEST FALL IN 24 HOURS		DATE AND YEAR		MEAN WIND SPEED																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
			DRY BULB	WET BULB	DAILY MAX	DAILY MIN	HIGHEST IN THE MONTH	LOWEST IN THE MONTH	HIGHEST	DATE AND YEAR	LOWEST	DATE AND YEAR	RELATIVE HUMIDITY	VAPOUR PRESSURE	ALL CLOUDS	LOW CLOUDS	MONTHLY TOTAL	NO. OF RAINY DAYS	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm		mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm

जलवायवी सारणी
CLIMATOLOGICAL TABLE

स्टेशन : नलन्दा
STATION : Nalgonda

	मौसम परिघटना						पवन														मेघ										दृश्यता									
	के साथ दिनों की संख्या						पवन की गती के साथ दिनों की संख्या (कि. मी. प्र. घं.)				पवन की दिशा के दिनों की संख्या का प्रतिशत										मेघ मात्रा (सभी मेघ) सहित दिनों की संख्या - अष्टमांश					निम्न स्तरी मेघ मात्रा सहित दिनों की संख्या - अष्टमांश					दृश्यता सहित दिनों की संख्या									
माह	वर्षण 0.3 मि.मि.या अधिक	ओले	गर्जन	कुहरा	धूल भरी आंधी	चंड वात	62 या अधिक	20-61	1-19	0	उ	उपू	पू	दपू	द	दप	प	उप	शांत	0	ले-2	3-5	6-7	8	0	ले-2	3-5	6-7	8	कुहरा 8	1 कि.मी. तक	1-4 कि.मी.	4-10 कि.मी.	10-20 कि.मी.	20 कि.मी. से अधिक					
	WEATHER PHENOMENA						WIND														CLOUD										VISIBILITY									
	No. OF DAYS WITH						No. OF DAYS WITH WIND SPEED (Km. p. h.)				PERCENTAGE No. OF DAYS WIND FROM										No. OF DAYS WITH CLOUD AMOUNT (ALL CLOUDS) O K T A S					No. OF DAYS WITH LOW CLOUD AMOUNT O K T A S					No. OF DAYS WITH VISIBILITY									
MONTH	PFT 0.3 mm Or more	HAIL	THUN DER	FOG	DUST STORM	SQU ALL	52 Or more	20-61	1-19	0	N	NE	E	SE	S	SW	W	NW	CALM	0	T-2	3-5	6-7	8	0	T-2	3-5	6-7	8	FOG 8	UP TO 1 Km.	1-4 Kms.	4-10 Kms.	10-20 Kms.	OVER 20 Kms.					
जनवरी JAN	0.5	0.0	0.0	0.0	0.0	0.0	0	0	29	2	0	30	3	39	3	4	0	11	10	25	0	2	1	3	25	0	2	1	3	0	0.6	6.7	21.3	2.3	0.1					
फरवरी FEB	0.6	0.0	0.0	0.0	0.0	0.0	0	0	28	0	1	26	1	55	3	5	0	7	2	18	1	3	2	4	21	1	2	1	3	0	0.1	7.8	18.0	1.7	0.5					
मार्च MAR	0.7	0.0	0.1	0.0	0.0	0.0	0	1	30	0	1	25	1	55	3	5	0	9	1	23	2	3	1	2	25	1	3	1	1	0	0.0	3.8	24.1	2.9	0.3					
अप्रैल APR	1.1	0.0	0.0	0.0	0.0	0.0	0	0	29	1	0	20	1	46	4	18	0	8	3	20	2	4	2	2	21	1	4	2	2	0	0.0	3.0	21.5	4.3	1.1					
मई MAY	1.8	0.0	0.0	0.0	0.0	0.0	0	0	31	0	1	14	0	27	3	21	3	30	1	19	2	5	2	3	21	2	4	1	3	0	0.0	3.1	22.5	3.4	1.9					
जून JUN	4.5	0.0	0.0	0.0	0.0	0.0	0	1	29	0	1	2	0	6	0	36	8	47	0	5	1	5	4	15	7	1	4	3	15	0	0.0	4.7	20.2	3.1	2.0					
जुलाई JUL	7.1	0.0	0.1	0.0	0.0	0.0	0	1	30	0	1	1	0	1	0	43	10	44	0	2	1	3	5	20	4	1	2	3	21	0	0.0	4.3	23.1	1.9	1.6					
अगस्त AUG	7.7	0.0	0.0	0.0	0.0	0.0	0	1	30	0	1	1	0	2	0	32	8	55	1	2	1	5	3	20	3	1	4	2	21	0	0.0	4.1	22.8	2.5	1.6					
सितम्बर SEP	6.6	0.0	0.0	0.0	0.0	0.0	0	0	29	1	1	6	0	11	1	29	4	42	6	4	1	6	4	15	5	1	4	3	17	0	0.0	3.2	20.9	3.6	2.3					
अक्टूबर OCT	3.9	0.0	0.0	0.0	0.0	0.0	0	0	29	2	1	29	4	16	1	15	2	23	9	18	1	5	2	5	21	0	3	2	5	0	0.1	3.7	22.4	3.8	1.1					
नवम्बर NOV	3.3	0.0	0.0	0.0	0.0	0.0	0	0	26	4	3	33	7	18	2	4	0	19	14	16	1	4	3	6	21	1	2	2	4	0	0.0	8.8	17.8	2.9	0.4					
दिसम्बर DEC	0.4	0.0	0.0	0.0	0.0	0.0	0	0	29	2	3	46	3	22	1	2	1	14	8	21	1	4	1	4	23	1	3	1	3	0	0.1	6.8	20.8	3.3	0.0					
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	33.3	0.0	0.1	0.0	0.0	0.0	1	5	346	13	1	19	2	24	2	18	3	26	5	205	13	46	29	70	238	11	37	22	57	0	0.8	60.1	255.4	35.6	13.0					
वर्षों की संख्या OF YEARS	22						1	3	355	6	1	21	4	33	1	15	3	19	3	238	14	39	26	48	257	14	34	20	40	0	0.1	20.1	49.9	269.9	25.0					
	22						22				22										21										21					22				



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**SECTION: I
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SPECIFIC TECHNICAL REQUIREMENT FOR VENTILATION
SYSTEM**



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1.0 INTENT OF SPECIFICATION

This specification includes, but not limited to, design, engineering, manufacturing, inspection and testing, painting, supply/delivery including mandatory spares, erection and commissioning spares and tools and tackles duly packed at project site including freight, unloading, storage and handling at site, civil and structural works, erection and commissioning, trial run at site, performance guarantee test and handing over to the customer in line with drawings/ documents/ test procedures approved by BHEL/Customer for Ventilation System except for following buildings:

- a) Canteen building
- b) Permanent stores and store office
- c) Security building
- d) Chemical Lab building (PCRI)
- e) Simulator building
- f) Main gate building
- g) Workshop building
- h) Fire station building

Bidder to note that even though the supply of ventilation equipment's of the above 8 buildings are not included in their scope, the engineering and selection of equipment's of ventilation system of these 8 buildings shall still be included in their scope.

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.

2.0 SPECIFIC REQUIREMENTS

2.1 Design Criteria for Ventilation system:

Outdoor conditions shall be considered as follows: -

	Summer	Monsoon	Winter
DBT (°C)	42.7	30.9	15.7
WBT (°C)	26.5	26.3	13.6

The inside design conditions: -

- i) For all evaporative cooled areas, the air quantity shall be calculated based on following



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a) Air quantity as per calculation based on air change method

OR

b) Air quantity shall also be calculated such that the inside temperature is restricted to 5-degree C below outside DBT during peak summer. This temperature will prevail up to 5 metres above floor level. The hot air will be exhausted out by means of Roof Exhausters / Wall mounted Exhaust Fans / Louvers / BDD.

Higher of the air quantity obtained by two methods above shall be selected.

ii) For evaporative ventilation system in Power house, ESP & FGD MCC cum Control Room, following air change shall be considered.

Sl.no	Areas	Air changes per hour
1	TG Hall	6
2	Cable Spreader	5
3	MCC/ Switchgear	15
4	ESP (Cable Spreader)	5
5	ESP (MCC/ Switchgear)	15

iii) For mechanical dry ventilated area, the air quantity shall be calculated based on the following air changes –

Sl.no	Areas	Air changes per hour
1	Cable spreader room	5
2	Pump houses	10
3	M.C.C. Room/ Switchgear room of Auxiliary Building	15
4	Battery Room areas	20
5	Oil room	20
6	Toilets	20
7	CPU	15
8	Compressor house	15

iv) In dry type forced (mechanical) Ventilation System where the ambient air is drawn and distributed inside the building/room and then exhausted, the average design condition inside the space to be ventilated is to be restricted about 3°C higher than



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the ambient (outside) dry-bulb temperature. Relative humidity will depend upon moisture content of ambient air. Higher of the air quantities obtained by the Air Change Method and Heat Load Calculation Method shall be selected.

- v) Fire Dampers (Motorized type electrically operated) shall be provided in at the duct / Fan opening of Switch Gear Room. The operation of these automatic dampers shall be interlocked suitably with the Air-Conditioning system PLC system by clubbing of multiple fire dampers and cabling through junction box (bidder's scope). Fire dampers shall be fusible link type for Oil room
- vi) The ducting shall be sized to have constant friction drop along its length with air velocity in the ducts normally not exceeding 12 m/sec. for ventilation system. However, the air velocity shall be increased more than 12 m/sec., in case of neck formation / transmission piece not exceeding one meter of length.
- vii) 10% margin shall be considered while sizing the equipment.
- viii) The system shall be design to maintain specified inside design conditions during peak summer under design outdoor condition.
- ix) All equipment shall be designed for continuous duty.
- x) All ventilation system shall operate on 100% fresh air.
- xi) The air washer shall have minimum 90% saturation efficiency and UAF shall have 60% saturation efficiency.
- xii) 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 in power house building, as well as Electrical areas of ESP Building & FGD MCC cum control building, which will close in case of fire. Fire Damper shall have fire rating minimum 120 minutes.
- xiii) Air Velocity through different system equipment should be maintained as follows:
 - a. Intake Louvers (except for AWU/UAF Units): 2m/s through face area (Max.)
 - b. Exhaust Louver: 2m/s through face area (Max.)
 - c. Volume Control dampers: 10m/s through face area (Max.)
 - d. Back Draft dampers: 5m/s through face area (Max.)
 - e. Moisture eliminators and Intake Louvers for AWU/UAF Units: 2.5m/s through face area (Max.)
 - f. Supply Air Grills: 6m/s through face area (Max.)



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- xiv) Motor rating for centrifugal fans with backward curved blades and axial flow fans shall be minimum 115% of the fan power at duty condition. Motor rating for Pump motor shall be minimum 115% of pump power at duty condition.

3.0 SYSTEM DESCRIPTION

3.1 The Ventilation System is provided in the following locations within the Power House by Air washers. Coursing of air in desired direction / areas shall be made by using roof extractors.

- i) TG bay (ground, mezzanine and operating floor), HP/LP heater area, condenser area, Boiler feed pump area Oil cooler area
- ii) MCC Rooms.
- iii) Cable Spreader Rooms
- iv) Switchgear Rooms
- v) Battery Charger Rooms

Cooled and filtered air from Air Washer Unit shall be distributed by means of ducting to the TG building near various heat sources like turbo-generator, condenser, Boiler feed pump HP & LP heaters etc. The hot air from the hall shall be exhausted by means of roof extractors. The quantity of air exhausted should be kept lower than the quantity of air supplied (usually 60% of the supply air is exhausted) in such a way that a little over pressure is maintained inside the hall. This will reduce infiltration of outside hot and dusty air.

The supply air quantity is supplied from Four (4) nos. Packaged type AWU for TG Building provided for each unit

- 2 nos. being located outside A-Row of TG building at 0.0 floor; and
- 2 nos. being placed on B-C bay at 32.5M floor level

Such division and location area decided to achieve effective air distribution.

The Air Washer Units will primarily serve TG hall and the electrical areas like MCC Room, Switchgear Room, and Cable Spreader Room. The washed air supplied to MCC / Switchgear/Cable Spreader Rooms shall be exhausted outside through Back Draft Dampers. Fire dampers are provided in the supply air ducting leading to all electrical rooms (MCC, Switchgear etc.)

The supplied air in the lower level of TG hall after taking the heat load of TG bay rises through different openings to the upper floors and is then finally exhausted (60% of total



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supplied by Air washers) by means of roof exhausters placed over the roof of TG Hall. Some quantity of air leaks out through various leakage areas thus maintaining slight positive pressure inside w.r.t. outside.

These being package type of air washers placed, outside, exposed to ambient and hence shall be designed accordingly. Further the casing colour shall be similar to the TG building cladding. Also the pump motors exposed of atmosphere shall be provided with IP-55 protection. Pump motor set shall be provided with canopy for protection from rain etc.

4. EQUIPMENT AND SERVICES PROVIDED FOR VENTILATION SYSTEM:

4.1 AIR-WASHERS

- a) Four (4) Nos. Packaged type Air washer units (AWU), each having a capacity of min. 2,80,000 m³/hr with 85 mm WC static pressure for each T.G. building considered. In total, 20 nos. air washers each of min. 2, 80,000 m³/hr. capacity for all 5 units shall be provided.
- b) Each air washer comprises of:
 - (i) Two (2) no. (2 x50% duty) Centrifugal fan backward inclined, DIDW Type, complete with electric drive motor, drive Pulleys, V-belt, belt guards, cushy foot mountings, slide rails, removable drain plug, and other accessories etc. and filter back wash arrangement.
 - (ii) Two (2) nos. (2 x 100 % duty) Back pull out / Horizontal Split Casing type centrifugal pumps for circulation of water shall be considered. Pump suction shall be provided with pot strainer with by-pass valves, inlet and outlet pressure gauge and filter back wash arrangement.

A spray nozzle system consisting of two banks spray system each connected to individual headers, flow regulating valves (Globe valve at Pump outlet) for controlling flow to spray header. Nozzles shall be of stainless steel, pressure drop across nozzle shall be 1.4 - 2.4 Kg./sq.cm.

- c) Moisture eliminators of die-extruded PVC construction.
- d) Automatically cleanable type Stainless Steel mesh filters complete with SS / Aluminum frame continuously flooded with water by double bank of spray header with Stainless Steel water spray nozzles spraying water over the filters in the direction of airflow.
- e) Air filters (SS-316) complete with fixing frame.
- f) Intake louver with frame & bird screen (of GI Construction).
- g) All valves, pipes, nuts & bolts, pipe hangers, supports, internal fittings and supports including ball float valves for makeup water connection, Low-level Switch with Alarm, quick-



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fill connection with valve, drain piping with valve up to the nearest drain point and overflow connection with siphon.

- h) Inspection door and marine lights with ladder for different section and cat walks as required.
- i) Drain pipe with siphon, marine light in each section.
- j) No masonry Room shall be provided for the Air washer units including its accessories. All accessories including centrifugal Fans shall be placed inside a double skin sheet metal casing. However, the water circulating pump sets shall be located outside this AWU casing which shall be provided with canopy.
- k) Double skin panel (inside and outside) shall be fabricated using (24 G) galvanized steel, with 25 mm. thk. Polyurethane insulation in between GSS channels. Outside skin shall be pre plasticized & inside sheet shall be plain GI.
- l) By pass arrangement to be provided as per attached P & ID for air washer arrangement in case RH in MCC/Switchgear room of power house exceed 60 %.
- m) Each Air washer unit shall have one local control panel located near each air washer unit for its control.
- n) Efficiency of centrifugal fan and pump shall not be less than 70%.
- o) For further details of Air Washer Units, refer Section-I, Sub-Section-C2A for Customer specification and P & ID for Air washer system and UAF's (Annexure-B) of this specification.
- p) Electrical feeder suitable for following motor rating shall be provided for Air washer equipment. Bidder to ensure that motor rating is not more than the rating mentioned below.

Sr. no.	Items	Motor rating (Kw)
1.	Centrifugal fan (140000 CMH / 85 mm WC SP)	55
2.	Centrifugal pump (min 310 CMH / min 30 m head)	45

4.2 UAF- Unitary Air Filtration

One (1) no. Sheet metal type Unitary Air Filtration system (UAF) having adequate capacity and static pressure shall be placed at roof of each ESP Control bldg. and stage-wise FGD MCC cum Control Bldg.

One (1) no. UAF comprises of:

- a) One (1) No. (1X100%) Centrifugal fan backward inclined, SISW type, complete with electric drive motor, drive Pulleys, V-belt, cushy foot type mounting, belt guards,



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slide rails, removable drain plug and other accessories etc. Both inside and outside of surfaces of all parts of the fans shall be spray galvanized.

- b) Fresh air intake louver with bird screen of GI construction.
- c) Two (2) Nos. (2 x100 % duty) Back pull out / Horizontal Split Casing type centrifugal pumps for circulation of water. Pump system shall be provided with pot strainer with by-pass valves, inlet and outlet pressure gauge with isolating cock, fitting and accessories, complete with makeup water plumbing with hangers/supports, float valve, internal fittings and supports, over flow connection and drain connection with valve and siphon and filter back wash arrangement. Each Pump motor set shall be provided with canopy.
- d) Automatically cleanable type Stainless Steel mesh Filters complete with SS / Aluminium frame continuously flooded with water by one bank of spray header with Stainless Steel water spray nozzles spraying water over the filters in the direction of airflow.
- e) Moisture eliminator sets of die-extruded PVC construction.
- f) GI sheet metal casing with inspection window, ladder and catwalk, water tank, flexible connection piece with tank.
- g) UAF chamber of sheet metal (2mm MS) construction with 3mm thick MS tank etc. Both the casing & the water tank shall be of epoxy painted from inside & outside and shall be complete with all valves, pipes, nuts and bolts, pipe hangers, supports, internal fittings and supports, suction pipe connection with coarse strainer, Low Level switch with alarm, make-up water connection with ball float valve, overflow connection with siphon, drain connection with valve, quick fill connection with valve etc.
- h) Intake louver with frame & screen (of GI Construction)
- i) Inspection door with ladder, marine light and cat walk in the spray chamber.
- j) Efficiency of centrifugal fan and pump shall not be less than 70%.
- k) Each UAF unit shall have one local control panel located near each UAF unit for its control.
- l) For further details of Unitary Air Filtration, refer Section-I, Sub-Section-C2A for Customer specification and P & ID for Air washer system and UAF's (Annexure-B) of this specification.
- n) Bidder to ensure that motor rating is not more than the rating mentioned below.



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Sr. no.	Items	Motor rating (Kw)
1.	Centrifugal fan (100000 CMH / 60 mm WC SP)	30
2.	Centrifugal mono block pump (min 77 CMH / 30 m head)	17

4.3 Centrifugal flow fan units

Each centrifugal fan shall be complete with

- a) Fan impeller (backward curved) with casing with removable drain plug, Steel Frame / Supporting Structures, as required.
- b) Electric drive motor.
- c) Drive Pulleys, V-belt, belt guards, slide rails Cushy Foot type Mountings etc.
- d) Dampers and flexible connection with matching flanges.
- e) Vibration isolators, foundation bolts and nuts.
- f) Rain Protection canopy for drive motor for outdoor.

4.4 Wall mounted axial flow fan

Each wall mounted axial flow fan shall be complete with

- a) Fan impeller & casing/short duct as required.
- b) Electric drive motor with coupling if any, including motor brackets.
- c) Inlet cone and grouting framework, if any.
- d) Rain protection cowl with bird-screen (of GI Construction).
- e) All supply air axial flow fans shall be provided with pre-filters (and also fine filters for MCC/switchgear room).

4.5 Roof Extractor unit

Each wall roof extractor unit shall be complete with

- a) Fan wheel, electric drive motor with motor coupling if any and motor bracket.
- b) Short duct mounting/axial fan casing having inspection door and base
- c) Grouting framework & foundation bolts including screen at bottom.
- d) Rain protection cowl with bird-screen (provided with roof – hood with limit switch).



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- e) Vibration Isolators and all other accessories shall be provided as per Specification requirement.

4.6 Ductwork

- a) GSS supply air ducting (as per IS 655) fabricated with GSS sheet (as per IS 277) having zinc coating of 180 g/sqm. The ducting shall be complete with vanes, splitters, dampers, hangers, supports, anchor bolts, sealing components, gaskets etc. However, minimum duct thickness shall be 1 mm (20 G).
- b) MS grilles & diffuser made of powder coated extruded Aluminum.
- c) Manually adjustable/back draft type/Gravity type exhaust air dampers.
- d) Fire Dampers (Motorised type electrically operated) shall be provided with open and close status limit switches).
- e) Thermal insulation on the ducting which is exposed to the atmosphere with 13 mm thick Aluminum Foil faced closed cell elastomeric Nitrile Rubber (of density min. 40 kg/Cu.m) / XLPE (of density min. 33 Kg/Cu.M) or equal having a thermal conductivity not exceeding 0.035W/MK. The insulation shall have self-extinguishing and non-dripping properties against fire attack.
- f) All ducts and pipes as well as machines shall be vibration isolated, or otherwise treated.

4.7 Circulating Water Pump Set for air washer

Each circulating water pump set for air washer shall comprise of the following:

- a) Centrifugal pump Horizontal split casing / Back Pull out type of adequate capacity to match the system requirement for Air washer.
- 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) Gate valve, one each at suction and Globe valve, one each at discharge side of the pump set.
- f) One no. non-return (check) valve at discharge side of each pump set.
- g) One set of base plate, coupling, coupling guard, anti-vibration mountings, foundation bolts etc.



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4.8 Circulating Water Pump Set for UAF

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

- a) Centrifugal pump Horizontal split casing / Back Pull out type of adequate capacity to match the system requirement for UAF.
- b) One no. Pot type strainer at inlet complete with screen, drain arrangement etc.
- c) 150 mm dia. Dial Type pressure gauges one each at suction & discharge side of the pump set.
- d) Gate valve, one each at suction and Globe valve, one each at discharge side of the pump set.
- e) One no. non-return (check) valve at discharge side of each pump set.
- f) One set of base plate, anti-vibration mountings, foundation bolts etc.

5.0 MATERIALS OF CONSTRUCTION

5.1 CENTRIFUGAL FAN

- a) Fan Scroll: Heavy Gauge MS (IS-2062 Gr.B) with Galvanized.
- b) Fan Casing (side plates & stiffeners): Mild Steel Sheets/plate to IS: 2062 Gr.B / IS: 1079 /Eq. The minimum thickness of casing shall be 3.15 mm.
- c) Impeller: M.S. sheet/plate (IS-2062 Gr.B) duly spray galvanized
- d) Impeller hub: Mild Steel
- e) Impeller back plate blade & shroud: Mild Steel to IS: 2062 Gr.B.
- f) Shaft: EN - 8 or eqv.
- g) Fan Supports, frames and structure: Mild Steel (IS-2062 Gr.B)
- h) Flexible connection at outlet/inlet: Fire resistant type plastic impregnated canvas with M.S. flange and cleats (3 mm thick).
- i) V Belt (matched sets): ISI marked (Reinforced rubber section to (IS: 4776)
- j) V Pulley: Cast Iron multi-groove to Gr-20 as per IS: 210.
- k) Slide rails: M.S. /C.I.
- l) Connection pieces: G.I. according to supplier's design.
- m) Bolts & nuts: Galvanized / MS (Epoxy painted).
- n) Vibration isolating cushy foot mountings, foundation bolts and nuts etc.
- o) Dampers: Heavy Gauge MS (IS-2062 Gr.B).

5.2 AXIAL FAN



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- a) Casing: M.S. sheet – 3 mm thk for fan dia upto 750 mm, 5mm thick for fan dia of 750 mm and above as per IS:1079 / IS:2062 Gr.B
- b) Impeller: Cast Aluminum. (Alloy A-6M, IS-617)
- c) Hub: As per manufacturer std. (AL- LM6)
- d) Support frame and structure: M.S. of adequate thickness (Galvanized / painted) IS-2062 Gr.B.
- e) Neoprene rubber pads: As required.
- f) Coned inlet for wall exhausters / supply fans: MS (IS-2062 Gr.B)
- g) Supporting frame for mounting: As Required.
- h) Protective screen at inlet: Yes (Min 14 SWG Galvanized wire knitted in 1" square mesh).
- i) Rain Protection Cowl: Aluminum or hot dip galvanized after fabrication from MS.
- j) Mounting flange on casing: At inlet and outlet.
- k) Painting / protecting coating – All the MS parts shall be galvanized or protected with three coats of epoxy paint.

5.3 ROOF EXTRACTOR UNIT

- a) Casing/cowl/hood: (Spray / hot galvanized M.S. Sheet to IS: 2062 Gr.B (Short duct casing).
- b) Impeller: Cast Aluminum alloy to Al-LM 6, IS-617.
- c) Support frame and structure: M.S of adequate thickness (IS-2062 Gr.B).

5.4 AIR WASHER

- a) Moisture Eliminators plates: 100% virgin PVC die-extruded construction of minimum finished thickness of 2 mm.
- b) Moisture Eliminator Frame: 22 SWG GI sheets and GI angle of adequate strength. ft sleeve: EN - 8 or eqv.
- c) Distribution plates: 18 G GSS to have 50% free area.
- d) Tank: Black MS for sheet metal Air washer (6mm) thk (Epoxy paint both inside and outside of tank). Min depth -800mm
- e) Piping: MS Heavy class (Galvanized) to IS: 1239 Part I or IS: 3589 depending on size.
- f) Suction Screen for Water: SS (40 mesh size 2 nos for each air washer)
- g) Spray and flooding nozzles: SS

5.5 UNITARY AIR FILTRATION



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- a) Eliminators plates: 100% virgin PVC die-extruded construction of minimum finished thickness of 2 mm.
- b) Top Surface of the UAF shall be thermally insulated with 13 mm thick thermal insulation made of Aluminium foil faced closed cell elastomeric Nitrile Rubber (of density min. 40 Kg/CuM) / XLPE (of density min. 33 Kg/CUM) or equal having a thermal conductivity not exceeding 0.035W/MK. The insulation shall have self-extinguishing & non-dripping properties against fire attack. Insulation shall be covered with metal sheet of min 18 SWG.
- c) Tank: M.S. 3mm thick (Epoxy Paint) both inside and outside of tank.
- d) Casing: M.S. 2mm thick (Spray galvanized or two coats of epoxy paint).
- e) Distribution plates: 18 G GSS to have 50% free area.
- f) Piping: MS Heavy class Galvanized to IS: 1239 Part I / IS 3589 depending on size.
- g) Suction Screen Water: SS.
- h) Spray and flooding nozzles: SS.
- i) Banks: Single bank type (along the air flow), spraying water over the filters.

5.6 AIR FILTERS

5.6.1 PRE FILTER

- a) Filter Media: The filter media shall be of High Density Poly Ethylene
- b) Efficiency: efficiency shall be about 90% down to 10-micron size particles when tested in accordance with BS: 6540 / ASHRAE – 52-76.
- c) Allowable pressure drop: Initial pressure drop – Not to exceed 6.0 mm WC at rated flow. Final pressure drops- Up to 10 mm WC.
- d) Frame Work 18 G GSS. Filter mounting frame shall be GI angle iron frame of adequate thickness.
- e) Size – 610 x 610 mm (Approx.)
- f) **SS FILTER** (for Air washer / UAF units) The filters shall be washable/cleanable type construction of SS 316 wire netting with three or more layers of wire mesh of different mesh sizes stitched together and held in a SS / Al frame of adequate thickness but not less than 18 SWG for Al and 20 SWG for SS suitable for long use in an industrial plant. The filter when flooded shall have a filtration efficiency of 90% down to 10 microns. The filter mat shall be weaved with SS wire of 0.16mm diameter providing an aperture of max 0.025mm
- g) The pressure drop across the filter shall be restricted to 8 mm of WG in clean condition and 12 mm of WG in dirty condition.

5.6.2 FINE FILTER



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- a) Filter Media: Synthetic non-woven for fresh air pressurization (MCC).
- b) Efficiency: 99.9% down to 5 micron
- c) Allowable pressure drop: For HDPE (SNW) -6 mm WG during clean condition & 12 mm WG during dirty condition.
- d) Frame Work: 18 G GSS.
- e) Size -610 x 610 mm (Approx.)
- f) The filter media shall be sandwiched in between two galvanized wire netting arrangement in a uniformly corrugated form to increase the surface area.
- g) The filter shall be fixed in GI angle iron frames of adequate thickness suitable for long use in an industrial plant.

5.7 WATER FILTER FOR UAF

As per clause no. 5.6.1(F)

5.8 VALVES:

- a) Valves shall have full sizes port and suitable for horizontal and as well as vertical installation.
- b) Valves for regulating duty shall be of globe type suitable for controlling throughout its lift.
- c) Gate, Globe and stop check valves shall have bonnet back seat to facilitate easy replacement of packing with the valves in service.
- d) All safety / relief valves shall be so constructed that the failure of any part does not obstruct the free discharge.
- e) Manual gear operator shall be provided for valves of size 250 NB and above.
- f) All valves with rising stem shall have position indicators.
- g) All valves shall be provided with locking arrangement.
- h) All water line valves shall be of cast iron body for sizes 65 NB and above conforming to IS: 14846 and Gun metal construction for sizes less than 65 NB conforming to IS: 778. Cast iron parts shall conform to IS: 210 Gr. FG 260.

5.9 CENTRIFUGAL PUMP

- a) Pump shaft: EN-8 as per ES-900
- b) Casing: Cast iron to IS: 210 GR. FG-260.
- c) Shaft Sleeve: SS 316/ Bronze as per IS-318.
- d) Base plate: Carbon steel as per the IS-2062 Gr.B.
- e) Bolt and nuts: M.S. (Epoxy painted / Galvanized).



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f) Type of seal: Mechanical

For further details of individual equipment listed at Sl.no 4 & 5, kindly refer attached customer specification Section-I, Sub-Section-C2A for Customer specification.

6.0 SPECIFIC REQUIREMENTS: -

- 6.1 The system shall be design to maintain specified inside design conditions during peak summer under design outdoor condition.
- 6.2 All ventilation system shall operate on 100% fresh air.
- 6.3 The air washer shall have minimum 90% saturation efficiency and UAF shall have 60% saturation efficiency.
- 6.4 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 in power house building, as well as Electrical areas of ESP Control Building, FGD MCC cum control building which will close in case of fire. Fire Damper shall have fire rating minimum 120 minutes.
- 6.5 The name plate rating of all motors at 50 deg C shall have at least 15% margin over the input power requirement of the driven equipment at rated duty point.
- 6.6 Design margin of 10 % shall be maintained on pump head as well as flow
- 6.7 Roof extractor / wall mounted fans shall be selected so as to have motor rating and wall / slab opening as under:

1.	Roof extractor units with 15 mmwc static pressure.		
	Capacity	Motor rating	Roof / Slab opening
a.	50,000 CMH	5.5 KW	1260 mm
b.	40,000 CMH	5.5 KW	1260 mm
c.	20,000 CMH	2.2 KW	900mm(to be decided during detail engineering)
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



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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.	6,000 CMH	1.1 KW	600mmx600mm
e.	4,000 CMH	0.75 KW	500mmx500mm
e.	2,000 CMH	0.55 KW	500mmx500mm
5	Axial flow exhaust fans (Bifurcated type) with 25 mmwc static pressure.		
	Capacity	Motor Rating	Wall Opening
a.	20,000 CMH	2.2 KW	900mm x 900mm (to be decided during detail engineering
b	15,000 CMH	1.5 KW	800mm x 800mm (to be decided during detail engineering
6	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



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e.	2,000 CMH	0.37 KW	500mmx500mm
7	Exhaust fan (propeller type) with 5 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	1200 CMH	100 W	400 mm circular

7.0 PLANT CONTROL FOR EVAPORATIVE COOLING AND VENTILATION SYSTEM

1. The operation of the Ventilation plant and associated Air washers/UAF shall be done from the PLC based control System which is common with air conditioning system (PLC shall be part of the air conditioning system package).
 - PLC based controls in the ventilation system is provided only for the air washers of the powerhouse building and UAF for ESP control building and FGD MCC cum control building.
 - Supply air fans, exhaust air fans / roof extractor units of each area shall be provided with their local starter panel(in BHEL scope).
2. Air washer units shall be started/stopped by initiation from air conditioning system PLC and the starting/stopping of fans and pumps shall be automatic upon such initiation.
3. There shall be inter-locking of the Fire dampers & AWU/UAF with the PLC panel of the air conditioning system (part of air conditioning system package) and the fire alarm panel (part of fire protection and detection system package).
4. The operation of the pumps shall be interlocked with the low level of water in the sump. High level of the sump shall be annunciated. The standby pump shall be started automatically when the working pump is stopped/tripped.
5. Auto/manual selector switches and working/standby selector switches for the pump shall be provided in the panel.
6. A selection switch enabling the running of AWU/UAF fan or pump alone shall be provided.
7. All instrument Air distribution for SOV shall be through SS manifold with SS isolation and auto drain traps
8. Solenoid valves shall be kept in pneumatic junction boxes only. SS tubing from SOV to valve shall not be more than 10 meters.



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9. Miscellaneous control requirements

- a. Separate emergency local stop push button shall be provided for each pump, fans etc. of ventilation system.
- b. Lamps shall be provided for indicating the status of each pump, fans etc. of ventilation system in the main and local panel.
- c. All the annunciations related to failure of equipment, tripping of equipment, source of failure / reason due to which the equipment is stopped / tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc. shall be provided for each pump, fan, AWU etc. in the respective panel.
- d. The fans (both supply and exhaust fans) associated with mechanical ventilation system shall be operated locally.
- e. Fully wired, twenty percent (20%) spare annunciation windows shall be provided in all the panels.

8.0 ACCEPTANCE TEST

Temperature test at the out let of Air washer & UAF. Both DB and WB temperature shall be measured by measured by sling psychrometer which will have accuracy of +/-0.5% with at least count of 0.5 deg C. This will be carried out for 24 hrs. Continuously and readings will be taken every one hours interval. Standby equipment should be changed over during these 24 hours. This test shall be carried out during summer. The format for recording the readings is enclosed at Annexure C.

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

The following measurements are also to be done prior to the acceptance of the plant by the client:

01. Air Quantity measurement to be taken at the Inlet Louver to establish the Equipment capacity in line with the specification requirement.
02. Power consumption to be measured for each equipment to establish the total Guaranteed Power consumption.
03. Measurement of Noise and Vibration for different Equipment.
04. Establishment of the saturation efficiency for all the Air Washer and Unitary Air Filtration Units.
05. Design dry bulb temperature and relative humidity of conditioned air



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Instruments required for performance testing of various equipment / system of the package shall be arranged by Vendor at site. All calibrated instruments to be used for the tests at manufacturer's works/site shall be arranged by the bidder. Any Electrical/C&I items and accessories like junction box, glands etc. shall be included by vendor in his scope.

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%.

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

9.0 GENERAL

- 9.1 Basis of design, all calculations including heat load calculations for all 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.
- 9.2 Vendor to include the Back wash arrangement of pot strainer with gate valve, piping etc for the Air Washer.
- 9.3 All drawings and documents shall be computer based.
- 9.4 All commissioning spares & consumables for trouble free operation shall be provided.
- 9.5 Quality Requirements in the Technical Specification are indicating minimum requirements for inspection and testing. Vendor shall note that quality plan is subject to Customer & BHEL approval during detail engineering stage.
- 9.6 Indicative list of makes is enclosed elsewhere in the specifications; however, this equipment's / items shall be subject to Customer & BHEL approval during detail engineering Stage.
- 9.7 Instruments required for performance testing of various equipment / system of the package shall be arranged by Vendor at site.
- 9.8 Instrument for testing shall be calibrated by Ventilation plant supplier before taking up testing.



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- 9.9 Inserts or any support arrangement for fixing ducting, fans, piping etc. shall not be provided by BHEL except for supporting structure mentioned in exclusion. Necessary supports may be taken from nearest structure / walls / roofs / floors etc. by Vendor.
- 9.10 Fixing frame works for diffusers and grilles in the scope of Vendor.
- 9.11 Anchor fastener shall be used by vendor for fixing duct pipes etc. wherever applicable.
- 9.12 Drain piping for ventilation equipment shall be terminated to the nearest drain by bidder.
- 9.13 The tools and machine required for erection of equipment shall be arranged by Vendor.
- 9.14 Tools & tackles as required for regular maintenance shall be supplied by Vendor.
- 9.15 Temperature gauges shall be provided with thermo wells and fixing arrangement.
- 9.16 Pressure gauges shall have provision for air venting. Three way valves shall be used which shall have air venting provision.
- 9.17 Matching sockets / stubs (weld type) for flow switches and other instruments shall be supplied.
- 9.18 Motorized fire damper will be installed at supply air duct in electrical areas like MCC / Switchgear room / cable spreader room etc. in power house building, ESP building and FGD MCC cum 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 respective Air washers / UAFs shall trip on receiving fire signal from fire protection system.
- 9.19 Tender drawings enclosed form the part of specification and the bidder shall check the space requirements.
- 9.20 The drawings/ documents submitted by vendor shall be complete in all respects with revised drawing submitted incorporating all comments. Any incomplete drawing submitted shall be treated as non- submission with delays attributable to vendor's account. For any clarification/discussion required to complete the drawings, the bidder shall himself depute his personal to BHEL / Customer's place any number of time as per the requirement for across the table discussions/ finalizations/ submissions of drawings.
- 9.21 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 provided by BHEL. Grouting of fans along with anchor fasteners shall also be done by bidder.
- 9.22 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 bidder. 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 bidder.
- 9.23 Flat, platform type RCC / PCC foundation shall be provided for installing Air washer / 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.
- 9.24 Bidder to note that the P&ID shows only the bare minimum requirement of valves and instruments. Any instrumentation & valves as required for the completion of the system in



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line with technical specification shall be provided by bidder during detailed engineering without any commercial implication.

- 9.25 Circulating water capacity for Air washer units shall be minimum 1 M3/hr per 1000 M3/hr of air flow while for Unitary Filtration Unit, it shall be minimum 0.7 M3/hr per 1000 M3 /hr of air flow.
- 9.26 All the equipment of Ventilation system shall be designed for continuous duty for continuous operation of 24 hours a day.
- 9.27 All codes and standards shall be as per contract specifications.
- 9.28 All chemical, regents, lubricants and consumables such as grease etc. required for pre-commissioning, commissioning, performance testing and till one year of operation after handing over shall be provided.
- 9.29 Vendor to furnish drawings / documents as per the drgs. /documents submission schedule given in the contract.
- 9.30 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.
- 9.31 All electrical equipment shall be suitable for the power supply fault levels and other climatic conditions indicated in project information / synopsis enclosed with the specification and Section-I, Sub-Section-C3 of the technical specification.
- 9.32 The bidder's proposal shall be for equipment in accordance with the Tech. Specification.
- 9.33 Bidder should suitably group the signals coming from various instrument etc. and the same shall terminate in local JB, from Local JB common cable to PLC / panel / MCC shall be selected. Any Electrical / C&I items and accessories like junction box, glands etc. shall be included by vendor in his scope. Only those items shall be provided free of cost which are categorically listed in the Electrical scope sheet of technical specification.
- 9.34 Feeder for a combination of fire dampers / valves etc. shall be derived from respective control panel by bidder. Distribution through junction box / distribution board shall be in bidders' scope and shall have provision for isolation of individual fire damper / valves. Suitable transformer shall be provided by bidder (if required) to derive the power input.
- 9.35 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.
- 9.36 Bidder to note that BHEL reserve the right for drg/doc submission through web based Document Management System. Bidder would be provided access to the DMS for drg/doc approval and adequate training for the same. Bidder to ensure proper net connectivity at their end.
- 9.37 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%.
- 9.38 Besides the system performance as above, bidder shall guarantee major technical parameters of various equipments as per design basis / details furnished.



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- 9.39 Secondary supports, anchoring/fastening, tie rods and other duct supports for the ducts along A-row and B –row in all areas of the plant shall be in bidder scope.
- 9.40 The guarantee tests shall cover but not limited to the following rated parameters for smooth operation of ventilation system.
- Design dry bulb temperature and relative humidity of conditioned air, Auxiliary power consumption, Vibration and noise level etc.
 - Performance test of the Ventilation system shall be carried out at site after proper installation. The site test shall include performance testing of equipment for 72 continuous hours in summer or monsoon and 24 continuous hours in winter. Bidder, as may be required to carry out site tests shall arrange all instruments, tools etc.
 - All calibrated instruments to be used for the tests at manufacturer's works/site shall be arranged by the bidder. Any Electrical/C&I items and accessories like junction box, glands etc. shall be included by vendor in his scope. Only those items shall be provide free of cost which are categorically listed in the Electrical scope sheet of technical specification.

10.0 EXCLUSIONS

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

- 10.1 Construction of foundations for Ventilation equipment's i.e, air washer unit and UAF along with pumps, roof/wall openings for RE/exhaust fans /supply fans /dampers/louvres. The openings shall be provided by BHEL and its dimensions shall strictly be in accordance to the dimensions of fans/RE's/ dampers/louvres mentioned in this specification. Further, making good, the civil works after completion of erection of HVAC equipment's for all the areas in the scope of this specification, where bidder's equipment's are going to be installed is in bidder' scope
- 10.2 Slab cut out for running ducts, pipes, cables, grilles/dampers, cable trenches for above mentioned buildings. However, 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 bidder
- 10.3 For Electrical scope, refer Electrical scope matrix sheet of Electrical specification.
- 10.4 For C&I scope, refer C&I specification.
- 10.5 Primary Structure for running the ventilation ducting header outside 'A'- Row and along the B-row, however required inputs shall be provided by the bidder. Further the secondary supports, anchoring/fastening, tie rods and other duct supports for the ducts in all areas of the plant shall be in bidder scope.

11. ELECTRICAL

For electrical requirements of air conditioning system, refer Section-I, Sub-Section-C3 of the technical specification.



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12. WATER SUPPLY ARRANGEMENT

Makeup water for cooling tower/Other HVAC Equipment's shall be supplied from HVAC make-up pumps by BHEL. The termination details of the water supply pipe shall be as indicated in the attached scheme (Annexure-D).

13. INSTRUMENT/SERVICE AIR ARRANGEMENT

Instrument air and service air requirement shall be met from the main plant compressors. The tapping for the instrument/service air from the nearest available header along with isolation valve shall be in bidder scope.

14. CONTROL AND INSTRUMENTATION -

For controls and instrumentation of air conditioning system, refer Section-I, Sub-Section-C4 of the technical specification.



**DESIGN MEMORANDUM FOR VENTILATION
SYSTEM
5X800 MW YADADRI TPS**

ANNEXURE-C

FORMAT FOR RECORDING ROOM CONDITION TEST

Instrument Used & Sl.no:
Reading Set No:
Location:
Date:

Time / hrs.	Outside condition	Inside condition
	Reading Dry bulb (Deg C)	Reading Dry bulb (Deg C)



**DESIGN MEMORANDUM FOR VENTILATION
SYSTEM
5X800 MW YADADRI TPS**

DESIGN MEMORANDUM FOR VENTILATION SYSTEM

ANNEXURE-C

FORMAT FOR RECORDING NOISE AND VIBRATION

Instrument Used & Sl.no:

Reading Set No:

Location:

Date:

<u>SR. NO.</u>	<u>EQUIPMENT</u>	<u>NOISE READING</u>	<u>VIBRATION READING</u>



**DESIGN MEMORANDUM FOR VENTILATION
SYSTEM
5X800 MW YADADRI TPS**

ANNEXURE-C

FORMAT FOR RECORDING SATURATION EFFICIENCY

Instrument Used & Sl.no:

Reading Set No:

Location:

Date:

METHOD OF CALCULATION:

$$T_e - T_1$$

$$\text{Saturation Efficiency \%} = \frac{T_e - T_1}{T_e - t_e} \times 100\% \geq 90\%$$

$$T_e - t_e$$

Where, T_e = Dry bulb temperature of air entering the Air Washer.

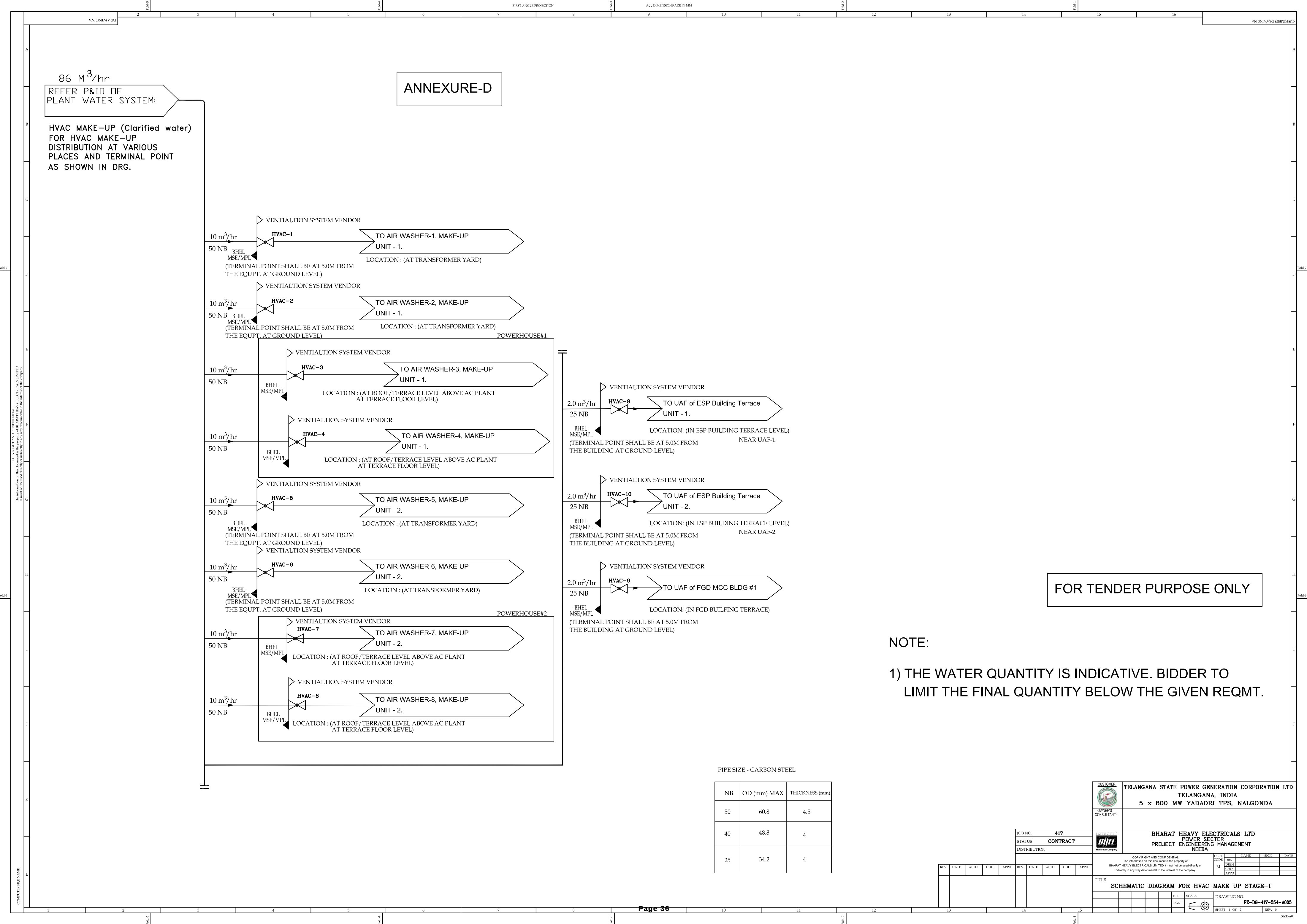
T_1 = Dry bulb temperature of air leaving the Air washer.

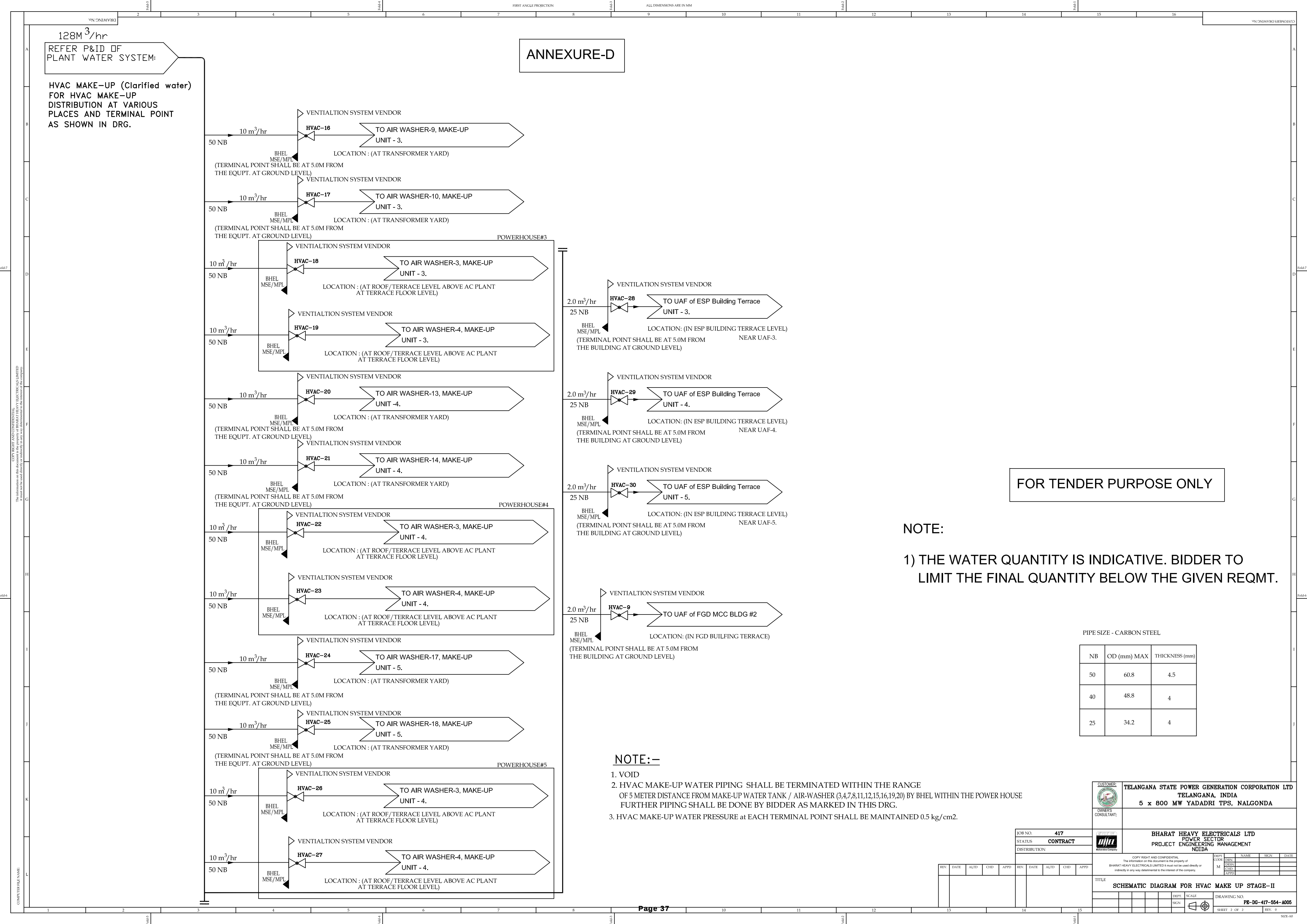
t_e = Wet bulb temperature of air entering the Air washer.

Dry bulb & Wet bulb temperature measured by sling psychrometer shall be taken through moving air and continued till thermometer reading becomes steady.

Enclosure: "Record Form" for recording dry bulb/wet bulb temp.

Note: Saturation (efficiency) measurement shall be done for other Air washer also.





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OWNERS CONSULTANT:	
DESIGNER:	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT Noida

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TITLE

SCHEMATIC DIAGRAM FOR HVAC MAKE UP STAGE-II

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**SPECIFIC TECHNICAL REQUIREMENT
FOR VENTILATION SYSTEM (SWITCHYARD AREA)
5X800 MW YADADRI TPS**

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SPECIFIC TECHNICAL REQUIREMENT FOR VENTILATION
SYSTEM (SWITCHYARD AREA)**



SECTION -1

INTENT, SYSTEM DESCRIPTION, DESIGN CRITERIA AND SCOPE

1.0 VENTILATION REQUIREMENTS FOR SWITCHYARD CONTROL BUILDING

1.1.0 Design Criteria:

1.2.0

	Summer	Monsoon	Winter
DBT (°C)	42.7	30.9	15.7
WBT (°C)	26.5	26.3	13.6

- ❖ Equipment loads for LT switchgear, Battery room & cable cellar room are tentative and may vary during detailed engg.

1.1.1 VENTILATION SYSTEM

- All the areas served by means of dry mechanical ventilation shall be designed for a maximum inside temperature of 3 deg. Celsius above the design ambient (DBT) condition during summer or according to suitable air changes per hour. The criterion that gives the highest flow rate will be considered for design & selection of the equipment.
- All the ventilation fans shall operate on 100% fresh air considering 15 air changes per hour (ACPH) for LT Switchgear room & cable spreader room, 20 ACPH for battery room.
- Tube Axial Supply air fans of suitable capacity (CMH) & required static head (WC) each having pre filter/ fine filter, rain protection cowl, bird screen and mounting arrangement shall be provided for positive pressurization of the LT Switchgear room. Suitable no. of back draft dampers shall be provided for air exhaust in this room.
- Tube Axial Exhaust fans of suitable capacity (CMH) each having intake louvers for intake air, rain protection cowl, bird screen and mounting arrangement shall be envisaged for the following rooms:
 - Cable spreader
 - Battery room - Motors for the fans of this room shall be flameproof with epoxy painting. These exhaust fans shall be of bifurcated construction with motor away from the air stream. These fans shall have spark proof construction. Static head of the fans shall be 15mm (min). Each fan shall have fusible link fire damper.
100% standby fans shall be provided for Battery room.
Supply of washed air to battery room shall be through intake louvers provided in wall opposite to the exhaust fan.



- e) Structural support for suitable placing of ventilation fans on walls shall be ensured for these rooms accordingly.
- f) Intake louvers shall be provided for rooms with exhaust ventilation in the wall openings provided.
- g) Air Velocity through different system equipment should be maintained as follows:
 - i. Intake Louvers: 2m/s through face area (Max.)
 - ii. Exhaust Louver: 2m/s through face area (Max.)
 - iii. Back Draft dampers: 5m/s through face area (Max.)

✓ **Notes:**

- i. The axial fans for shall be of tube axial type.
- ii. Painting of all equipment and structures shall be provided and the colour & quality shall be subject to approval by the Client / Engineer.

h) ELECTRICAL REQUIREMENTS FOR VENTILATION SYSTEM

Wall mounted panel with TPN MCB as incomer & outgoing feeders for extending power supplies to ventilation fans shall be provided in each of the LT Switchgear Room, Cable cellar room & Battery rooms. Indication lamps for incoming power supply, ON/ OFF/ TRIP indication lamps for fans shall be provided.

Incomers of suitable rating from the ACDB will be terminated in each of these 3 nos. wall mounted panel. Spare feeders shall be provided in these panels as per requirement.

i) MANDATORY SPARES

Following items shall be provided as spares against the main items:

S. N.	Item	Qty
1	Fan-motor Bearing	2 sets for each rating of fan
2	Vibration Isolators	2 sets for each fan
3	Fan Motor	2 sets for each rating of fan

j) Equipment Specification

A. Axial Flow Fans

Each of the Wall mounted axial flow fans to be provided shall be complete with:

- i. Casing: M.S. sheet – 3 mm thk for fan dia upto 750 mm, 5mm thick for fan dia of 750 mm and above as per IS:1079 / IS:2062 Gr.B
- ii. Impeller: Cast Aluminum. (Alloy A-6M, IS-617)
- iii. Hub: As per manufacturer std. (AL- LM6)
- iv. Support frame and structure: M.S. of adequate thickness (Galvanized / painted) IS-2062 Gr.B.



CLIENT – TELANGANA STATE GENERATION COMPANY (TSGENCO)
CONSULTANT- TATA CONSULTING ENGINEERS, BANGALORE
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- v. Neoprene rubber pads: As required.
- vi. Coned inlet for wall exhausters / supply fans: MS (IS-2062 Gr.B)
- vii. Supporting frame for mounting: As Required.
- viii. Protective screen at inlet: Yes (Min 14 SWG Galvanized wire knitted in 1" square mesh).
- ix. Rain Protection Cowl: Aluminum or hot dip galvanized after fabrication from MS.
- x. Mounting flange on casing: At inlet and outlet.
- xi. Electric drive motor of suitable rating considering at least 15% margin over the shaft power consumption including motor brackets.
- xii. Short duct (wherever required).
- xiii. Dry filters including fixing framework for fan filter unit (wherever required).
- xiv. Back draft dampers, wherever specified.
- xv. Protective wire netting inside the room, wherever required.
- xvi. Painting / protecting coating – All the MS parts shall be galvanized or protected with three coats of epoxy paint.

B. Drive Motors

Motors shall cater to the following requirements:

- i. All exhaust fan motors shall be designed for a minimum of 55 Deg C ambient temperatures.
Supply air fan motors shall be designed for a minimum of 50 Deg C ambient temperatures.
- ii. Motor rating for axial flow fans shall be minimum 115% of the fan power at duty condition.
- iii. Insulation of motor windings shall be class 'B'. In case of substitution by class F insulation, the temperature rise shall be limited to class B temperature rise as per IS: 325.

C. Dry Filter

The filter media shall be designed to hold dust and prevent it from being dislodged by vibration or other cause and passing through filter. The filter media shall be of High Density Poly Ethylene. The filter shall have G.I. frames of adequate thickness but not less than 18 SWG suitable for long use in an industrial plant. The filters may be in panels of sizes about 610 mm x 610 mm for easy handling of the same. The face velocity of air across the filters shall not exceed 2.5 m/sec. The efficiency of fine filter shall be about 99% down to 5 micron size particles. Allowable pressure drop during clean and dirty conditions shall be 6 mm WG and 10 mm WG respectively.

2.0.0 SCOPE

The requirement(s) mentioned under this clause are indicative and minimum for the system. Any other item / service required to complete the work for safe and sound operation of system shall be provided and installed by the bidder at no extra cost to the Purchaser / Customer. The bidder may bring out such requirement(s) suitably.



CLIENT – TELANGANA STATE GENERATION COMPANY (TSGENCO)
CONSULTANT- TATA CONSULTING ENGINEERS, BANGALORE
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2.1.0 SCOPE OF SUPPLY

2.1.1 Complete supplies for Ventilation system (as per clause no. 2.0)

The equipments and services to be furnished under this contract are detailed here under Annexure-III of price schedule for reference. Bidders shall work out the actual requirement based on the building layout enclosed with this specification. The items though not specifically mentioned but required for safe and satisfactory operation of the system will also be treated as included and the same shall be supplied at **NO EXTRA COST** to BHEL.

The Bill of Quantities shall be read in conjunction with the Instructions to Bidders, General and Special Conditions of Contract, Technical Specifications, and Drawings.

The quantities given in the Bill of Quantities are estimated and provisional, and are given to provide a common basis for bidding. The basis of payment will be the actual quantities of work ordered and carried out, as measured by the Contractor and verified by the Purchaser and valued at the rates and prices bid in the priced Bill of Quantities.

A rate or price shall be entered against each item in the priced Bill of Quantities. The cost of Items against which the Contractor has failed to enter a rate or price shall be deemed to be covered by other rates and prices entered in the Bill of Quantities.

The whole cost of complying with the provisions of the Contract shall be included in the Items provided in the priced Bill of Quantities, and where no Items are provided, the cost shall be deemed to be distributed among the rates and prices entered for the related Items of Work.

General directions and descriptions of work and materials are not necessarily repeated nor summarized in the Bill of Quantities. References to the relevant sections of the Contract documentation shall be made before entering prices against each item in the priced Bill of Quantities.

Miscellaneous items like hardware, fixtures etc. shall be deemed to be included under the relevant BOQ items and bidders shall consider the same while quoting for BOQ items.

2.1.2 Besides, the Bidder shall take a note of the following while preparing his offer:

- Supply of power & control cables have been excluded from contractor's scope of supply. BHEL will provide power & control cables to the vendor as free issue item. Contractor shall have to choose their cables from the available sizes as listed in Annexure – I to Section-1 and necessary modifications in their equipment for termination of these cables shall be made by contractor.
- Purchaser will lay incomer cables upto contractor's wall mounted panel in each of the rooms specified above. Termination of the same shall be done by the contractor. Cabling (laying & termination) further to fans etc. and for control & interlocking of various equipments shall be in contractor's scope. Supply of cable accessories such as lugs, glands, cable tags & markers etc. shall be included by the bidders in their offers.
- Necessary cable trays will be supplied on free issue basis to the contractor, however necessary hardware for fixing the same on walls or elsewhere shall be included by the bidders in their offers.



- d) Earthing material viz. (GS flat 75 x 10, 50 x 6 & 25 x 3 mm) will also be supplied on free issue basis to contractor; however requirement shall be given by the bidders in their respective bids.
- e) Contractor shall submit valid Type test report for approval by Customer. Fresh type test of equipment is not envisaged. It is presumed that equipment offered is duly type tested.
- f) In case the type test reports are found un-satisfactory, tests shall be carried out afresh by contractor without any additional cost implication to BHEL.
- g) Bidder shall submit quality plan of the items of this system during detailed engineering stage in standard BHEL quality plan format for customer approval.
- h) Obtaining, "As Built" certification from purchaser or Customer on applicable drawings. Completing documentation as per specification requirement shall be in contractor scope of services.

2.1.3 SCOPE OF SERVICES

2.1.3.1 Erection, Testing & Commissioning (ETC) requirements

- i. The scope of ETC shall include receipt of material at site, safe storage of material, handling of equipment/material at site, erection of equipment /material at site including fabrication, equipment and system testing, commissioning of the entire system. All material, consumables plus tools & tackles required for completion of ETC work shall be arranged by the bidder.
- ii. Conducting performance guarantee tests to the satisfaction of Customer/ Purchaser and handing over of the system to Customer / Purchaser. Bidder shall submit the PG test procedure at the time of detailed engineering for approval by customer/ purchaser.
- iii. It is the responsibility of the Bidder to maintain the system till it is handed over to customer / Purchaser.
- iv. Earthing of all installation under the present scope shall be done by the contractor.
- v. All machinery - tools & tackles and consumables required for erection / commissioning of the system shall be arranged by the bidder.
- vi. Bidder shall ensure that sufficient quantities of commissioning spares are made available for timely completion of commissioning of the system. The bidder shall furnish a list of Commissioning spares that will be brought by him. The unused commissioning spares shall be returnable to the Bidder.
- vii. Laying & fixing of cable trays on walls or elsewhere. Necessary hardware for the same shall be included by the bidder in their offer.
- viii. Painting of all the equipments shall be as per customer specification.

2.1.3.2 Civil Works

Following shall be in contractor scope of services:



CLIENT – TELANGANA STATE GENERATION COMPANY (TSGENCO)
CONSULTANT- TATA CONSULTING ENGINEERS, BANGALORE
PROJECT: 5 x 800 MW, YADADRI TPS, NALGONDA
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- Providing necessary guidance to/ coordination with civil contractor so that appropriate sized / correctly located wall openings are made (by civil contractor) for installation ventilation fans.
- In case desired inputs for wall openings are not provided/ delayed by the contractor the same shall be made by the contractor without any cost implication to BHEL. Associated civil works such as grouting, filling up crevices/cut outs etc during installations of equipments shall also be in contractor's scope. Any other damage caused to civil works during ETC work of the equipment/system shall be made good to the original finish by the contractor at no extra cost to the purchaser.
- Minor modifications, alterations in system installation as per customer's specific requirements shall be done without any extra cost to purchaser.
- Fans of various sizes shall be suitable for the wall opening as per the following details:

S. N.	Fan	Space provided for wall opening
1.	7500 CMH fan in LT Switchgear room	600 mm x 600 mm
2.	7500 CMH fan in Battery room	600 mm x 600 mm
3.	7500 CMH fan in Cable Cellar room	600 mm x 600 mm

3.1 Exclusions

- Supply of Cable trays for laying cables. Installation wherever required is in contractor scope.
- Supply of power and control cables. The bidder shall chose from the BHEL procured cables listed in Annexure-I to this section & furnish **quantity** and **type** of cables required complete system in their respective bids. Laying & termination is in contractor scope.
- Supply of GI flat for earthing of equipments.

3.2 OPERATION & MAINTENANCE (O&M) MANUAL

Operation and Maintenance manuals shall be specifically compiled for the project by the bidders. The draft O&M manual shall be submitted along with supply of the various items. The O&M manual shall contain the following information:

- Description of the system and equipment with design particulars.
- Instruction for erection.
- Instruction for operation, maintenance and repair.
- Recommended inspection practices and inspection schedule.
- Ordering information for all replaceable parts.
- Recommendation for type of lubricants and frequency of lubrication.

3.3 Handing & Taking Over

It is the responsibility of the contractor to maintain the system till it is handed over. The system/ equipment before being handed over shall be subjected to successful run test for a minimum period



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of one week during which all readings shall be taken and recorded. Any defect noted during the period shall be rectified by the contractor. This running test shall be in addition to the performance tests specified earlier.

3.4 Inspection & Testing

All equipments shall be inspected prior to dispatch in line with relevant IS, approved GTP/ drawing, technical specification & BHEL/ customer approved QAP.

- Equipment Specification shall be as per TSGENCO/BHEL specification attached herewith.



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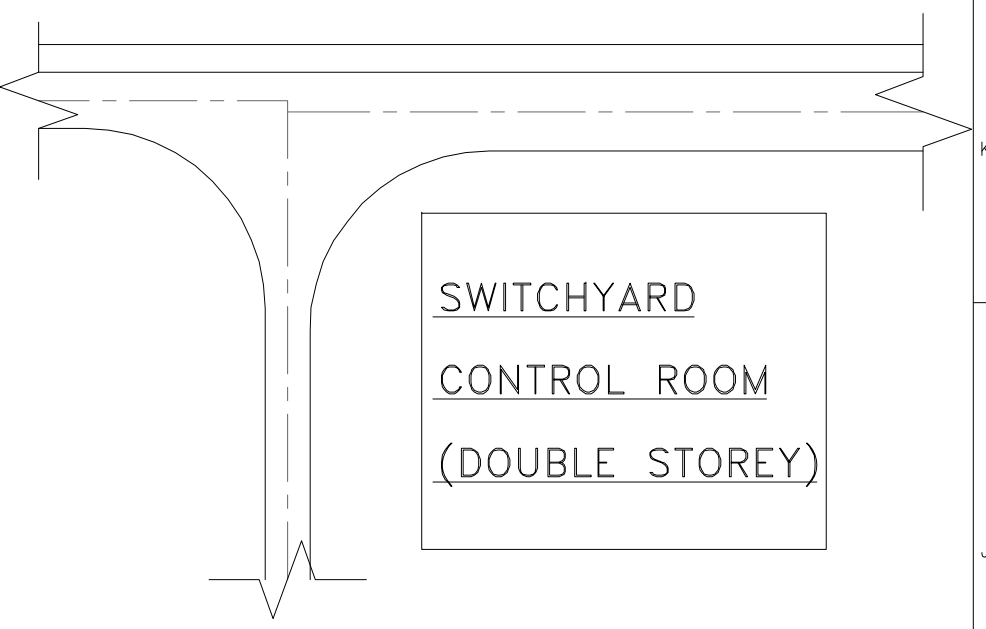
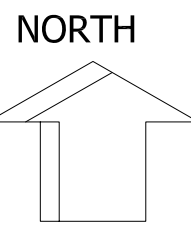
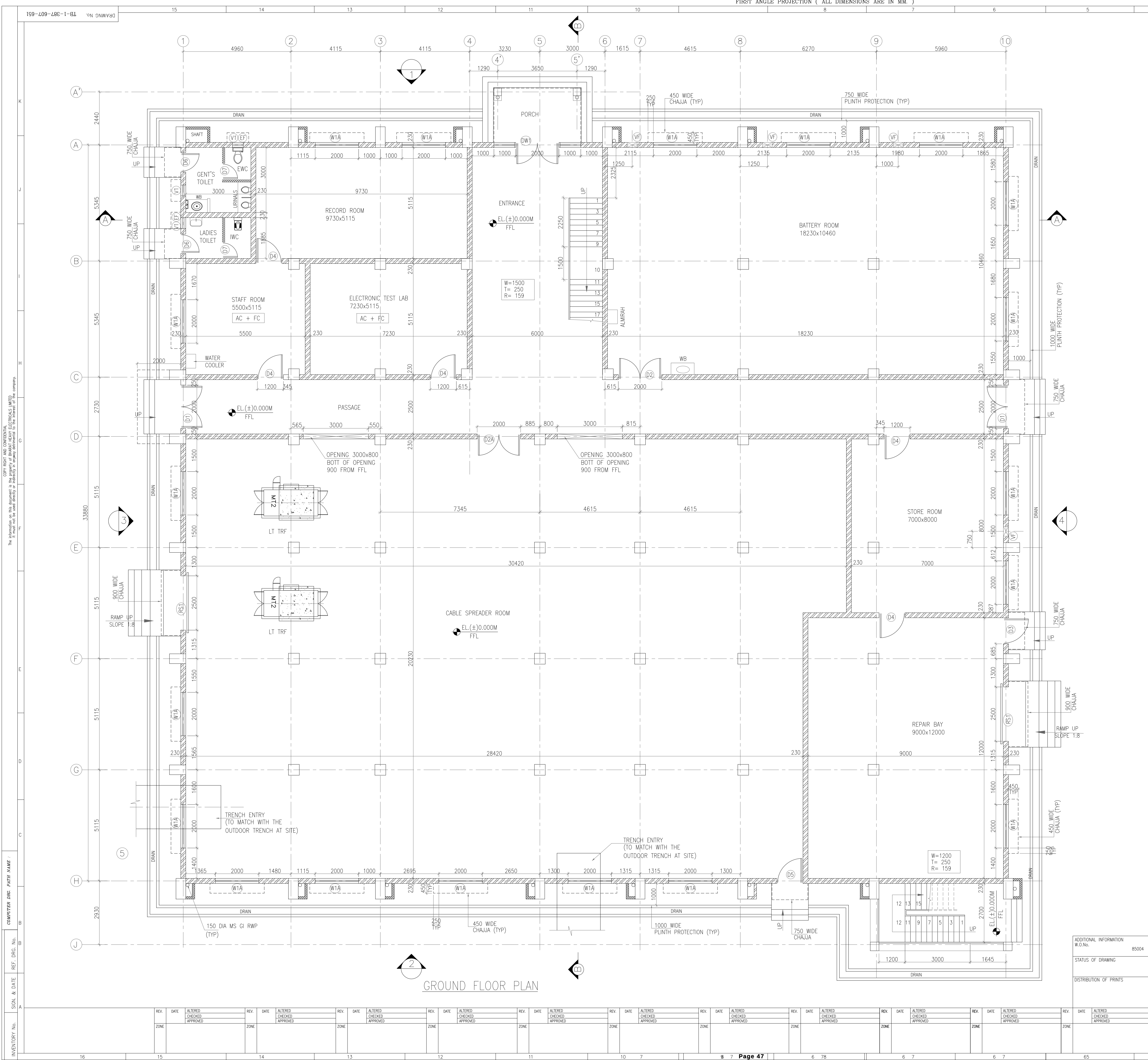
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ANNEXURE - I

LIST OF THE CABLES PROCURED BY BHEL

2C x 2.5 sq mm PVC/ Copper, Armoured
5C x 4 sq mm PVC/ Copper, Armoured
5C x 2.5 sq mm PVC/ Copper, Armoured
7C x 2.5 sq mm PVC/ Copper, Armoured
14C x 2.5 sq mm PVC/ Copper, Armoured
19C x 2.5 sq mm PVC/ Copper, Armoured
2C x 10 sq.mm XLPE/ Aluminium, Armoured
4C x 10 sq.mm XLPE/ Aluminium, Armoured
4C x 16 sq.mm XLPE/Aluminium, Armoured
3.5C x 35 sq.mm XLPE/ Aluminium, Armoured
3.5C x 70 sqmm XLPE/ Aluminium, Armoured
3.5C x 300 sqmm XLPE/Aluminium, Armoured



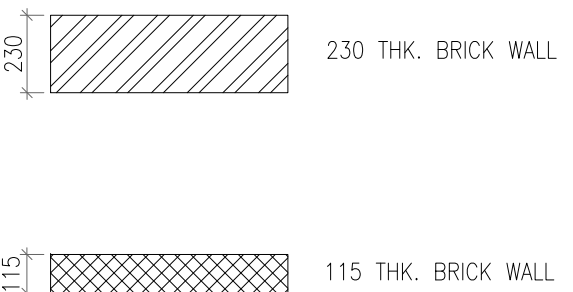
SWITCHYARD
CONTROL ROOM
(DOUBLE STOREY)

KEY PLAN

- NOTES:-
1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
 2. ALL WINDOWS AND VENTILATORS ON GROUND FLOOR OF ALL BUILDINGS SHALL BE PROVIDED WITH SUITABLE MS GRILL.
 3. ALL DOOR-WINDOW, ETC. HEIGHT SHALL BE CONSIDERED FROM FINISH FLOOR LEVEL.
 4. EL.(±)0.00M SHALL BE READ AS GROUND FLOOR LEVEL OF SWITCHYARD.
 5. FINAL LOCATION OF CABLE TRENCHES REFER APPROVED ELECTRICAL DRAWINGS.
 6. SIZE OF EXHAUST FAN & VENTILATION FAN SHALL BE PROVIDED LATTER.

SCHEDULE OF DOORS & WINDOWS					
TYPE	OPENING SIZE	CILL LEVEL	LINTEL LEVEL	NOS.	DESCRIPTION
RS1	2500x3000	-	3000	2	STEEL ROLLING SHUTTER
DW1	4000x2500	-	2500	1	DOUBLE SHUTTER ALUMINIUM DOOR
D1	2000x2500	-	2500	5	DOUBLE SHUTTER ALUMINIUM DOOR
D2	2000x2500	-	2500	3	DOUBLE SHUTTER 2Hrs FIRE RATED DOOR
D2A	2000x2500	-	2500	1	DOUBLE SHUTTER LOUVERED DOOR
D3	1200x2500	-	2500	3	SINGLE SHUTTER ALUMINIUM DOOR
D4	1200x2100	-	2100	7	SINGLE SHUTTER ALUMINIUM DOOR
D5	1200x2500	-	2500	3	SINGLE SHUTTER 2Hrs FIRE RATED SINDOOR
D6	900x2100	-	2100	5	SINGLE SHUTTER WOODEN PANEL DOOR
D7	750x2100	-	2100	4	SINGLE SHUTTER PVC DOOR
W1	2000x1600	900	2500	15	ALUMINIUM GLAZED WINDOW
W1A	2000x1200	900	2100	19	ALUMINIUM GLAZED WINDOW
W2	1200x1400	900	2500	3	ALUMINIUM GLAZED WINDOW
V1	500x900	1600	2500	5	ALUMINIUM GLAZED VENTILATOR
FG1	3000x1600	900	2500	6	ALUMINIUM GLAZED WINDOW
FG2	4000x1600	900	2500	1	ALUMINIUM GLAZED WINDOW

LEGEND :-	
RL	REDUCED LEVEL
FGL	FINISHED GROUND LEVEL
TRL	TOP OF ROAD
FFL	FINISHED FLOOR LEVEL
BOB	BOTTOM OF BEAM
TOC	TOP OF CONCRETE
TOP	TOP OF PARAPET WALL
PCC	PLAIN CEMENT CONCRETE
TOB	TOP OF BEAM
BOF	BOTTOM OF FALSE CEILING
FC	FALSE CEILING
UDI	UNDER DECK INSULATION
W/O	WITH OUT
WPC	WATER PROOF COURSE
RS	ROLLING SHUTTER
D	DOOR
W	WINDOW
FG	FIX GLAZING
EF	EXHAUST FAN
VF	VENTILATION FAN
WB	HAND WASH BASIN



CUSTOMER:	TELANGANA STATE POWER GENERATION CORPORATION LIMITED [TSGENCO] 5X800 MW YADADRI THERMAL POWER STATION
CONSULTANT:	TATA CONSULTING ENGINEERS LTD,BANGALORE
	BHARAT HEAVY ELECTRICALS LTD TRANSMISSION PROJECTS DIVISION
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TITLE	ARCHITECTURAL PLAN OF 400 KV SWITCHYARD CONTROL ROOM BUILDING
DEPT. SCALE 1:75	DRAWING NO. BHEL TB-1-387-607-651
SHEET 01 OF 02	REV. 00



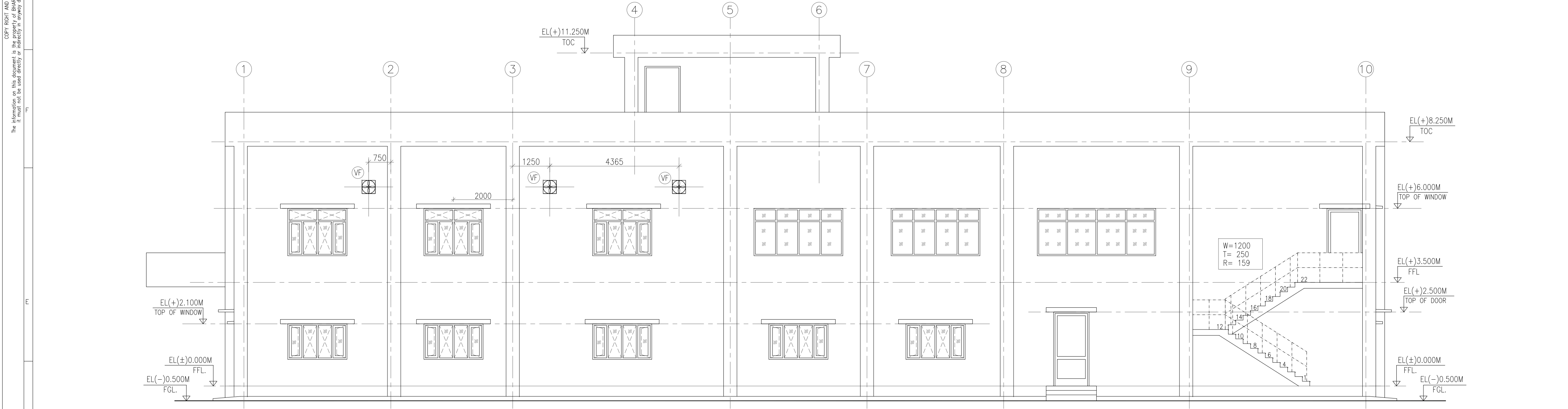
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 Maharashtra Company		BHARAT HEAVY ELECTRICALS LTD TRANSMISSION PROJECTS DIVISION																													
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ELEVATION - 1



ELEVATION - 2

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CONSULTANT: TATA CONSULTING ENGINEERS LTD,BANGALORE

CLIENT: BHARAT HEAVY ELECTRICALS LTD
TRANSMISSION PROJECTS DIVISION

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TITLE
ARCHITECTURAL ELEVATIONS OF 400 KV SWITCHYARD CONTROL ROOM BUILDING

DEPT.	SCALE	DRAWING NO.
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SIGN	DATE	REV.
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ELEVATION - 4



ELEVATION - 3

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**CUSTOMER SPECIFICATION
FOR VENTILATION SYSTEM
5X800 MW YADADRI TPS**

DOCUMENT NO.: PE-TS-417-554-A001

REVISION 00

DATE: FEB 2020

**SECTION: I
SUB-SECTION: C 2
CUSTOMER SPECIFICATION**



**CUSTOMER SPECIFICATION
FOR VENTILATION SYSTEM
5X800 MW YADADRI TPS**

DOCUMENT NO.: PE-TS-417-554-A001

REVISION 00

DATE: FEB 2020

**SECTION: I
SUB-SECTION: C 2A
CUSTOMER SPECIFICATION-TECHNICAL REQUIREMENT**

VOLUME: IIID

SECTION-II

**TECHNICAL SPECIFICATION
FOR
VENTILATION SYSTEM**

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	INTRODUCTION
2.00.00	SYSTEM DESCRIPTION
3.00.00	SCOPE OF SUPPLY
4.00.00	CONTROL PHILOSOPHY
5.00.00	DESIGN CRITERIA
6.00.00	DESIGN AND CONSTRUCTIONAL REQUIREMENT
7.00.00	SPECIAL TOOLS
8.00.00	TESTING AND INSPECITON AT MANUFACTURER'S WORKS
9.00.00	FIELD TEST
10.00.00	PERFORMANCE GUARANTEE, TOLERANCE, PENALTY AND RECORDS
11.00.00	SPECIAL CLEANING, PROTECTION & PAINTING
12.00.00	DOCUMENTS, DATA TO BE FURNISHED WITH TENDER PROPOSAL
13.00.00	POST AWARD DOCUMENTS, DATA TO BE FURNISHED
14.00.00	LIST OF DRAWINGS

VOLUME: IIID**SECTION - II****VENTILATION SYSTEM****1.00.00 INTRODUCTION**

1.01.00 The purpose of the system is to provide ventilation for different areas of 1X800 MW Supercritical Thermal Power Plant (Stage –VII, Unit #12 at Kothagudem Thermal Power Station, Telangana) to achieve the following :-

- i) Acceptable working environment.
- ii) Scavenging out structural heat gain and heat load from various equipment, hot pipes, lighting etc.
- iii) Dilution of air polluted due to generation of obnoxious & hazardous gaseous/aerosol contaminants like acid/chemical fumes, dusts etc.

1.02.00 Evaporative Cooling System with Air Washer Units (AWU) shall be adopted for the ventilation of the following areas of Power House Building:

- i) TG Hall
- ii) MCC, Switchgear rooms and cable spreader rooms
- iii) Battery Charger Rooms

1.03.00 Mechanical Dry Ventilation System with either Supply or Exhaust Fans shall be provided for the following areas of the Power House Building:

- i) Battery Rooms
- ii) Elevator Machine Rooms
- iii) Toilets

1.04.00 Mechanical Dry Ventilation System with Exhaust Fans shall be provided for the following areas of Mill Bay:

- i) Coal Conveyor Tripper floor

1.05.00 Similarly evaporative cooling system with Unitary Air Filtration Units (UAF) shall be provided for the ventilation system for the MCC / Switchgear Rooms and other non-AC areas of the following areas:

- i) Non-AC areas of ESP Control Building
- ii) Ash handling electrical / control building.
- iii) CHP control building

1.05.00 Dry Ventilation System with either Supply or Exhaust Fans shall also be provided for the following Auxiliary Buildings:

- a) DG and Compressor House
- b) Ash slurry pump house
- c) HFO & LDO forwarding pump house
- d) CW treatment building
- e) DM Plant building
- f) DM, service and potable water pump house
- g) Non-AC areas of Chemical House
- h) CPU Regeneration Building
- i) Switch yard control building
- j) CW Pump House
- k) AHP Compressor Building
- l) Non-AC areas of Service Building
- m) Silo Utility-cum-HCSD Pump House
- n) Vacuum pump house
- o) Ash water pump house
- p) Clarified water pump house
- q) Centrifuge building
- r) Store Building

2.00.00 **SYSTEM DESCRIPTION**

2.01.00 Evaporative cooling system by adopting Air Washer Unit (AWU) is to be provided for the ventilation of Power House Building. Cooled and filtered air from Air Washer Units should be distributed by means of ducting to the TG building near various heat sources like turbo-generator, condenser, boiler feed pump, HP & LP heaters, oil coolers etc. The quantity of air exhausted should be kept lower than the quantity of air supplied (usually 60-65% of the supply air is exhausted) in such a way that a little over pressure is maintained inside the hall. This will reduce infiltration of outside hot and dusty air.

On the basis of net heat gain and assumed temperature rise, the supply air quantity for TG hall is to be worked out. This air quantity will be supplied from four (4) AWU - two (2) being placed on B-C bay at De-aerator floor and two (2) being located outside A row of Power House building. Such division and location area is decided to achieve effective air distribution with fewer amounts of duct work and less pressure drop in fans with no cross-over of ducting across A-B bay.

The Air Washer Units will primarily serve TG hall and the electrical areas like MCC Room, Switchgear Room and Cable Spreader Room. The washed air supplied to MCC / Switchgear / Cable Spreader Rooms will be exhausted outside through gravity dampers / exhaust fans (usually 60-65% of the supply air is exhausted to maintain a little overpressure inside the room). Fire dampers (Motorized) shall be provided in the supply air ducting / fans leading to all electrical rooms (MCC, Switchgear etc.).

The supplied air in the lower level of TG hall after taking the heat load of TG bay rises through different openings to the upper floors and is then finally exhausted by means of Roof extractors placed over the roof of TG Hall. Some quantity of air leaks out through various leakage areas due to the overpressure maintained inside the TG Hall.

All these Air Washer Units shall be of package type construction enclosed in sheet metal casing to avoid the problem of water seepage and also to reduce load on building structure. Sump of AWU to be made out of sheet metal / masonry construction with anti-corrosive paintings. All accessories (except water circulation pumps with drive motors, strainers and some portion of piping) shall be placed inside the AWU casing.

Roof extractors are to be provided with rain water protection cover.

While developing the layout, all fresh air ventilation louvers shall be considered 1000 mm from floor level and directed downwards at an angle. Ventilation fans on AB bay roof shall be kept staggered and shall not be near the centerline of turbo generator set.

- 2.02.00 Exhaust (pull type) ventilation system is adopted for the Battery Rooms by providing Bifurcated type axial flow exhaust fans (1R+1S) of spark proof construction and with flame proof motors and fusible link type fire dampers. In the event of failure of any of the battery room exhaust fans, the second fan will be put into operation to take care of the ventilation need of this Battery Room. All the parts of this system coming in contact with acid fumes shall be epoxy painted. The air discharge from the Battery Room shall be taken to a high level (around 1M above TG Building Roof Level) through an exhaust duct (MS Epoxy painted). In case routing of such exhaust duct is not feasible, the steel parts in a radius of around 5M from the discharge end of the Battery Room Exhaust Fans shall have to be painted with acid resistant epoxy resin based paint. Intake Air for the battery room shall be drawn from the adjacent TG hall through manually operated louver shutter provided in the Battery Room.

A negative pressure shall be maintained inside the Battery Room to prevent leakage of acid fumes and other hazardous gases outside the Battery Room.

- 2.03.00 Coal conveyor tripper floor of the Mill Bay shall be ventilated by means of Roof Extractors. Air intake louvers should be provided at lower level for air entry to the coal tripper floor.

- 2.04.00 Pressurized Ventilation system shall be provided for the Elevator Machine rooms with the help of wall mounted Fan-Filter Units. Air will be exhausted through Back Draft Dampers.
- 2.05.00 Exhaust Ventilation system shall be provided for the Toilets by installing wall mounted type exhaust fans. Air will enter the toilets through door grilles.
- 2.06.00 In the MCC/ switchgear room of ESP, AHP & CHP Control Building, washed and filtered air supply will be provided by the Unitary Air Filtration Unit due to the reasons that the this building is located in a very dusty zone and heat load of this Building is high.
- 2.07.00 Ventilation provision for Auxiliary Buildings in various locations shall be done as follows:

Sl. No.	Building	Ventilation System
1.	Electrical MCC/Switchgear areas of ESP Control Building.	Washed and filtered air supply from Unitary Air Filtration Unit (UAF) and exhausting it by back Draft Dampers.
2.	Electrical MCC/Switchgear areas of AHP Control Building.	Washed and filtered air supply from Unitary Air Filtration Unit (UAF) and exhausting it by back Draft Dampers.
3.	Electrical MCC/Switchgear areas of CHP Control Building.	Washed and filtered air supply from Unitary Air Filtration Unit (UAF) and exhausting it by back Draft Dampers.
4.	DG and Compressor Building	For DG area air entry through intake louvers for radiator cooling (in case of air cooled DG) will serve the purpose of ventilation. For water cooled DG, exhaust ventilation will be provided by wall mounted exhaust fans and air entry through inlet louvers. For Compressor area wall mounted Supply air Fan Filter Units and air exhaust through Back Draft Dampers. For the associated Electrical room, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers.
5.	DM Plant building	Wall mounted Exhaust Fans for Plant area and Chemical Storage area and fresh air entry through Inlet Louvers.

6.	Ash Slurry Pump house	Wall mounted supply fans for the pump area. Hot air will be exhausted through wall mounted louvers. For the associated Electrical room, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers.
7.	HFO & LDO Forwarding Pump house	For pump area, wall mounted Exhaust fans of spark proof construction with flame-proof motors and fusible link type fire dampers and fresh air entry through Inlet Louvers. For the associated Electrical room, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers.
8.	CW Treatment Building	Wall mounted Exhaust Fans and fresh air entry through Inlet Louvers.
9.	DM, Service & Potable Water Pump House	Wall mounted supply fans for the pump area. Hot air will be exhausted through wall mounted louvers. For the associated Electrical room, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers.
10.	Chemical House	Wall mounted Exhaust Fans for Plant area and fresh air entry through Inlet Louvers. For the associated Electrical room, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers.
11.	CPU Regeneration Building	Wall mounted Exhaust Fans for Plant area and fresh air entry through Inlet Louvers.
12.	Switch Yard Control Building	For battery room, wall mounted Exhaust fans of spark proof construction with flame-proof motors and fusible link type fire dampers and fresh air entry through Inlet Louvers. For the associated Electrical room, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers.

13.	Store Building	Wall mounted Exhaust Fans and fresh air entry through Inlet Louvers.
14.	CW Pump House	Wall mounted supply fans for the pump area. Hot air will be exhausted through wall mounted louvers. Alternatively, evaporative cooling system may be considered for pump area. For the associated Electrical room, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers.
15.	AHP Compressor Building	For Compressor area wall mounted Supply air Fan Filter Units and air exhaust through back draft dampers. For the associated Electrical room, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers.
16.	Service Building	For Electrical rooms, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers. Exhaust Ventilation system shall be provided for the pantries by installing wall mounted type exhaust fans. Air will enter through door grilles / inlet louvers. Exhaust Ventilation system shall be provided for the stores by installing wall mounted type exhaust fans. Air will enter through door grilles / inlet louvers.
17.	Silo Utility cum HCSD Pump House	Wall mounted supply fans for the pump area. Hot air will be exhausted through wall mounted louvers. For Electrical rooms, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers.
18.	Vacuum Pump House	Wall mounted supply fans for the pump area. Hot air will be exhausted through wall mounted louvers.
19.	Centrifuge Building	Wall mounted Exhaust Fans and fresh air entry through Inlet Louvers.

20.	Ash Water Pump house	Wall mounted supply fans for the pump area. Hot air will be exhausted through wall mounted louvers. For the associated Electrical room, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers.
21.	Clarified Water Pump house	Wall mounted supply fans for the pump area. Hot air will be exhausted through wall mounted louvers. For battery room, wall mounted Exhaust fans of spark proof construction with flame-proof motors and fusible link type fire dampers and fresh air entry through Inlet Louvers. For the associated Electrical room, Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers.
22.	Toilets (For all areas)	Exhaust Ventilation system shall be provided for the Toilets by installing wall mounted type exhaust fans. Air will enter the toilets through door grilles.

N.B. Above requirement is tentative only based on the current Plot Plan. Final requirement of ventilation will be decided during detail engineering when the list of buildings will be finalized and layout drawing of each building will be frozen.

2.08.00 In general, for a particular area / room ventilation equipment / systems shall be selected in multiple modules and therefore no idle stand-by equipment has been envisaged. However, for the Battery Rooms one idle stand-by fan unit shall be provided in consideration of their locations and hazardous spreading of acid fumes in case of failure of running fan.

3.00.00 SCOPE OF SUPPLY

3.01.00 Equipment

Equipment sizing is to be done on the basis of heat load and number of air changes. The higher of the sizes arising out of these requirements should be considered. Selection of fan duty conditions is to be supported by back-up calculations, to be enclosed with bid.

- 3.01.01 Centrifugal Fan unit each complete with:
- a) Fan impeller (backward curved) with casing and supports and required steel frame / supporting structure, if any.
 - b) Electric drive motor of suitable rating considering at least 15% margin over the shaft power consumption.
 - c) Drive Pulleys, V-belt, belt guards, slide rails etc.
 - d) Dampers at fan outlet and flexible connection (Rubberized Canvas) with matching flanges.
 - e) Vibration isolators (rubber in shear type / neoprene rubber pad), foundation bolts and nuts.
 - f) Removable drain plug with the fan casing.
- NB: These Centrifugal fans also cover those required for Air Washer and Unitary Air Filtration Units.
- 3.01.02 Wall mounted axial flow fans each complete with:
- a) Fan impeller of cast alloy aluminium construction (LM-6 Grade) with blades of aerofoil design.
 - b) Electric drive motor of suitable rating considering at least 15% margin over the shaft power consumption including motor brackets.
 - c) Vibration Isolators.
 - d) Short duct (wherever required).
 - e) Coned inlet and grouting framework, if any.
 - f) Rain protection cowl with bird-screen made of GI, Foundation Bolts etc.
 - g) Dry filters including fixing framework for fan filter unit (wherever required).
 - h) Back draft dampers, wherever specified.
 - i) Protective wire netting inside the room, wherever required.
- N.B. For Toilets, Pantries, Stores requiring small capacity fans, Propeller type fans are acceptable.
- 3.01.03 Roof mounted axial flow fan (Roof Extractor) each complete with:
- a) Fan impeller of cast alloy aluminium construction (LM-6 Grade) with blades of aerofoil design.

- b) Electric drive motor of suitable rating considering at least 15% margin over the shaft power consumption including motor brackets.
- c) Vibration Isolators.
- d) Short duct mounting (if required) having inspection door and base with proper water sealing arrangement.
- e) Grouting Frame.
- f) Fan casing of heavy gauge sheet steel construction.
- g) Rain protection hood / cowl with bird screen and disconnection switch, foundation bolts etc.

3.01.04 Sheet metal type Air washer Units (AWU), each complete with:

- a) Air Intake Louver with bird screen of GI construction.
- b) Automatically cleanable water flooded stainless steel mesh filters cleaned by one bank of spray header with stainless steel water spray nozzles spraying water over the filter in the direction of air flow and one more bank of spray header with stainless steel water spray nozzles spraying water opposing the air flow.
- c) Two numbers Horizontally Split casing / back pull-out type Centrifugal pump sets (one running and one standby) complete with drive motor for circulation of water through the above spray header banks and provided with pot type suction strainer with bypass valves, inlet and outlet pressure gauges and filter back wash arrangement.
- d) Moisture eliminator sets of die-extruded PVC construction.
- e) Inspection doors with ladder and marine lights for different sections and cat walks as required.
- f) All valves, pipes with fittings, nuts and bolts, internal fittings and supports, including ball float valves for make-up water connection, quick-fill connection with valve, drain piping with valves up to the nearest drain point, and overflow connection with siphon.
- g) Double inlet Double width Centrifugal fan with electric drive motor, drive pulleys, v-belt, belt guards, cushy foot mountings, removable drain plug and other accessories as required. Both inside and outside surfaces of all parts of the fan shall be spray galvanized. The fan with drive motor shall be placed inside casing of AWU.

- h) Air washer casing shall be sheet steel fabricated construction with adequate stiffeners, bracings etc. (duly spray galvanized / painted with epoxy resin based paint from inside and outside) covering all components of the Air Washer Unit including Centrifugal Blowers, but excluding the water circulating pump sets.

Top Surface of the AWU shall be thermally insulated with 13 mm thick thermal insulation made of Aluminium foil faced closed cell elastomeric Nitrile Rubber (of density min. 40 Kg/CuM) / XLPE (of density min. 33 Kg/CUM) or equal having a thermal conductivity not exceeding 0.035W/MK. The insulation shall have self extinguishing & non-dripping properties against fire attack.

Air Washer Sump made of sheet metal construction / masonry construction and duly painted with epoxy resin based paint both from inside and outside. The sump shall be complete with make-up water connection with float valve, quick fill connection with isolating valve, drain connection with valve, overflow connection with siphon and coarse strainer chamber and low level switch.

NOTE: Bidder will indicate make up water requirement for the equipment offered by them.

3.01.05 Unitary Air Filtration (UAF) units each consisting of:

- a) Air Intake Louver with bird screen of GI construction.
- b) Automatically cleanable type Stainless Steel mesh Filters complete with SS / Al. frame continuously flooded with water by one bank of spray header with stainless steel water spray nozzles spraying water over the filter in the direction of air flow.
- c) Two (2) nos. (one no. working and one no. stand-by) Centrifugal mono-bloc pumps for circulation of water. Pump system shall be provided with pot strainer with by-pass valves, inlet and outlet pressure gauges and filter back wash arrangement.
- d) Moisture eliminator sets of die-extruded PVC construction.
- e) UAF chamber & sump shall be of sheet metal construction. Both the casing and water sump shall be duly spray galvanized / painted with epoxy resin based paint from inside and outside and shall be complete with all valves, pipes, nuts and bolts, pipe hangers, supports, internal fittings and supports, suction pipe connection with coarse strainer, make-up water connection with ball float valve, quick fill connection with isolating valve, drain connection with valve, overflow connection with siphon and low level switch.

Top Surface of the UAF shall be thermally insulated with 13 mm thick thermal insulation made of Aluminium foil faced closed cell elastomeric Nitrile Rubber (of density min. 40 Kg/CuM) / XLPE (of density min. 33 Kg/CUM) or equal having a thermal conductivity not exceeding 0.035W/MK. The insulation shall have self extinguishing & non-dripping properties against fire attack.

- f) Interconnecting G.I. piping between pump and UAF Spray Header / Sump complete with necessary supports and supporting structures etc.
- g) Inspection door with ladder, marine lights and cat walk in the spray chamber.
- h) Single inlet single width Centrifugal fan complete with electric drive motor, drive pulleys, V-belt, belt guards, slide rails and other accessories etc. Both inside and outside surfaces of all parts of the fan shall be spray galvanized.
- i) GI connection piece between the centrifugal fan and UAF casing.

3.01.06 GI sheet steel fabricated ducting including the following:

- a) GI sheet metal (180 Grade) duct as per IS 655. Minimum duct thickness shall be 1 mm (20 G).
- b) Damper with control arrangement at each branch off and whatever necessary.
- c) All supply air grilles and diffusers made of powder coated MS sheet (20 SWG) / extruded aluminium with volume control dampers and supporting frames as required at site.
- d) Supports and hangers including anchor bolts as required.
- e) Sealing compound and jointing gasket for ducts.
- f) Flexible connections of rubberized canvas.
- g) The exposed portion of the ducting shall be thermally insulated with 13 mm thick thermal insulation made of Aluminium foil faced closed cell elastomeric Nitrile Rubber (of density min. 40 Kg/CuM) / XLPE (of density min. 33 Kg/CUM) or equal having a thermal conductivity not exceeding 0.035W/MK. The insulation shall have self extinguishing & non-dripping properties against fire attack.
- h) Motorized Fire Dampers with supply and Fusible Link type Fire Dampers with exhaust air duct / path (wherever applicable).

Motorized fire dampers will be provided in the supply air ducts and supply air openings leading to all the electrical areas (MCC and Switchgear Rooms, cable spreader rooms of Power House as well as ESP, AHP & CHP control buildings).

The signal from smoke detectors / thermal sensors including potential free contact at the fire panel shall be sent to operate the supply air fire damper. In case of fire / power failure, the damper actuator shall be de-energized to close the damper and respective fan motor shall be tripped in case of fire.

Power supply for the motorized dampers shall be arranged from Bidder's respective Local Starter cum Control Panels (LSCP) for AWU / UAF unit. The fire dampers shall be electrically operated motorized type (rated $240V \pm 10\%$ volt, $50 \pm 5\%$ HZ AC). The damper shall be suitable for electrical opening and closing for their automatic operation and manual testing purpose with the help of bypass Push Buttons. The damper actuators shall be spring return type. The damper shall be interlocked with respective motors of ventilation system.

Fusible Link type Fire Dampers are to be provided with Exhaust duct / path wherever applicable.

- h) Back draft dampers will be provided at the air outlet areas where pressurized ventilation has been envisaged.

- 3.01.07 All drive motors.
- 3.01.08 Local Starter Cum Control Panels (LSCP) for AWU and UAF units.
- 3.01.09 Local Starter Panels (LSP) for Ventilation fans except AWU and UAF units.
- 3.01.10 Power and Control Cabling and Grounding details.
- 3.01.11 Installation of all equipment supplied by bidder.
- 3.01.12 Anchor bolts, nuts and bolts and loose fitting as would be necessary for erection and commissioning.
- 3.01.13 One complete set of tools and tackles.
- 3.01.14 One set of recommended spare parts for trouble free operation of the system together with mandatory spare parts as specified.
- 3.01.15 Cleaning protection and painting as specified herein.
- 3.01.16 The above clauses specify the equipment for general guidance only. Any other equipment and/or material necessary to ensure safe and satisfactory erection, commissioning, operation and maintenance shall also be included in the scope of the specification.
- 3.01.17 Grounding of all drives and equipment required for Power House Ventilation system as per Main Plant Package, Technical Specifications, and relevant volume for Electrical Works.

4.00.00 CONTROL PHILOSOPHY**4.01.00 Ventilation fan motors**

All ventilation fan motors except Air Washer / UAF Units shall be controlled from Local Starter Panel / Switch to be provided near each fan.

4.02.00 Air Washer / UAF Units

Each Air Washer / UAF Unit will have one Local Starter cum Control Panel (LSCP) located near each Air Washer / UAF Unit for its control.

a) Humidity Control (applicable for Air Washer)

To protect the equipment located in the ventilation space (mainly for the MCC/ Switchgear Room) from effects of high humidity, the control device using humidistat is interlocked with a two-way actuator operated control valve to be mounted on the header of that spray bank which is not connected with the filter washing. Humidity beyond 60% RH in these ventilated spaces shall automatically close the two-way valve. The valve may be opened automatically at about 50% RH. However, manual over-riding facility shall be provided for this humidistat controlled valve. Minimum two (2) nos. Humidistat shall be provided for each Air Washer Unit.

Relative humidity inside the ventilated areas shall also be displayed digitally on the LSCP.

b) AWU / UAF Unit Sump Water Level Control

The water sump of each Air Washer / UAF Unit shall be provided with a low level switch which will initiate an alarm & will trip the pump, in case water level falls below a pre-determined mark. At the delivery pipe of each pump a pressure switch will be provided along with pressure indicator.

c) Following indications are to be provided in Local Starter-cum-Control Panel for Air Washer / UAF Units.

- I. FAN RUNNING.
- II. FAN STOP.
- III. PUMP – 1 RUNNING (FOR SPRAY SET ARRANGEMENT).
- IV. PUMP – 1 STOP (FOR SPRAY SET ARRANGEMENT).
- V. PUMP – 2 RUNNING (FOR SPRAY SET ARRANGEMENT).
- VI. PUMP – 2 STOP (FOR SPRAY SET ARRANGEMENT).

- VII. FAN MOTOR OVER LOAD TRIP.
- VIII. PUMP - 1 MOTOR OVER LOAD TRIP.
- IX. PUMP - 2 MOTORS OVER LOAD TRIP.
- X. RH HIGH.
- XI. RH LOW.
- XII. SUMP WATER LEVEL LOW.
- XIII. Relative Humidity

Provision of alarm (audio-visual) for Trip of any motor & low water level in the sump shall also be kept in the Local Starter cum Control Panel.

d) Motorized Fire Dampers

Motorized Fire Dampers are to be installed in the ventilation supply air ducting / with the supply air fans leading to electrical rooms like various MCC Rooms, Switchgear Rooms and Cable Spreader Rooms. These dampers shall be operated with the help of signal from smoke detectors / thermal sensors through zone fire panel. Motors shall remain energized in normal condition to effect opening of dampers. In the event of fire, the motors will be de-energized and the damper will close due to spring action.

In case of fire, all the motorized fire dampers provided in the supply air duct will close and the relevant fan motors will be tripped at the same time. The signals for this operation will come from zone fire panel.

In case of fire in the TG Hall or in the electrical rooms, all the supply fans of AWUs shall be stopped automatically with the sense from smoke detectors / thermal sensors through zone fire panels.

5.00.00 **DESIGN CRITERIA**

5.01.00 The design outside condition are taken from the Meteorological Station at Khammam nearest to the Kothagudem Thermal Power Station shall be considered as follows:

Summer: 42.6 Deg. C (DB), 26.6 Deg. C (WB)

Monsoon: 30.9 Deg. C (DB), 25.8 Deg. C (WB)

Winter: 20.8 Deg. C (DB), 18.4 Deg. C (WB)

5.02.00 **Inside Design Condition**

The desired condition inside the ventilated space has to be maintained by selecting proper type of Ventilation System.

- 5.02.01 In dry type forced (mechanical) Ventilation System where the ambient air is drawn and distributed inside the building/room and then exhausted, the average design condition inside the space to be ventilated is to be restricted about 3°C higher than the ambient (outside) dry-bulb temperature. Relative humidity will depend upon moisture content of ambient air.
- 5.02.02 In the areas ventilated by evaporative cooling units, the inside dry bulb temperature will be restricted to 5°C less than the summer ambient temperature (DB). This temperature will occur only for a few hours of some days in peak ambient condition and will prevail near the roof level where the hot air along with some solar heat load through roof will be exhausted out by roof extractors /wall mounted exhaust fans/louvers/back draft dampers.
- 5.02.03 Inside condition of TG hall and other electrical areas like switchgear room, MCC room of Power House building will be made reasonably dust free by adopting flooded type filter in the Air Washer Units. Moreover some amount of over pressure will be maintained inside the TG hall and electrical areas, and dust infiltration will be prevented thereby. For this system to work effectively, the rolling shutters should be kept closed. In some dry type mechanical ventilation, dry type washable metallic filter shall be adopted where cleanliness requirement is of importance. Here also some amount of over pressure will be maintained by using back draft damper to prevent the ingress of dust.
- 5.02.04 Auxiliary buildings should be ventilated generally as mentioned earlier. Areas not covered in these places but require ventilation should also be ventilated.
- 5.02.05 The following minimum air change rates are to be maintained for the areas indicated below.

Building / Area	Air Change / Hour
TG Hall	6
Cable Spreader Room	5
Electrical Room like MCC Room, Switchgear Room in the TG Building	15
Oil Room	20
Battery room	20
Elevator Machine Room	15
Mill building – coal bunker area	30
Non AC areas of ESP, AHP & CHP control building	15
Chemical House	20
DM plant	10
HFO & LDO forwarding pump house	20
Stores	5
DG area	10

Building / Area	Air Change / Hour
Compressor house	15
Switchyard Control Building (Non AC area)	15
Pump Houses –pump area	10
Electrical Rooms associated with the pump Houses	15
Electrical Rooms for all Auxiliary Buildings	15
Toilets	20
Pantries	20

Note:

The fan capacities shall be decided on the basis of the actual Heat Load and specified temperature rise or specified minimum air change rate, whichever is higher.

6.00.00 **DESIGN AND CONSTRUCTIONAL REQUIREMENT**6.01.00 **General**

- 6.01.01 All equipment shall be heavy-duty type suitable for installation in heavy industries and long period of uninterrupted service.
- 6.01.02 The equipment shall be designed to permit interchangeability of parts and ease of access during inspection, maintenance and repair.
- 6.01.03 All parts subject to substantial temperature changes shall be designed and supported to permit free expansion or contraction without resulting in leakage, harmful distortion or misalignment.
- 6.01.04 All electrical and mechanical equipment shall be designed and manufactured so that no damage will result from transportation, storage, installation and operation of the equipment with the climatic conditions to which it will be subjected.
- 6.01.05 All materials used shall conform to the specification and shall be new and first class in all respects.
- 6.01.06 Anchor bolts, nuts and seating steel work shall be supplied with the equipment. Only hexagonal nuts shall be used for holding down the equipment, with proper lock nuts. All bolt holes shall be spot faced for nuts. In specific cases where not necessary, spot facing may be omitted.
- 6.01.07 Casting and welding shall conform to their respective specifications and shall be free from flaws and objectionable imperfections, machined true and in a work-man like manner.

- 6.01.08 Proposal for repair or any similar operations involving the plugging, welding, boring or addition of metal to the original castings, shall be submitted to the Purchaser/Consulting Engineer and approval shall be received before any such work is carried out. Drawings showing details and locations of such modifications shall be submitted to the Purchaser/Consulting Engineer for his records.
- 6.01.09 The separate pieces of equipment shall be marked with unit number. The assembly drawing shall indicate part number of each equipment and unit number for easy correlation.
- 6.02.00 **Centrifugal and Axial Flow Fans**
- 6.02.01 Centrifugal fans shall be SISW/DIDW as mentioned in the Specification. The design shall be in general end suction and upward/downward/inclined/horizontal discharge type as demanded by the system/installation need. All centrifugal fans are coupled to the drive motors with V-belts. Puller holes should be provided on fan impellers and pulleys for ease of extraction from fan/motor shaft. Fan/motor shafts should have threaded centre holes for fixing pushers and locking the impeller/pulley axially on fan/motor shaft.
- 6.02.02 All Roof extractors / supply fans and wall mounted exhaust/supply fans are of direct drive axial flow type. Roof extractors/supply fans shall have multi-bladed impeller with a short duct casing while wall mounted exhaust/supply fans shall have coned inlet suitable for free discharge of air.
- 6.02.03 The centrifugal fans and axial flow fans shall be capable of withstanding the stresses which may be experienced during normal operation under the condition which it is required for and during over speed test.
- 6.02.04 It is desirable that all centrifugal fans shall be designed to operate within 9% and 25% of system throttling line.
- 6.02.05 All the fan units shall be reasonably noise and vibration free in operation and therefore of reasonably low speed. RPM of axial flow fans shall be restricted within 1000 to reduce their noise level excepting roof extractors for which RPM shall be restricted to 1500. Outlet air velocity of all fans shall be restricted within 12 m/s.
- 6.02.06 Casing for centrifugal and axial flow fans shall be reasonably leak proof.
- 6.02.07 The first critical speed of the rotating assembly shall be at least 25% above the operating speed.
- 6.02.08 Fan wheels shall be statically and dynamically balanced according to AMCA standard. Fans of 5 HP and above sizes must be dynamically balanced.

6.02.09 Impeller

- a) The blades of the centrifugal fan impeller for all units shall be backward curved unless otherwise specifically mentioned. The blades of the impeller shall be die formed aerofoil or laminar type. They shall have self-cleaning and non-overloading characteristics, and shall be welded to the back plate and shroud, if any. The fan wheel shall be statically and dynamically balanced.
- b) The axial flow fan impeller shall be cast in one piece, finished all over and are fully balanced both statically and dynamically. Finally the assembled rotor shall be dynamically balanced. All axial flow fan impeller shall consist of high efficiency aerofoil section blades. Puller holes should be provided on fan impellers and pulleys for ease of extraction from fan/motor shaft. Fan/motor shafts should have threaded centre hole for fixing pushers and locking the impeller/pulley axially on fan/motor shaft.

6.02.10 Casing

- a) Centrifugal fan casing shall be of welded construction and provided with flanges on inlet and outlet sides for duct connection. Mounting legs welded to the casing shall be provided. Plummer blocks should preferably be not supported on the bracings/stiffeners of casing sidewalls.
- b) Axial flow fan casing for roof extractors/supply fans and their components shall be suitable for outdoor installation. The casings will be provided with flanges at inlet and outlet. All nuts & bolts associated with it shall be of zinc or cadmium plated with proper baking to remove hydrogen.

Easily removable inspection cover having galvanized fly nut shall be provided. The inspection covers shall be located such that the grease nipple for all bearings and also motor terminals are easily accessible through the cover. It is however, preferred that provisions will be there for greasing the fan bearings from outside the fan casing.

Suitable motor brackets as per manufacturer's standard for both roof and wall exhausters/supply fans shall be fitted. The brackets shall be designed to provide rigid mounting for motors.

6.02.11 Bearing

Centrifugal fan shaft shall be mounted on self-aligning, heavy-duty spherical roller bearing of adequate capacity and life. In no case the life of the bearings shall be less than 40,000 hours. Centrifugal fans for air washers installed in the T.G. Building, should have minimum bearing life of 100,000 hours. Bearings shall be grease lubricated and provided with fittings for lubrication from outside. The bearings shall be located in an easily accessible location to facilitate maintenance.

- 6.02.12 Roof extractors/wall mounted fans (if located on the exposed wall) shall be provided with hood for protection against rain and other contingencies. It must ensure no dripping of rainwater under any circumstances and will have low-pressure drop of air. The hoods shall be provided with a heavy gauge expanded metal bird screen. Axial flow fans should be fitted with protective screens from inside of room.
- Rain protection cowls will be designed to suit wall mounted exhaust/supply fans for protecting fans from rain. The cowls will be provided with bird screen of heavy gauge expanded metal netting.
- A typical sketch enclosed herewith shows arrangements for both roof extractors and rain protection cowl. Any other approved design for the hoods and cowls can be considered. Grouting frames for the cowls if required shall be included in the supply along with nuts and bolts.
- 6.02.13 Coned Inlet
- Wall mounted exhaust fans shall be provided with coned inlet made of M.S.
- 6.02.14 Inlet Screen
- Inlet screen shall be manufactured of min. 14 SWG galvanized wire knitted in 1" square mesh. Suitable flanges to protect the edges of the screen shall be provided.
- 6.02.15 Vibration Isolator
- Double deflection rubber in shear or rubber in compression type vibration isolators shall be provided with each centrifugal fan and each axial flow fan. Rubber bushes, washers, wherever needed for the vibration isolators shall be included in the supply. Sufficient number of such isolators shall be provided to ensure isolation of foundation from vibration of the equipment.
- 6.02.16 Fans For Special Application
- Fans for battery room, oil rooms and fuel stores shall be of spark proof construction. These axial flow type fans shall be bifurcated type construction with motor away from air stream. Motors for these fans shall be of flameproof construction.
- All fans for special application shall have all accessories as mentioned in the Specification.
- 6.02.17 Fan Drive
- a) Centrifugal fans shall be provided with V-belts and sheaves. All belts shall be sized with minimum 1.5 service factor. All V-belt drives shall be equipped with removable guards that do not impede the air flow to the fan inlet. There shall be a minimum of two belts per drive. All pulleys should have threaded puller holes for the ease of their extraction.

- b) All direct drive axial flow fan impellers shall be directly mounted on extended motor shaft.

6.02.18 Materials of Construction

The following materials shall be used for the construction of various parts:

a)	Centrifugal fan impeller	:	MS sheet (IS-2062) duly spray galvanized
b)	Axial flow fan impeller	:	Cast Aluminium Alloy (LM-6 Grade)
c)	Fan shaft	:	EN-8 as per BS-900 or equivalent
d)	Fan Scrawl	:	Heavy gauge M.S. (IS-2062)
e)	Fan supports, frames and	:	M.S. of adequate thickness (IS-Structure.- 2062)
f)	Coned inlet for wall mounted exhaust fans / Supply fans	:	M.S. (IS-2062)
g)	Dampers	:	M.S. of heavy gauge (IS-2062)
h)	Flexible connections for fan inlet and outlet	:	Plastic impregnated canvas with M.S. flange & cleats.
i)	"V" pulleys	:	G.I. multi-grooves (IS-210, Gr.20)
j)	"V" belts (Matched sets)	:	Reinforced rubber of appropriate section.
k)	Slide rails	:	C.I. or M.S.
l)	Connection pieces	:	Galvanized iron according to supplier's design.
m)	Bolts and Nuts	:	GI or cadmium plated unless otherwise specified.
n)	Rain protection cowls, hoods And casing for roof Exhausters/wall exhausters/ Supply fans	:	Aluminium or hot dipped galvanized after fabrication from M.S.
o)	Vibration isolating pad washers & bushes, if any.	:	Hard synthetic rubber of Hardness 40° shore.

6.03.00 Air Washer Units**6.03.01 General**

- I. Air washer shall be of sheet metal type construction. The air washer unit is a complete system comprising air washer internals, casing, Masonry Sump (tank), associated pumps and fans.
- II. The air washer unit shall be designed as Two Banks water spray system type units. Ambient air is sucked by the centrifugal fan unit / units successively through the Air Intake Louver with Bird Screen of GI construction, automatically cleanable type Stainless Steel mesh Filters complete with SS / Aluminium frame continuously flooded with water through Stainless Steel water spraying Nozzles from one spray bank header and another bank of spray header with Stainless Steel water spraying Nozzles spraying water in the opposite direction of air, Die-extruded PVC moisture eliminators and finally delivered to the duct system with Supply air Grilles for distribution. Properly hinged air tight epoxy painted inspection doors of suitable sizes shall have to be provided in each sheet metal Air Washer.
- III. The Air Washer Units shall be suitable for running with clarified water.
- IV. The air washer units shall be designed for a saturation efficiency of 90%.
- V. All the equipment for the air washer units shall have to be accommodated as per space availability. But within the space allotted the equipment design and location may be modified to suit the supplier's standard equipment.
- VI. The various sections of the unit shall be bolted with suitable gasket to avoid leakage of water. All the sections of the units shall be Epoxy painted from inside and outside to prevent corrosion/ weathering damage. The nuts and bolts used for jointing the sections shall also be galvanized. All in side and out site parts of the fan shall be spray galvanized except the fan shaft that shall be of epoxy painted.

6.03.02 Filter Section

The Filter section consists of a set of Stainless Steel (SS-316) mesh filter modules mounted on a ladder type SS / Aluminium framework of not less than 16 G thick and quick release mechanism for easy dislodgement of the filter modules. The filter material shall be weaved with SS wire of 0.16 mm dia. providing an aperture of max. 0.025 mm. Such filters are continuously flooded with water spray from double bank spray header system in the direction of airflow. The water will be collected in a masonry tank and will be re-circulated by means of the said pump.

The filter module size shall not be more than 610 mm x 610 mm.

The pressure drop across the filter shall be restricted to 8 mm of WG in clean condition and 12 mm of WG in dirty condition. The face velocity across the filter shall not exceed 2.5 m / sec.

6.03.03 Spray Arrangement

- I. There will be two bank water spray system each bank is having a number of branches with spray nozzles. The Spray nozzles shall be made of Stainless Steel and shall be of hollow-cone type with an orifice dia. of 6 mm. Supplier shall confirm the layout of the nozzles on the vertical face. The nozzle arrangement shall ensure good spray distribution and fine break-up of water across the air stream.
- II. The water header and piping shall be of G.I. One pot strainer with very fine mesh brass screen shall be fitted preferably in the suction line of all the pump sets. The strainer should have a by-pass line.
- III. Water from the washer chamber tank shall be taken through a primary screen type water filter fitted in an accessible position in the tank. The filter screen shall be manufactured of S.S netting in a S.S. Frame.
- IV. All accessories like valves, drain valves, fittings, pipe support, hangers, etc. shall be included in the supply. These will be manufactured according to the supplier's standard.
- V. The Contractor shall use the regular type fittings / bends for piping as per IS-1239. Spacing and location of hangers shall conform to the preferred engineering practice. All materials for anchoring the hangers with reinforced concrete work or building structural beams and columns shall be furnished by the Tenderer.
- VI. All drain pipes will use "Tee" fitting instead of elbows or bends. "Tee" fittings should be installed such that the plugs can be removed and any section of the pipe can be cleaned. Drain valve will be located at the lowest point of the pipelines. If necessary, more than one drain valve will be installed to facilitate complete drainage from pipe. The make-up piping including all valves, bends, fittings, supports etc. shall be supplied by the Tenderer.

6.03.04 Pumps

The water spray will be generated with the help of a Horizontal Split Casing / back pull out type Centrifugal Pump-Motor set and associated Medium Class GI piping with all fittings and supports.

Details on pumps are furnished under separate clauses.

6.03.05 Moisture Eliminator Sets

- I. Moisture eliminator sets used for the air washer units shall be vertical and die-extruded PVC construction.

- II. Face velocity of air for the PVC Eliminator sets shall not exceed 2.5 m / sec.
- III. Eliminators shall be manufactured in suitable sizes for easy handling, erection and replacement whenever necessary.
- IV. Moisture Eliminator shall have bends at 30° with the direction of airflow and shall have 2 effectively hooked edges for trapping the carry over of water. The catcher should face the direction of airflow.
- V. The Moisture Eliminators shall be fixed rigidly in their proper position and spacer shall be provided to maintain the proper gap.
- VI. Holding frame for the PVC Eliminators shall be of G.I. angles of adequate strength for support.
- VII. Eliminator plates shall be of die-extruded PVC having at least three (3) bends and shall be provided with suitable drip tray and draining facility.

6.03.06 CENTRIFUGAL FANS

Details of fans are furnished under separate clauses.

6.03.07 CASING & TANK

The equipment shall be located within the sheet metal fabricated casing as specified in the other part of the specification with adequate stiffeners, bracings etc duly epoxy painted / spray galvanized from inside and outside. The overflow pipe connected with masonry water tank must be terminated with a siphon, to avoid leakage of air into the air washer chamber. All air washer internals coming in contact with moist air shall be epoxy painted. All inside and outside parts of the fans shall be spray galvanized whereas the shaft shall be epoxy painted. Provision of Marine lights shall be kept in both the Filter and Fill section.

Top Surface of the AWU shall be thermally insulated with 13 mm thick thermal insulation made of Aluminium foil faced closed cell elastomeric Nitrile Rubber (of density min. 40 Kg/CuM) / XLPE (of density min. 33 Kg/CUM) or equal having a thermal conductivity not exceeding 0.035W/MK. The insulation shall have self extinguishing & non-dripping properties against fire attack.

This air washer contain the sheet metal / masonry sump (tank) shall be connected with the Filter section and shall be complete with make-up connection with float valve, quick fill connection, drain connection with valve and overflow connection with siphon. The tank shall be of epoxy painted / spray galvanized from inside and outside.

6.04.00 UNITARY AIR FILTRATION UNIT

6.04.01 Unitary Air Filtration Unit is a complete system comprising UAF internals, casing, tank, associated pumps and fan.

6.04.02 The UAF units shall be designed for a saturation efficiency of 60%.

6.04.03 Unitary Air Filtration Unit shall have in general one set of air intake louver, one set of automatically cleanable type Stainless Steel mesh Filters with continuous water spraying arrangement over the surface of it to clean the filters and PVC die-extruded Moisture Eliminator sets after the above water flooded filters to eliminate the carry over of moisture. Suitable stainless steel grid shall be used inside both the filters and eliminators for reinforcement.

6.04.04 Water will be re-circulated by means of mono-bloc pumps.

Details on pumps are furnished under separate clauses.

6.04.05 The unit shall be self-enclosed by MS casing duly painted with epoxy resin based paint / spray galvanized. The casing front shall be provided with the air intake louvers with bird screen of GI construction. Water with the dirt will be collected in the MS sump duly painted with epoxy resin based paint and bled off to the drain in small quantity.

Top Surface of the UAF shall be thermally insulated with 13 mm thick thermal insulation made of Aluminium foil faced closed cell elastomeric Nitrile Rubber (of density min. 40 Kg/CuM) / XLPE (of density min. 33 Kg/CUM) or equal having a thermal conductivity not exceeding 0.035W/MK. The insulation shall have self extinguishing & non-dripping properties against fire attack.

6.04.06 The drain pan shall be provided with overflow pipe terminating to the nearest drain point. The unit may be installed indoor or outdoor as shown in drawings. Suitable rain protection sheds of sheet metal construction shall be provided for the motors installed outdoors.

6.04.07 One backward curved Centrifugal Fan Motor unit shall be used for conveying the air. All parts of the fan for this system coming in contact with moist air shall be spray galvanized except the fan shaft, which shall be epoxy painted.

Details of fans are furnished under separate clauses.

6.04.08 Velocity through any section of UAF unit shall not exceed 2.5 M/Sec. except for Inlet louver for which the face velocity shall not exceed 2 M/Sec.

6.05.00 WATER PUMP

6.05.01 Each water circulating pump set shall be of horizontal split casing / back pull out type centrifugal type, directly coupled to electric drive motor and mounted on a common base plate. However, pumps having motor of 5 HP or below can be of mono-block construction.

The pump shall be complete with casing, impeller, renewable type wearing rings, shaft, shaft sleeve, bearings, stuffing box, cowlings, base plate etc. as applicable. The design pressure for the casing shall not be less than 16 bar for Air Washer pump sets.

6.05.02 The pumps will operate under flooded suction and shall have radial suction and vertical discharge.

6.05.03 Pump head-capacity characteristics shall be gradually rising from operating to shut-off point without any zone of instability. The pump BHP flow characteristics shall preferably be non-over loading type beyond rated capacity point.

Pump shall be rated for continuous operation.

6.05.04 Operating speed of the pump shall preferably be not more than 1500 RPM. Vibration isolators of efficiency 90% (approx.) shall have to be provided for each pump set.

6.05.05 Material of the pump sets shall preferably be as follows (all material shall be of tested quality):

- | | | | |
|----|----------------------------|---|--------------------------------------|
| a) | Casing | - | Cast iron, Grade-FG200 as per IS-210 |
| b) | Impeller and wearing rings | - | Bronze |
| c) | Shaft | - | EN-8 as per ES-900 |
| d) | Shaft sleeve | - | Bronze as per IS-318 |

6.05.06 The pump bearings and the shaft shall be sized adequately to take the maximum possible unbalance loads occurring due to all mechanical and hydraulic reasons. Bearings should have a minimum life of 40000 hours of operation.

6.05.07 Pump and drives shall be directly coupled though a flexible coupling. Suitable coupling guard shall be provided for each pump.

6.05.08 Each pump shall be complete with the following accessories:

- Pot type strainer at inlet complete with screen, drain arrangement etc. All pot type strainers shall have easily removable top cover for access to the filter cartridge. The filters shall be fitted with fine mesh copper or brass wire strip.
- 150mm dia dial type Pressure Gauges, one each at the suction and discharge side of the pump set. The pressure gauge of the pump sets will be connected with a siphon and a two position brass cock.
- Butterfly type isolating valves, one each at suction and discharge side of the pump.

- Non-return (check) valve at the discharge side of the pump set.
 - Base plate, coupling, coupling guard, anti-vibration mountings and foundation bolts.
 - All integral piping required for sealing, cooling, casing, drains and vent connections.
- 6.05.09 The design of the pumps shall conform to the relevant IS Code, Standards of Hydraulic Institute of U.S.A. or approved equivalent.
- 6.05.10 Pump motor will be selected on the basis of 15% margin over the shaft power consumption or more than the limit load of the pump which ever is higher. For other electrical particulars of the motor refer detailed specification of the motors.
- 6.05.11 Major rotating components of the pumps like impellers, balancing drums etc. shall be individually balanced statically and finally each pump shall be dynamically balanced.
- 6.05.12 The critical speed of the pump shall be at least 20% above the operating speed.
- 6.05.13 All pumps and motors shall be aligned properly, and bolted and doweled to a common base frame.
- 6.06.00 **WATER PIPING**
- 6.06.01 Water piping for 150 NB or below GI-Heavy Class conforming to IS-1239, Part-I. For higher sizes black steel pipe, heavy grade conforming to IS-3589, Fe 410 grade shall be supplied. Drain water piping shall be of M.S. heavy grade.
- 6.06.02 The piping shall be so designed that the water velocity through the piping shall not exceed 2.5 m/sec and also the piping friction drop shall be limited to 4 m per hundred meter of pipe length. Pipe sizes, if indicated in tender drawings shall be followed.
- 6.06.03 The pipes shall be of plain end in case of M.S. Pipes (i.e., suitable for welded connections) as far as possible.
- 6.06.04 Counter-flanges for connecting to flanges on valves or equipment shall be made of IS-2062 or superior and shall preferably be slip on type, suitable for welding on the piping in case of M.S. Piping.
- 6.06.05 All bolts and nuts for flange connection shall be hexagonal carbon steel type as per IS-1363 and with the material and other requirements as per IS-1367. All threaded valves shall be provided with nipples and flanged pairs on both sides to permit flanged connections for ease of removal / replacement of valves.
- 6.06.06 Bends, fittings fabricated at site is not acceptable. The Contractor shall use the standard fittings / bends, as per IS-1239, Part-II.

6.06.07 Spacing and location of hanger shall conform to preferred engineering practice. Hangers and supports shall be made up of structural steel sections. The design of the hangers and supports shall provide for suitable protection to insulation on the pipes, wherever applicable. All materials for anchoring the hangers with reinforced concrete work or building structural beams and columns shall be furnished by the Bidder. The supports within the plant room shall be of structural / pipe supports from the floor and is to be provided by the Contractor.

6.06.08 The flanged joints for water line will use canvas, impregnated rubber gasket. Compressed fiber gaskets shall be used with flat face flanges and raised face slip-on flanges. Spiral wound gaskets shall be used with raised face flanges, except for raised face slip-on flanges. Gaskets containing asbestos are not acceptable.

Gaskets shall be suitable for the design pressures and temperatures: -

- i) Compressed Fiber Gaskets: Compressed fiber gaskets shall be in accordance with ANSI B16.21, and materials shall be suitable for a maximum working pressure of 40 bar and a maximum working temperature of 400° C. Gaskets shall be dimensioned to suit the contact facing. They shall be full faced for flat face flanges and shall extend to the inside edge of the bolt holes on raised face flanges. Gaskets for plain finished surfaces shall be not less than 1.6 mm thick and for serrated surfaces shall be not less than 2.4 mm thick.
- ii) Spiral Wound Gaskets: Spiral wound gaskets shall be constructed of a continuous stainless steel ribbon wound into a spiral with non-asbestos filler between adjacent coils. The gasket shall be inserted into a steel gauge ring whose outside diameter shall fit inside the flange bolts properly positioning the gasket. The gauge ring shall serve to limit the compression of the gasket to the proper value. Compressed gasket thickness shall be 3.3 mm $\pm$ 0.1 mm.
- iii) Ring Joint Gaskets: Ring joint gaskets shall be octagonal in cross section and shall have dimensions conforming to ANSI B16.20. Material shall be suitable for the service conditions encountered and shall be softer than the flange material.
- iv) Rubber Gaskets: Rubber gasket materials shall be cloth inserted sheet rubber and shall conform to ANSI B16.21. They shall be full face and 1.6mm thick.

The material should be able to withstand adequate strength in compression without damage. Pipe lines should be such installed that any equipment or valves can be removed by disconnecting flange bolts and nuts union joints. If necessary, a short piece joint to be installed for easy removal. All threads for screwed joints should be properly made. The threads will be covered to make a leak proof joint. Pipes passing through any building structure will pass through a pipe sleeve. The thickness of pipe sleeve will be not less than the thickness of the passing pipe itself. A rubber grommet or such other material will protect pipes entering any equipment.

6.06.09 All drain pipes will use 'tee' fitting instead of elbows or bends. 'Tee' fitting should be such installed that the plug can be removed and any section of pipe can be cleaned. Drain valves will be located at lowest point of pipelines. If necessary, more than one drain valve will be installed to facilitate complete drainage from pipe.

6.06.10 Water filling valve and air vent shall be installed on the highest point of pipeline. If necessary, more than one valve is to be installed for satisfactory operation or maintenance of the plant. Location of instruments, fittings, fixtures shall be as in single line flow diagram. Location / sizes of air vents are also indicated.

6.06.11 Piping arrangement and alignment shall be as per layout.

6.07.00 VALVES & ACCESSORIES

6.07.01 General

Water line gate valves shall conform to IS: 778-1984 for smaller sizes and IS: 780-1984 for larger sizes. Those shall be designed for working pressure of 16 Kg/Sq.Cm. The valves shall be I.S.I. marked and of reputed make. Alternatively water type, butterfly valve can be offered. Those valves shall be manufactured and tested conforming to BS: 5155 and AWWA C504.

Note: Butterfly type valve can be offered in the range 80 mm N.B. up to and including 150 mm N.B.

6.07.02 Gate Valves

Those shall be non-rising stem of following material of construction.

Up to 65 mm dia	:	Brass body and Brass internals, Screwed Ends
Valve rating	:	Class - 2
75 mm dia and above	:	CI Body and high tensile brass internals, Flanged Ends
Valve ratings	:	PN 1.6

6.07.03 Wafer Type Butterfly Valves

These valves shall be of single piece ribbed steel construction and of flange less wafer type. Discs shall be of high duty iron with epoxy coating or electrolytic nickel plating.

Material specification : Body IS-210 FG 260 CI or cast steel to suit working pressure of 16 Kg/sq. cm.

Disc	:	Epoxy coated / EN plated FG 260 CI or AISI 316 SS.
Seat	:	Nitrile rubber bonded on bakelite hard back.
Top Shaft	:	EN 8 Carbon steel or AISI 304 SS.
Bottom shaft	:	AISI 410
Body seal	:	SS AISI 304 L
Disc seal	:	Nitrile rubber / EPDM / Vitron
Bearings	:	Phosphor Bronze
Gear unit	:	Worm type
Bottom cover	:	CI IS 210 GR FG 260/CS IS 2062 GR B
Bolting (Internal)	:	SS AISI 304
Bolting (External)	:	CS IS 1367 GR 8.8

6.07.04 Globe Valves

Those shall be Straight type and with following material of construction.

Up to 65 mm dia	:	Brass body and Brass internals Screwed Ends
Valve rating	:	Class - 2
75 mm dia and above	:	CI Body and Flanged Ends high tensile brass internals
Valve ratings	:	PN 1.6

6.07.05 Check Valves

These shall be swing check type with following material of construction.

Up to 65 mm dia	:	Brass body and Brass internals, Screwed Ends
Valve rating	:	Class - 2
75 mm dia & above	:	CI Body and Flanged Ends high tensile brass internals
Valve ratings	:	PN 1.6

6.08.00 **DUCT WORK**

6.08.01 Duct Fabrication

I. General

- a) Velocity of air in any section of the supply duct shall not exceed 12 M / Sec.
- b) The construction of ducts and sheet metal thickness for ventilation duct shall conform to IS: 655 / ASHRAE / SMACNA as far as applicable, unless otherwise stated here. However, minimum duct thickness shall be 1 mm (20 G).
- c) The general layout of the ducting location and number of air grilles and diffusers etc. shall conform to the specific requirements of individual areas of application so as to ensure proper air distribution of all the zones. The same shall be subject to approval by the Purchaser / Consultant.
- d) All duct work for supply of air inclusive of accessories such as damper, vanes, access doors etc. shall be fabricated from G.I. sheet of 180 grade as per IS-277. The ductwork shall be properly reinforced to prevent sagging, buckling or vibration. Interior of all ducts shall be smooth and free from obstruction. All duct sections shall be cross broken.
- e) Suitable drain point with water trap shall be provided for all washed air duct routing at suitable places, preferably just after Air Washer Units.

II. Joints

- a) All longitudinal joints for the ducts will be Pittsburgh Lock seam type.
- b) Transverse joints for the low-pressure ducting shall be continuous around the four sides, the corner closure are required. The type of transverse joints shall be as follows:

Large side mm	Type of transverse joints
Up to 600	25 mm wide pocket, drive or S-slip
601 - 1000	85 mm wide, bar s-slip or pocket slip
1001 - 2250	40 mm x 40 mm x 6 mm M.S. Angle connection.

- c) The low-pressure ducting work shall be provided with intermediate transverse bracing continuous around the four sides between the joints according to the following sizes:

Large side mm	Bracing
0 - 450	None
451 - 1500	40 mm x 40 mm x 6 mm angle 1200 from joints.
1501 and above	40 mm x 40 mm 6 mm angle 600 mm from joints.

- d) RIVETING AND SEALING

All joints, slips and seams shall be made secure by reverting on centers not exceeding 150 mm. All transverse stiffeners and all reinforced bar slip joints shall cross at corners and be riveted. All bar slip joints and angle iron bracing shall be riveted on centers not exceeding 75 mm.

- e) All construction joints and duct seams shall be reasonably sealed with bitumastic cold emulsion or equivalent vapour seal.

III. HANGERS AND SUPPORTS

- a) All ductwork shall be provided with adequate hangers or supports to ensure rigid support and to prevent vibration. Spacing of duct supports shall not exceed 3 m centers.
- b) Hangers shall be suspended from the building steel with provision for necessary auxiliaries, or by special steel members, or by an inch anchor / expansion bolts, or by hooks fixed to the embedded plates provided in the ceiling.
- c) Hangers for all ducts shall be trapeze type with the shelf construction from 35 mm x 35 mm x 5 mm angle iron and hung by two steel rods each of not less than 10 mm dia. for ducts, with larger side less than 2250 mm while for those greater than 2250 mm shall be with 50 x 50 x 5 angles and rods not less than 16 mm dia.
- d) All hangers and supports shall be as per drawings / specifications. When vertical ducts pass through floor slab, they shall be supported by means of collars, constructed of steel structural angles securely fastened about the girth of the duct and bitumastic compound between the horizontal leg of the supporting angle and the floor.

IV. ACCESS DOORS

- a) All main ductwork shall be accessible throughout using tight fitted hinged access doors. Doors shall have to be cemented on sponge rubber gaskets. Angle joints shall be provided with felt or rubber gaskets for leak-tightness of the joints.
- b) Access doors / panels are to be provided near each fire damper.
- c) In case access doors are to be installed in the insulated ducts, the access door panel should be suitably insulated, such that it can be operated without damaging the duct insulation.

6.08.02 FLEXIBLE CONNECTION

Rubber impregnated canvas or equal flexible connections of at least 150 mm length shall be provided at each connection between ductwork and fan units to isolate vibration.

6.08.03 VOLUME CONTROL DAMPER

I. SPLITTER DAMPER

Splitter dampers in branch take off shall be provided. Damper blades shall be minimum 16 SWG thick. Alternatively catcher shall be provided in right angle tee of ducts.

II. OPPOSED MULTIPLE LOUVER DAMPER

Opposed multiple louvers dampers shall be provided at the fan outlets and wherever mentioned in the drawings, specification and fan schedule. Each blade of the dampers shall be provided with bronze, gunmetal or nylon bearing at each end of its spindle. The spindle with bearing shall be mounted in a strong structural framework. Operating lever with fixing device for keeping the damper at the desired position shall be fitted for the manually operated dampers.

Operating level will be fixed on an indicator to show the percentage of opening of the damper in all cases except for the application with grilles and nozzles.

Velocity across the dampers shall not exceed 10 m/sec. Damper blades at fan outlet shall be made up of 16 gauge M.S.

III. GRAVITY OPERATED DAMPER

Gravity operated back draft dampers are needed to protect the back flow of air wherever specified. These dampers shall be designed such as not to allow infiltration of air from outside while forced ex-filtration by the fan will be achieved through the above dampers. The louvers of the dampers shall be freely mounted on the spindles to allow the damper to open with the pressure developed by the fan. The dampers shall be provided with flanges at inlet. The damper blades shall be made of aluminium and the frame shall be of CRCA sheet duly galvanized / Aluminium.

6.08.04 GRILLES & DIFFUSERS

- I. Design of grilles and diffusers shall be such as to create desired throw and spread of air and shall be approved by the Purchaser / Consultant.
- II. All diffusers and grilles shall be made up of powder coated sheet steel / extruded aluminium with finish painting. Design of all diffusers and grilles shall be made by the Contractor matching with the lighting and other fittings and to be approved by the Purchaser / Consultant. Each supply air diffusers shall be fitted with opposed blade damper, built-in vanes and louvers arranged as per manufacturer's std. design.
- III. Side throw type supply registers shall have two sets of adjustable louvers with opposed blade dampers. The front of louvers shall be horizontal to provide horizontal deflection and the rear set of vertical louvers shall adjust vertical deflection. The dampers shall have horizontal opposed blades regulated by an operating lever in the frame. All wall type exhaust / return air grilles shall have one set of louvers in the front. The louvers shall be fitted such as to remain in position by friction grip. All supply air grilles shall have one set of opposed multiple louver damper at the inlet. The dampers shall be gang operated and will have a device to keep the dampers fixed in one position.
- IV. The grille frame and louvers shall be manufactured of at least 20 SWG GI sheet and 22 SWG MS. respectively. No grilles should, by any chance, make any rattling sound during continuous operation.
- V. All grilles/diffusers shall be fitted with suitable gasket to prevent air leakage and shall match the decor of the space.

6.09.00 DRY FILTER

The filter media shall be designed to hold dust and prevent it from being dislodged by vibration or other cause and passing through filter.

The filter media shall be of High Density Poly Ethylene. The filter shall have G.I. frames of adequate thickness but not less than 18 SWG suitable for long use in an industrial plant. The filters may be in panels of sizes about 610 mm x 610 mm for easy handling of the same. The face velocity of air across the filters shall not exceed 2.5 m/sec. The efficiency shall be about 90% down to 10

micron size particles. Allowable pressure drop during clean and dirty conditions shall be 6 mm WG and 10 mm WG respectively.

6.10.00 **THERMAL INSULATION**

6.10.01 The exposed portion of the ducting shall be thermally insulated with 13 mm thick thermal insulation made of Aluminium foil faced closed cell elastomeric Nitrile Rubber (of density min. 40 Kg/CuM) / XLPE (of density min. 33 Kg/CUM) or equal having a thermal conductivity not exceeding 0.035W/MK. The insulation shall have self extinguishing & non-dripping properties against fire attack.

6.10.02 Top Surface of the AWU & UAF shall be thermally insulated with 13 mm thick thermal insulation made of Aluminium foil faced closed cell elastomeric Nitrile Rubber (of density min. 40 Kg/CuM) / XLPE (of density min. 33 Kg/CUM) or equal having a thermal conductivity not exceeding 0.035W/MK. The insulation shall have self extinguishing & non-dripping properties against fire attack.

6.11.00 **Electrical items shall consist of:**

I. **DRIVE MOTORS**

- All exhaust fan motors shall be designed for a minimum of 55 Deg C ambient temperatures. Supply air fan motors shall be designed for a minimum of 50 Deg C ambient temperatures.
- Motor rating for centrifugal fans with backward curved blades and axial flow fans shall be minimum 115% of the fan power at duty condition. Motor rating for Pump motor shall be minimum 115% of pump power at duty condition.
- Insulation of motor windings shall be class 'B'. In case of substitution by class F insulation, the temperature rise shall be limited to class B temperature rise as per IS: 325.
- Motors rated 30 KW and above shall be provided with 240V space heater.
- Motor T.B. shall be suitable to receive the cables as detailed elsewhere in the specification.
- Motors rated 250 watts and up to 160 KW shall be suitable for 415V $\pm$ 10%, 3-Phase, 50Hz $\pm$ 5% AC.
- Motors rated below 250 watts shall be fed with 240 V, single phase, 50 Hz. AC supply.
- Motors rated above 125 KW shall be fed by Air Circuit Breaker.
- All motors shall be suitable for D.O.L starting.

- All motor enclosures located indoors shall conform to the degree of protection IP-55 unless otherwise specified. Motor for outdoor or semi-outdoor service shall be weather-proof construction.
- II. Local Starter cum Control Panels (LSCP) for AWUs and UAF Units
- Local Starter Cum Control Panel shall be provided for each Air-washer Units in and for each UAF unit.
 - Each Air Washer / UAF system will have one LSCP located near each Air Washer / UAF Unit. These LSCPs shall house all electrical devices for power and control purposes of Air Washer/ UAF Unit loads, (Fan Motors, Pump Motors, Fire dampers etc. and other controls.)
 - This LSCP shall house incoming MCCB for incoming power supply, outgoing MCCB/MCB with power contactors, auxiliary contactors, thermal overload relays, Start-Stop push buttons, and indication lamps for incoming power supply, ON/OFF/TRIP indication lamps, terminal block, wiring for fan and pump motors, motorized fire dampers and controls
 - Stop P.B. shall be pressed to latch and turn to release type.
 - Control Voltage at LSCP shall be 240V, 1Ph, 50HZ. Necessary control transformer shall be provided in LSCP.
 - For Motors rated 30KW and above, Ammeters shall be provided in LSCP.
 - For all motors having long starting time, the thermal overload relays shall be provided with saturable core current transformer to avoid spurious tripping during starting of the motor, the current transformer will have linear characteristics up to approximately twice the setting current.
 - The panel shall be wall/floor mounted.
 - By-pass P.B. for manual testing of fire-dampers for Air washer system from remote shall be provided in this panel.
 - Power supply to 240V motorized Fire Dampers shall be fed from respective LSCP through MCB and Contactors.
 - Audio-visual Annunciations with common hooter, Accept, Reset PB for Trip of any motor & low water level in the sump shall be provided in LSCP.
 - Potential free contact for 'Air Washer/UAF Trouble' Group Annunciation in each LSCP for AW / UAF system. Remote Group Annunciation in each LSCP shall be provided by the contractor for Purchaser's use.

- 10% spare annunciation facia shall be provided over and above the annunciations as listed and / or recommended by the bidder, spare facia shall be equipped with all devices as provided for the active facia.
- Lamps shall be LED type.
- 1 module of each type and rating as spare shall be provided in each LSCP.

III. Local starter Panels for ventilation fans except AWUs and UAF Units

- 415V, 3 phase, 4 wire, 50Hz Local Starter Panel shall be provided at each auxiliary building for feeding ventilation fan motors. For Power House Building and Auxiliary buildings grouping of fan motor starter in each Local Starter Panel will depend on the number of ventilation fans, their motor ratings and locations.
- Local Starter Panel shall also house incoming MCB for incoming power supply, outgoing MCB with power contactors, auxiliary contactors, thermal overload relays, Start-Stop push buttons, and indication lamps for incoming power supply, ON/OFF/TRIP indication lamps, terminal block, wiring for fan motors, etc.
- Emergency Stop P.B. shall be pressed to latch and turn to release type and provided for each fan.
- The LSPs shall be suitable for cable entry from top and suitable mounting arrangement. The LSPs shall be front wired and front connected and their enclosure shall be dust and splash proof, conforming to degree of protection of IP-54.

IV. All 240V, 1ph fans (below 0.25KW motor rating) will be operated by switches located near the individual fans. Power supply to the fans through their switches shall be arranged from their nearest Distribution board.

V. Cabling and Grounding.

All power and Control Cabling and Grounding will be provided for the ventilation system.

7.00.00 **SPECIAL TOOLS**

The Bidder shall furnish a complete set of all special tools, wrenches, etc. with necessary tool boxes as required for erection, maintenance, overhaul or complete replacement of any equipment supplied under this specification. The Bidder shall enclose a list of such tools.

8.00.00 TESTING & INSPECTION AT MANUFACTURER'S WORKS

8.01.00 The minimum quality assurance plan / test of various components of Ventilation System are listed below. However, Bidder shall conduct any other tests/ inspection required at the manufacturer's works to ensure that the equipment being supplied shall conform to the requirement of this specification and other applicable standards and codes. The detail of checks to be carried out in various stages of manufacturing and erection of various items of the system shall be submitted for Purchaser's approval in the form of quality assurance plans, field quality plans and procedures.

The items covered under the scope of supply and erection shall be of Purchaser's approved makes. Bidder has to ensure that the proposed bought out makes have proven track record and meet the qualification criteria mentioned elsewhere in the spec. Bidder is to submit the proposal of sub vendors of bought outs for Customer's approval along with their offer and no deviation with regard to approved sub vendors shall be acceptable to the Purchaser.

Material tests like physical, chemical test on various components being used shall be done as per relevant standards. Manufacturer's test certificates shall be submitted for all those tests for the review and approval of Purchaser.

All raw materials including the bought out shall be subjected to bidders inspection/ TC review as per their procedure / approved QAP for total compliance. The same shall not be limited to mechanical, physical, electrical, operational, aesthetic and functional checks, but shall confirm to the best engineering practice and strict adherence to the specifications and standards. Bidders QAP shall indicate all such tests and procedures.

The in process checks for various components shall confirm to the bidder's internal procedures which shall confirm to best manufacturing practices, national and international standards. QAP shall reflect all such tests/ standards and procedures in detail.

Internal test records / test reports shall be produced to Purchaser as required.

All panel mounted components/items like circuit breakers, switches, contactors, relays, push buttons, isolators, fuses, terminal blocks etc. shall be type and routine tested as per relevant IS/ international standards including special tests as applicable.

Type test certificates for Degree of Protection (of various items as applicable) as per the required degree specified elsewhere in the specification shall be submitted for Purchaser's review and approval.

Further to verify compliance to degree of protection on routine basis, following shall be carried out:

1. For IP-5X - It shall not be possible to insert a thin sheet of paper under gaskets and through enclosure joints.

2. For IP-4X - It shall not be possible to insert a one mm dia steel wire in to the enclosure from any direction without force.

8.02.00 **Routine Tests**

8.02.01 Centrifugal Fan

- a. 20% DPT of welding on fan hub, blades, casing and impeller as applicable.
- b. UT of fan shaft (if dia. ≥ 50 mm) shall be carried out.
- c. 100% DPT of the fan shaft after machining shall be carried out.
- d. All rotating parts shall be statically & dynamically balanced as per IS 1940 Gr. 6.3 or better as applicable.
- e. All centrifugal fans shall be subjected to free run test to check the temperature rise, noise, vibration, current drawn during testing.
- f. Fans shall be performance tested with job motor (if required) as per relevant IS for airflow, static pressure, speed, efficiency, power consumption, noise and vibration.

8.02.02 Axial Flow Fan

- a. Acceptance tests and routine test shall be carried out as per IS: 3588.
- b. Dynamic balancing of the rotating part shall be carried out as per relevant standards.
- c. NDT of the fans blade/impeller shall be carried out as per relevant standard as required.
- d. Complete fan shall be performance tested with job motor (if required) as per relevant IS for airflow, static pressure, speed, efficiency, power consumption, noise and vibration.

8.02.03 Centrifugal Pump

- a. Non-destructive examination as follows:
 - i. Impeller/wearing ring/shaft sleeve/Casing/diffuser: MPI/DPT.
 - ii. Shaft, Couplings and other active components: UT (If shaft dia. ≥ 50 mm) and DPT.
 - iii. Fabricated Pump components: DPT on welds.
- b. Hydrostatic test at two times the bowl discharge pressures at rated capacity or 1.5 times the shut off head whichever is greater.
- c. Dynamic balancing of assembled rotor to grade 6.3 or better as per ISO-1940.

- d. Performance test with job motor as per Hydraulic Institute Standards over entire operating range at rated speed, including vibration and noise measurement.
- e. Strip test after performance test (if required).

8.02.04 Air Distribution System & Air Filter

- a. Functional test of fire damper along with actuator shall be done.
- b. Filters shall be tested for pressure drop, efficiency and dust holding capacity and test certificates shall be submitted for review.
- c. All ductwork shall be carefully examined to determine their performance with the specification with respect of dimensions, materials, marking, workmanship and other requirement.
- d. After completion, all main ducting shall be checked for air leakage/tightness by smoke test method for leakages (at site). Leakages if any shall be made good by bidder.

8.02.05 Pipe and Fitting

- a. All pipes shall be hydrostatic pressure tested (UT/ECT are allowed as alternative) at tube mill as per relevant Std.
- b. All mother pipes used for fittings shall be subjected to hydraulic or ultrasonic test at tube mill.
- c. Non-destructive examination of welds shall be carried out in accordance with the relevant design/manufacturing codes.
- d. All welds shall be subjected to a visual examination and DPT.

8.02.06 Valve

- a. Hydraulic pressure tests shall be carried out on each valve to check body and bonnet strength. Seat leakage shall also be carried out as per approved drg. /data sheet. Check valve shall also be tested for leak tightness test at 25% of specified seat test pressure.
- b. Functional and dimensional testing and wear travel, seat contacts, smooth opening & closing shall be carried out on each valve.

8.02.07 Insulation

- a. Insulation material shall be tested for all mandatory tests as per relevant standards/ specification.
- b. Thermal conductivity test (only for thermal insulation) shall be done once in six months for the insulation material manufactured during six

months period for the same density, outer dia. and thickness of material as per IS: 3346 or equivalent standard. However if such tests have been carried out by the bidder on similar item which is not older than six months in a third party laboratory, test reports shall be submitted for review.

8.02.08 Air Washer Unit

- a. Dimensional check shall be carried out after a complete assembly as per the approved drawing/data sheet.
- b. Each component of the AWU & UAF shall be tested separately as per the inspection requirement mentioned herein above and relevant standard.
- c. Performance and functional test after a complete assembly shall be carried out with job motor at site if supplied in knock down condition.

8.02.09 Electric Motor

Every motor shall be routine tested as per IS: 325 to the extent necessary to establish that it is identical to the type tested motor.

8.02.10 Local Starter cum Control Panel / Local Starter Panel

- a. Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme and proper functioning of equipment.
- b. All wiring and current carrying parts shall be subjected to HV/IR test as applicable.
- c. Primary current and voltage shall be applied to all instrument transformers.
- d. Routine tests shall be carried out on all equipment such as instrument transformers, meters, contactors, switch fuse unit etc.
- e. The tests shall include wiring continuity tests, insulation tests, and functional tests to ensure operation of the control / protection / metering of individual equipment.
- f. All switches, meters, and other devices shall be tested and calibrated in accordance with relevant IS standards.
- g. Dimensional checks, bill of material check for quantity & make, painting checks shall also be carried out.

8.02.11 Cable Tray and Galvanizing Structure (if applicable)

Material check, Dimensional Check, Zinc coating thickness as per IS: 3203, IS: 4759 and Mass of zinc coating as per IS: 4759 & IS: 6749 including Adhesion

	test and Uniformity of Zinc coating as per relevant IS shall be conducted on cable tray and accessories.
8.02.12	Gauges, Switches, Instruments, etc. Accuracy, calibration, repeatability, material, dimension, functional tests and other checks as applicable shall be checked.
8.02.13	Painting Painting of all surfaces shall be checked for shade, surface finish, uniformity, coating thickness (DFT) and adhesion test/peel off test.
9.00.00	FIELD TEST
9.01.00	Type Tests Bidder should have performed the applicable type tests as per the IS / applicable standards on various components of each type and rating. Reports not older than five years shall be submitted to this effect. All such type test reports shall be subjected to the approval of Purchaser. In case the bidder has to carry out these type tests, all such tests shall be done at bidder's risk and cost within the schedule specified herein. No deviation in this regard is acceptable.
9.02.00	Field Test Overall performance of the ventilation system shall be tested after complete installation at site. This test shall be carried out to determine whether the plant meets the performance requirements specified here in and shall include measurements of all parameters under various outside conditions and establishment of correct supply of equipment. All testing and calibrating instruments required for this purpose shall be supplied by the contractor.
10.00.00	PERFORMANCE GUARANTEE, TOLERANCE, PENALTY AND TEST RECORD
10.01.00	The Tenderer shall have to guarantee the performance of individual equipment. The Tenderer shall also guarantee maintenance of the inside conditions and the minimum air changes as indicated under "design criteria".
10.02.00	The test shall be conducted at the manufacturer's works / site in accordance with the specification and if the shop / site performance tests indicate the failure of the guaranteed performance for the equipment concerned, it would be necessary for the manufacturer to make good the deficiency at its own cost by incorporating the necessary modification, alteration and replacement.
10.03.00	The additional test required to show the effect of such alteration shall be performed by the manufacturer at no expense to the purchaser.
10.04.00	TEST RECORDS
DEVELOPMENT CONSULTANTS	
(e-PCT-TS-K-02-2014-15-Vol IIID-SECTION-III)	

The certificates and records of all tests shall be submitted to the purchaser / Consultant for approval. The manufacturer shall maintain records of all tests required in the specification during manufacturing, erection and commissioning. A list of records shall be submitted to the purchaser on completion of the job. The purchaser shall be able to obtain certified copies of such records at any time.

11.00.00 **SPECIAL CLEANING, PROTECTION & PAINTING**

11.01.00 Internal surface of all parts shall be cleaned to remove loose scales and dirt. The external surface of the motor and end-shield shall be sand blasted to remove all rusts, scale etc. All sharp edges shall also be removed. Welding rods, studs & other foreign objects shall be removed prior to final assembly. Excess oil and grease shall be removed by wiping.

11.02.00 All shop finished parts shall be painted with two (2) coats of rust preventing paint. One (1) coat of synthetic enamel final paint shall be applied over and above the rust proof paint before despatch of material.

11.03.00 All surfaces coming in contact with corrosive fumes / gases during exhaust ventilation system, e.g., that in the battery room shall be painted with chlorinated rubber paint or suitable epoxy paint.

11.04.00 All equipment shall be boxed / crated or otherwise protected for shipment. Dry nitrogen desiccant and other protections shall be provided as may be necessary.

12.00.00 **DOCUMENTS, DATA TO BE FURNISHED WITH TENDER PROPOSAL**

Besides submitting the enclosed Technical Proposal Particulars Sheets duly filled in, the proposal shall also include the following drawings, curves and information wherever applicable:

12.01.00 Preliminary equipment layout drawings for Air Washer and UAF units, as well as preliminary ducting layout drawing.

12.02.00 Characteristic curves of each type of centrifugal and axial flow fans.

12.03.00 Characteristic curve of each pump.

12.04.00 Descriptive and illustrative literature / catalogues / leaflets on each of the equipment and components offered.

12.05.00 Sectional drawings for air diffusers and grilles, as applicable.

12.06.00 An experience list about supply of similar plant and equipment. The list shall indicate the salient technical parameters in each case, the status of execution and the scope of approx. value of the work undertaken by the bidder.

- 12.07.00 A comprehensive write-up and / or brochure on details of manufacturing and testing facilities in the shop of the manufacturer.
- 12.08.00 Any other relevant data and particulars as needed.
- 12.09.00 Guaranteed motor input power requirement for each and every equipment.
- 13.00.00 **POST AWARD DOCUMENTS, DATA TO BE FURNISHED**
- 13.01.00 Particulars of drawings, data and documents
- 13.01.01 Design Calculation supporting sizing of Ventilation equipment.
- 13.01.02 Equipment layout and sectional drawings of
- a. Air Washer Unit.
 - b. UAF Unit.
- 13.01.03 Schematic flow and instrumentation diagram of the complete system indicating the limits of supply and erection.
- 13.01.04 Ducting layout drawing including sectional views indicating the details of duct sizes, duct joints, duct insulation, duct supports, diffusers, grilles, dampers etc for various floors of Power House Building, ESP, AHP & CHP Control Building and other auxiliary buildings, as applicable.
- 13.01.05 Layout drawings showing the roots of water pipe line with details of hangers, supports etc.
- 13.01.06 Outline drawings incorporating all principal dimensions, civil foundation drawings and weight etc. and also sectional drawings incorporating data of material of construction wherever applicable for following equipment:
- a. Air Washer Units
 - b. UAF Units
 - c. Centrifugal Air Blower with the Drive Motors
 - d. Centrifugal Pump sets with Drive Motors for circulation of water
 - e. Fan Filter Units, Supply Fans and Exhaust Fans with drive Motors
 - f. Roof Extractor fans with Drive Motors
 - g. Supply Air Grilles / Diffusers
 - h. Fire Dampers
 - i. Back Draft Dampers
- 13.01.07 Technical Catalogues and data sheet for each Equipment and instrument.
- 13.01.08 Drawings and data sheets for Dry Panel Type Filters.
- 13.01.09 Location details of all wall mounted type Axial Flow Fans.

- 13.01.10 Write up on system interlock and / or interlock block diagram.
- 13.01.11 Electrical schematic and wiring diagram for Electrical Panels and the system as applicable with back-up write-up.
- 13.01.12 Control panel outline drawings, Bill of instruments and drawings showing construction of control panels.
- 13.01.13 Material Test Certificates.
- 13.01.14 Layout drawing showing route of cables and trays.
- 13.01.15 Cable schedule.
- 13.01.16 Manufacturer's Quality Assurance Plan for various equipment.
- 13.01.17 Shop test reports and certificates.
- 13.01.18 Operation, maintenance and overhauling manuals as per specification.

14.00.00 LIST OF DRAWINGS

Sl. No.	Drawing no.	Description
01.	13A06-002-DWG-VA-001	Typical Scheme for Air Washer Unit
02.	13A06-002-DWG-VA-002	Typical Scheme for Unitary Air Filtration Unit
03.	13A06-002-DWG-VA-003	Typical Detail of Wall Mounted Axial Flow Fan and Roof Extractor Units
04.	13A06-002-DWG-VA-004	Typical Scheme of Air Distribution System for Power House Building
05.	13A06-002-DWG-VA-005	Scheme of Ventilation System for Different Auxiliary Buildings

LOW PRESSURE PIPING, VALVES AND SPECIALTIES

1.00.00 GENERAL INFORMATION

This section covers all the low-pressure piping up to 400mm NB size, associated valves and specialties that include but is not limited to the following systems.

- 1.01.00 Service Air System - shall consist of distributions service air to different buildings.
- 1.02.00 Instrument Air System - shall comprise of distribution of instrument quality air to pneumatically operated instruments/ valves/dampers.
- 1.03.00 Demineralised Water Supply system including hot well make-up water piping from condensate storage tank.
- 1.04.00 Demineralised Water closed cycle cooling system.
- 1.05.00 Service water system.
- 1.06.00 Potable water system.
- 1.07.00 Any other low pressure piping as found necessary during detail engineering shall also be included.

2.00.00 CODES AND STANDARDS

- 2.01.00 In addition to the requirements spelt out in Volume IIA, the design, manufacture, inspection and testing of the piping, fittings, valves and specialties covered under this specification shall conform, in general, to the standards and codes (latest edition) mentioned below:
 - 2.01.01 IS-1239 : Mild steel tubes, tubular and other wrought steel fittings
[Part-I & II]
 - 2.01.02 IS-3589 : Electrically welded steel pipes for water, gas and sewage (150 to 2000 mm nominal diameter)
 - 2.01.03 IS-554 : Dimensions for pipe threads where pressure tight joints are required on the threads.
 - 2.01.04 IS-1363 : Hexagonal head bolts, screws and nuts (size range M5
[Part-I & II] M36)

2.01.05	IS-1364	:	Precision and Semi-precision hexagon bolts, screws, nuts and lock nuts (diameter range 6 to 39 mm)
2.01.06	IS-3138	:	Hexagon bolts & nuts (M42 to M150)
2.01.07	IS-5312	:	Swing check type reflux (non-return) valves.
2.01.08	IS-2379	:	Colour code for the identification of pipelines.
2.01.09	IS-2016	:	Plain washers
2.01.10	IS-2712	:	Compressed asbestos fibre jointing
2.01.11	ANSI B-16.5	:	Steel pipe flanges and flanged fittings
2.01.12	ANSI B-16.9	:	Wrought steel Butt welding flanged
2.01.13	ANSI B-16.11 : ANSI B-36.10 :		Forged steel fittings, Socket-welding and Threaded. Steel pipes thickness
2.01.14	API-600	:	Steel gate valves
2.01.15	BS-2633	:	Class I Arc welding of ferrite steel pipe work for carrying fluids.
2.01.16	BS-534	:	Specification for steel pipes and specials for water and sewage.
2.01.17	BS-5351	:	Specification for Ball valves.
2.01.18	AWWA-C-504	:	Specification for Butterfly valves.
2.01.19	AWWA-C-208	:	Dimension for fabricated steel water pipe fittings.
2.02.00	Other international codes and standards may also be offered by bidder. However, same may be subject to acceptance by the Purchaser.		
3.00.00	SCOPE OF WORK		
3.01.00	The equipment and materials to be supplied shall include but not be limited to the following:		
	a)	Supply of all low pressure piping including bends, elbows, tees, branches, laterals, crosses, reducing union, couplings, caps, saddles, shoes, flanges, blank flanges, Y-pieces etc. as required for the piping system under the scope of this section.	
	b)	Matching pipes, matching pieces like reducers/enlargers etc., counter flanges with bolts, nuts, washers, temporary and permanent gaskets, threaded union etc.	
	c)	Supply and machining work of flanges, pipe spools and matching pipes to connect flow measuring orifices/nozzles with the main pipe work.	

- d) All isolating and regulating valves, non-return valves, steam/air traps, relief/safety valves (wherever applicable), strainers, pressure reducing orifices etc. complete with the counter flanges and matching connecting pieces as required within the entire low pressure piping system.
- e) Anchors, hangers and supports, etc. as required. Any platform necessary for maintenance and operation of valve and equipment located 1.5 m above any permanent floor or platform including access ladders, supporting structures etc.
- f) All secondary structural steel members required for pipe supports from building steel structures and from embedded steel wherever provided including pipe supports in trenches. However, trench piping should be avoided to the extent possible.
- g) Funnels, tundishes for drips and drains including all miscellaneous drain piping and drain piping from tundish outlet up to drain points. All drain and vent lines shall be conveniently terminated to floor drain points/permanent drain trenches.
- h) Flanges, counter flanges, blank flanges, bolts, nuts, washers, temporary and permanent gaskets, fasteners caps etc. as required for interconnecting piping, valves & fittings.
- i) Cleaning and Painting of all piping, valves & specialties at manufacturer's shop.

3.02.00 Following general requirements shall however be provided

- a) Instrument Connections including instruments, root valves, sensing lines etc.
- b) Pipe stubs and blanking plates etc. required for chemical cleaning and hydro testing.

For conducting acceptance test, the required pressure, temperature, flow measurement points shall be provided.

3.03.00 All miscellaneous instruments

4.00.00 **GENERAL DESIGN AND CONSTRUCTION**

4.01.00 **General Considerations**

4.01.01 The piping systems included in this section shall be designed to operate continuously without replacement during the plant service life of 30 years.

4.01.02 The piping system shall be complete in every detail and in accordance with the highest standard of workmanship.

- 4.01.03 All design and fabrication shall be in accordance with codes/standards specified.
- 4.01.04 No pipe work shall be run in trenches carrying electrical cables.
- 4.01.05 Pipe size above 50 NB shall be shop fabricated and of size 50 NB and below shall be field run.
- 4.01.06 All piping shall be identified by means of colour strips and by adequate lettering, conveniently spaced and located. Identification colours and lettering shall be as approved.
- 4.01.07 Air release and drain branches shall be provided wherever necessary depending upon the layout and arrangement so that the drains and air release valves are located for easy operation.
- 4.01.08 Unless otherwise specified, all pipe work shall be suitable for a minimum pressure of 10.0 kg/sq. cm(g) at 80 deg. C or as required by the design of the different piping system, if higher.
- 4.01.09 **Drain Pipe Work**
- a) Low pressure drains shall have an isolating valve at the point of take-off from the pipe or vessel to be drained, or as near as possible for conventional operation.
 - b) Unless otherwise stated, all drain piping shall be of 25 mm NB minimum and all vent pipings shall be of 15 mm NB size minimum. For pipes up to 50mm NB, pipe wall thickness shall be as per schedule 80 of ANSI B36.10.
 - c) Unless otherwise stated, wherever a main or branch of any pipeline is terminated with a valve, such terminal valve shall be provided with a blank flange/blanking cap at the free end.
- 4.01.10 Specification of pipes used in different services included in the L.P piping section has been detailed in Annexure-I.
- 4.02.00 **Material Specification**
- 4.02.01 Materials for pipes and fittings shall be as stipulated in Annexure-I. In case bidder wants to offer alternative piping material, same may be accepted by the Purchaser depending on the merits of alternative material.
- 4.02.02 Pipe attachments for supports, anchors and restraints, which are coming in direct contact with pipes, shall have similar materials as the piping concerned. All other materials of supports, anchors and restraints shall be of tested quality and as per manufacturer's standards.

4.03.00 **Fabrication**

Except where otherwise specified all piping shall have butt-welded connections with a minimum of flanged joints necessary for maintenance. Where flanges are adjacent to welded fittings, weld neck flanges shall be used.

Branches shall, in general, be formed by welding. Standard fittings may be used in positions and for sizes where approval has been given in detail drawings. Pipe bends and tees shall be truly cylindrical and of uniform section. all welded branches shall be reinforced where needed as per the applicable codes/regulations.

4.03.01 Piping shall be fabricated in the shop in the largest transportable sections to minimize the number of field weld joints. The choice of field weld joints locations shall be based on the traverse of the pipe through walls, floors, sleeves or other restrictive areas. Support attachments for major piping shall be done at shop.

4.03.02 All pipes bends shall be made true to angle with no negative tolerance and shall have a smooth surface free of flat spots, crease and corrugations. A cross section through any bent portion of the pipe shall be true in diameter, within plus or minus 3% of the pipe diameter. Pipe bends shall be made from straight pipe pieces of sufficiently higher thickness so that after thinning, the minimum thickness of bends shall not be less than the minimum thickness required for the straight pipe. Thinning allowance shall be considered as per the relevant code.

4.03.03 For bends in pipes straight piece of pipes shall be bent by the contractor to required bend radius. However, forged bends (Bend radius = $1.5 \times$ pipe diameter) wherever required shall be provided.

4.03.04 The ends of Pipe and welded fittings shall be bevelled according to details shown in the relevant piping code. All welding shall be made in such a manner that complete fusion and penetration are obtained without an excessive amount of filler metal beyond root area. The reinforcement shall be applied in such a manner that it shall have a smooth contour merging gradually with the surface of adjacent pipe and welded fittings. Backing rings shall not be used on any pipe welds, unless otherwise approved by the Engineer.

4.03.05 Cutting and Bevelling

- a) Carbon steel piping - End preparation for butt welding shall be done by machining/flame cutting.
- b) Socket welding - Socket weld and preparation shall be done by saw or machine cutting.

4.04.00 **Hangers, Supports, Anchors**

Normally pipe supports and anchors shall be selected at those points in the buildings where provision has been made for the loads imposed. The cutting of floor/roof beams or the reinforcement in slabs will not be permitted. Piping attached to a plant item shall be supported in such a way that the weight of the piping is not taken by the plant item.

4.04.01 Support spacing shall be as per good engineering practice. However in no case it shall be less than support spacing stipulated in ANSI B31.1.

4.04.02 Accurate weight balance calculations shall be made to determine the required supporting force at each hanger location and the pipe weight load at each equipment connection.

4.04.03 All large pipes and all long pipes shall have at least two supports each arranged so that any length of pipe or valve may be removed without any additional supports being required.

4.04.04 Support steel shall be of structural quality. Perforated strap, wire or chain shall not be used. Support components shall be connected to support steel by welding, by bolting or by beam clamps. Bolt holes shall be drilled not burned. Support components may be bolted to concrete using approved concrete anchors.

4.05.00 **Valves and Accessories**

4.05.01 General Requirements

- a) All valves shall be of approved make and type and shall have cast/forged bodies with covers and glands of approved construction and materials as specified in Annexure-II & III. In general all pumps (other than sump pumps), discharge valves shall be motor operated only. Tank inlet valves shall be motor operated only.
- b) Valves and specialties to be supplied under this specification will be used for various air and water services and will be located indoor/outdoor and on horizontal/vertical runs of the pipelines. However, mounting of valves in vertical pipe runs should be avoided as far as possible.
- c) All valves shall, unless otherwise stated, have the internal diameter same/as the internal diameter of the pipes to be joined.
- d) All valves shall receive tests at manufacturer's or contractor's works in accordance with the specific requirements of the approved Codes of Practice. Valves shall be rising stem or otherwise as approved by the Purchaser.
- e) Gate valve and Ball valve have been specified with the intention of achieving isolation and tight shut-off. In full open condition, these valves should offer minimum of resistance to fluid flow.

- f) Globe valves have been specified with the intention of achieving good control of fluid passing. The plug and seat will have therefore suitable profiles for obtaining such controlling action.
- g) Check valves have been specified in order to prevent reverse flow through them.
- h) All valves shall function smoothly without sticking, rubbing or vibration on opening or closing and shall be suitable for most stringent service conditions i.e. flow, temperature and pressure under which they may be required to operate.
- i) Material, design, manufacture, testing etc. for all valves and specialties along with the accessories shall conform to the latest editions of codes.
- j) By pass valves shall be provided for larger size valves as per standards followed and as felt necessary for smooth and easy operation, even though not specifically mentioned in the specification.
- k) All flanged valves and specialties to be supplied under this section shall be provided with two (2) counter flanges, bolts, nuts, washers, gaskets etc.
- l) All valves shall be of approved design and manufacture. Where valves are of similar size and type they shall be interchangeable with one another. Valves shall have welded or flanged connections subject to the Purchaser's approval.
- m) All valves shall have outside screwed spindles and screwed thread of spindle shall not pass through or into the stuffing box. Where valves are exposed to the weather, protective covers shall be provided for the spindles, which shall be subject to approval.
- n) Gate, Globe and Ball valves shall be provided with the following accessories in addition to other standard items:
 - i) Hand wheel with embossed open and shut directions.
 - ii) Local position indicator.
 - iii) Motorised operation as specified by Engineer.
- o) Gate valves, in addition shall be provided with following extra features
 - i) Bypass valve for larger valves
 - ii) Draining arrangement
 - iii) Enclosed Gear operators for valves 300 mm size and above for ease in operation.
 - iv) Motorised operation as specified by Engineer.
- p) All gate and globe valves shall be rising stem type.

- q) All valves shall be provided with hand-wheels, chain, operator, extended spindle and floor stand wherever required so that they can be operated manually by a single operator from the nearest operating floor either at a lower or higher elevation as the case may be. If such a valve is provided with integral bypass then similar arrangement shall be done for the bypass valve also.
- r) All valves and specialties shall be provided with brass Tag Discs indicating Tag numbers and nomenclature of the valve including duty or service intended and the function of the valves specialties.
- s) Stems shall preferably be arranged vertically with gland at the top, however, in no circumstances must the stem be inclined downward from horizontal or gland be at the bottom. Globe valves shall be installed with the pressure under the disc. Valves shall not be fitted in inverted position.
- t) Where necessary, for accessibility, grease nipples shall be fitted at the end of extension piping and where possible these shall be grouped together and mounted on a common panel situated at a convenient position. A separate nipple shall be provided to lubricate each point. The Bidder shall supply the first fill of oil or grease for these parts. The Bidder shall supply a suitable manually operated grease gun for the standard type of nipple provided.
- u) The spindles for all valves for use outside the building shall have weatherproof protection covers of approved construction.
- v) All valves shall be fitted with indicators so that it may be readily seen whether the valves are open or shut. In the case of those valves fitted with extended spindles, indicators shall be fitted both to the extended spindles and to the valve spindles.
- w) Plastic or bakelite valve hand wheels will not be accepted.
- x) All valves shall be closed by rotating the hand wheel in a clockwise direction when looking at the faces of the hand wheel. The face of each hand wheel shall be clearly marked with the words 'Open' and 'Shut' with arrows adjacent to indicate the direction of rotation to which each refers.
- y) Wherever practicable heavy valves of total weight including actuator, drive motor, integral by-pass etc., equal to or greater than 500 kg. shall be provided with suitable lugs to permit direct suspension by hanger rod or direct resting on bottom support, as applicable.
- z) Special attention shall be given to the operating mechanism for large size valves in order that quick and easy operation is obtained and maintenance is kept to a minimum.
- aa) Eyebolts shall be provided where necessary to facilitate handling heavy valves or parts of valves.

- bb) The Bidder shall supply with his bid and in addition during the course of the Contract, comprehensive drawings showing the design of valves, test pressure and working pressure/temperatures. They should include a parts list referring to the various materials used in the valve construction.
 - cc) All sampling and root valves shall be of integral body bonnet type.
- 4.05.02 For Design Requirements for different valves refer Annexure-II & III.
- 4.06.00 **Safety/Relief Valves**
- Safety/Relief valves shall be of direct spring loaded type and shall have a tight, positive and precision closing.
- All safety valves shall be provided with manual lifting lever.
- Valves used for air and any other compressive fluid shall be of pop type.
- Safety/Relief valves shall be constructed and adjusted to permit the fluid to escape without increasing the pressure beyond 10% above the set blow off pressure. Valve shall reset at a pressure not less than 2.5% and more than 5% of the set pressure.
- Releasing capacity of the safety/relief valves shall be as per the applicable codes and standards and shall be subject to the approval of the Engineer.
- The seat and disk of safety valves shall be of suitable material to resist erosion. The seat of valve shall be fastened to the body of the valve in such a way that there is no possibility of the seat lifting.
- 4.07.00 **Hosepipe and Accessories**
- 4.07.01 Hose valves for service water system shall be Gate valves and service air system shall be Globe valves.
- 4.07.02 Hose pipes with fittings for Service Water System:
- a) The water hose shall be as per IS-444 (Type-3).
 - b) Length of each hose shall be 15 metres.
 - c) For each hose, one end shall be fitted with M.S. female coupling with swiveling nuts and soft seating ring suitable for connection to male end of hose valve and other end shall be made threaded for joining with the swiveling nut of a second hose whereby two hose lengths may be joined.
- 4.07.03 Hose pipes with fittings for Compressed air System
- a) The compressed air hose shall be as per IS-911 (Type 2).

- b) The length and type of each end shall be similar to as specified in above clause no. (4.07.02) above.

5.00.00 **DRAWINGS, DATA, INFORMATION & MANUALS**

5.01.00 Drawings, data, Information to be furnished by the Bidder besides those already mentioned in volume : IIA with the offer.

5.01.01 A complete list of all piping and fittings of various sizes with their quantities and details e.g. nominal size, O.D., I.D. (as applicable) thickness, design pressure, design temperature, material of construction/code/standards etc.

5.01.02 A complete list of all valves with their type, quantities & ratings.

5.01.03 Manufacturer's catalogue indicating complete range of available size and rating of pipes & fittings.

5.01.04 Descriptive literature on the manufacturing process and quality control procedures highlighting the manufacturing, fabricating and testing facilities available in the shop.

5.02.00 **After Award of Contract**

Detail drawings including fabrication drawings of all shop fabricated piping system indicating design parameters and complete bill of material (Relevant Standards and grades to be indicated) and information/data pertaining to the hydrostatic and non-destructive test requirements to be submitted progressively.

5.02.01 Detail dimensioned drawing of each valve, specialties, indicating tag no., pressure rating, manufacturing standard, the bill of materials and hydrostatic test pressures. The drawing shall include the end preparation details and shall indicate the position of the hand wheel/operator. Technical particulars of motor operators wherever applicable shall also be indicated.

5.02.02 General arrangement drawing for each hanger/support/anchor etc. indicating identification number, auxiliary supporting structural details, other details & information as required in the specification.

5.02.03 Wiring diagram for all limit switches of motor operated valves.

5.02.04 The loading data required for design of structures shall be furnished well in advance to suit Purchaser's time schedule.

6.00.00 **BROAD GUIDELINES FOR ERECTION AND INSTALLATION OF LP PIPING**

6.01.00 All fittings like "T" pieces, flanges, reducers etc. shall be suitably matched with pipes for welding. The valves will have to be checked, cleaned or overhauled in full or in part before erection, after chemical cleaning and during commissioning.

6.02.00 Adjustments like removal of oval ties in pipes and opening or closing the fabricated bends of high pressure piping to suit the layout shall be considered

part of work and is required to carry out such work as per instruction of Owner, which shall include specified heat-treatment procedures, etc. also wherever required.

- 6.03.00 Certain adjustments in length may be necessary while erecting high pressure pipelines and the contractor should remove the extra lengths to suit the final layout after preparing edges afresh and adopting specified heat treatment procedures.
- 6.04.00 Suspension for piping, pressure parts, etc., will be supplied in running lengths, which shall be cut to suitable sizes and adjusted as required.
- 6.05.00 All the valves, lifting equipments, actuators, power cylinders, etc., shall be serviced and lubricated to the satisfaction of Engineer before erecting the same and also during pre-commissioning. Even after commissioning, the equipments, if there are problems in the operation, they have to be attended to by the Bidder during the tenure of the contract. Welding or jointing of extension spindle for valves to suit the site conditions and operational facility shall be part of erection work.
- 6.06.00 All tubes and pipes shall be cleaned and blown with compressed air and shown to the engineer before lifting. Bigger size pipes should be cleaned with flexible wire brush, wherever necessary. After cleaning is over the end caps shall be put back in tube openings till such time they are welded to other tubes.
- 6.07.00 Fine fittings, drain piping, oil systems & other small bore piping have to be routed according to site conditions and hence shall be done only in position. As such, layout of small-bore piping shall be done as per site requirement. There is a possibility of slight change in routing the above pipelines even after completion of erection, which shall be carried out by the Bidder without any extra cost to the Purchaser. Work shall also include fabrication of small bends at site from straight lengths to suit the site conditions.
- 6.08.00 No temporary supports shall be welded on the pressure parts. Welding of temporary supports, cleats, etc., on the building columns shall also be avoided. In case of absolute necessity, Contractor shall take prior approval from Engineer. Further, any cutting or alteration of member of the structure or platform or other equipments shall not be done without specific prior approval of Engineer.
- 6.9.00
- a) All piping shall be grouped wherever practicable and shall be routed to present a neat appearance.
 - b) The piping shall be arranged to provide clearance for the removal of equipment for maintenance and for easy access to valves, instruments and other piping accessories required for operational maintenance.
 - c) Piping shall be routed above ground unless otherwise specifically indicated/ approved by the Engineer. In such special case, the piping may be arranged in trenches, or buried and properly protected as per AWWA Standards.

- d) Overhead piping shall have a minimum overhead clearance of 4 meters above walkways and working areas and 7 meters above roadways unless otherwise approved by the Engineer.
- e) Drains shall be provided at all low points and vents at high points as per actual layout regardless of whether some have been shown in respective drawings or not. The pipelines shall be sloped towards the drain points.

6.10.00 All drips and drains for piping and equipment whether shown in the drawings or not shall terminate on the ground floor up to station drain unless otherwise specified. Leading such drains up to station drainage is also the responsibility of the Contractor.

ANNEXURE-I
SPECIFICATION OF PIPES FOR DIFFERENT SERVICES

	A		B		C	D
Services	1. Clarified Water piping 2. DMCW piping		1. Drinking/ Potable Water Supply, piping (Clarified water, chlorinated)		1. Demineralised Water, Service and Instrument Air Piping less than and equal to 50 mm NB	1. Demineralised Water, Service and Instrument air piping for sizes equal to greater than 65 mm NB
1.00.00 Material of Pipe	Carbon Steel IS-1239 Heavy Grade upto 150 mm NB and IS-3589 for sizes above 150 mm with minimum pipe thickness of 6 mm.		Carbon Steel as per IS-1239 Heavy Grade for sizes upto 150 mm NB and IS-3589 for sizes above 150 mm NB with minimum pipe thickness of 6 mm. The pipes shall be galvanized as per IS-4736		Stainless Steel as per ASTM A-312 Gr. 304. Size- as per schedule 40 ANSI B36.10	Stainless steel as per ASTM A-312 Gr. 304. Size-upto 150 mm NB as per schedule 10S, ANSI B-36.10.
2.00.00 Construct ion	ERW / Seamless		ERW / Seamless		ERW	ERW
3.00.00 Joints	Slip-on Flange and butt weld for size 65 mm NB and above and Socket weld joint for size 50 mm NB and below.		Screwed flange for sizes 65 mm NB and above and screwed socket for size 50 mm NB and below.		Socket welded for size 50 NB and below	Slip-on flange and butt weld joint.
4.00.00 Fittings	Pipe Sizes > = 65 mm NB	Pipe Sizes < = 50 mm NB	Pipe Sizes > = 65 mm NB	Pipe Sizes < = 50 mm NB		

	A		B		C	D
Services	1. Clarified Water piping 2. DMCW piping		1. Drinking/ Potable Water Supply, piping (Clarified water, chlorinated)		1. Demineralised Water, Service and Instrument Air Piping less than and equal to 50 mm NB	1. Demineralised Water, Service and Instrument air piping for sizes equal to greater than 65 mm NB
4.01.00 Materials	ASTM-A-234 Gr. WPB	ASTM-A-105	ASTM-A-234 Gr. WPB galvanized as per IS-4736	ASTM-A-105 galvanised as per IS- 4736	ASTM-A-182 F304	ASTM-A-351-CF8
4.02.00 Construct ion	Welded/ Seamless	Forged	Welded/ Seamless	Forged	Forged	Welded/Seamless
4.03.00 Standard	ANSI-B-16.9 for fabricated fitting AWWA- C-208	ANSI-B- 16.11	ANSI-B-16.9	ANSI-B-16.11	ANSI-B-16.11	MSS-SP-43
4.04.00 End details	Pipe size ≥65mm NB Butt welded as per ANSI-B- 16.25	Pipe size ≤50 mm NB Socket welded as per ANSI-B- 16.11	Pipe size ≥65 mm NB Screwed Flanged	Sizes ≤50 mm Screwed socketed as per ANSI-B- 16.11All fittings shall be galvanized.	Socket welded	Slip - on flanges

	A	B	C	D
Services	1. Clarified Water piping 2. DMCW piping	1. Drinking/ Potable Water Supply, piping (Clarified water, chlorinated)	1. Demineralised Water, Service and Instrument Air Piping less than and equal to 50 mm NB	1. Demineralised Water, Service and Instrument air piping for sizes equal to greater than 65 mm NB
5.00.00 Flanges	150 lb class as per ANSI-B-16.5 complete with nuts, bolts and gaskets	As per ANSI-B-16.5 pressure class 150lbs - galvanised-complete with nuts, bolts and gaskets.	As per ANSI-B-16.5 pressure class 150lb complete with nuts, bolts and gaskets. Material as per class 4.01.00.	150lb class, flat face, as per ANSI-B-16.5 complete with nuts, bolts and gaskets.
Pipes which fall under IS:1239 shall be hydrostatically tested according to the said code, for others refer Section-V, Vol.: II-A.				

SERVICES OF VARIOUS CATEGORIES OF VALVES

Valve Classification		Service		
A.	Cast iron body Gate/Globe/Check Valve	i)	Service Water	For sizes 65mm NB and above.
		ii)	Clarified Water	
		iii)	Drinking/ Potable Water	
		iv)	Inhibited Demineralised Water	
B.	Stainless steel body/ Gate/Globe /Check/Ball Valve	i)	For Demineralised water	For all sizes
		ii)	Potable/ Drinking Water	For sizes less than and equal to 50 mm NB
		iii)	Service and Instrument Air	For all sizes. Ball valves to be used in air line.
C.	Steel Body valves	i)	Clarified Water	For sizes less than and equal to 50 mm NB
		ii)	Inhibited Demineralised Water for DMCW system	
D.	Cast Iron body butterfly valve	i)	For Demineralised Water	For butterfly valve specification refer Annexure II, Sec.IV of Vol. IIIE. For DM water line rubber lining/ EPDM/equivalent protection to be provided
		ii)	Raw water	
		iii)	Clarified Water	
		iv)	Filtered Water	
		v)	Inhibited Demineralised Water for DMCW system	

ANNEXURE-III

SPECIFICATION OF VALVES

		A. Cast Iron Body Gate/ Globe/Check Valve	B. Stainless steel Body Gate/Globe/Check/Ball Valve	C. Steel Body Gate/ Globe/Check Valve/ Ball Valve
1.00.00	Valve Classification Code	CIGC	SSGC	STGC
2.00.00	Basic Design Code			
	a) Gate	a) i) IS 780 for 50 mm - 300 mm NB ii) IS2906 for 350 mm NB and above or as per MSS-SP-70	a, b, c) ANSI-B-16.34	i) API 600 for 50mm ii) API 602 for size
	b) Globe	b) MSS - SP - 85		b) BS-1873/ANSI-B-16.34
	c) Check	c) IS-5312/MSS - SP -71		c) BS-1868/ANSI B16.34
	d) Ball		d) BS-5351	
3.00.00	Pressure Class	To be suitably chosen considering the pressure requirement. Refer Clause No. 4.01.08 in this regard.		
4.00.00	Construction	Cast body and bonnet / cover	Forged body up to 50mm NB and Cast body above that	Same as Group-B
5.00.00	Material			
5.01.00	Body & Bonnet/ cover	IS 210 Gr. FG 260	ASTM-A-182 F304 for Ball Valves: A351 CF8M for cast body, A 182 F304 for forged body.	ASTM-A-216 Gr. WCB for cast body & ASTM-A-105 for forged body

		A. Cast Iron Body Gate/ Globe/Check Valve	B. Stainless steel Body Gate/Globe/Check/Ball Valve	C. Steel Body Gate/ Globe/Check Valve/ Ball Valve
5.02.00	Trim / Disc.	IS-210 Gr. FG 260	ASTM-A-182 F304 for Gate, Globe, Check valves and 351CF 8M for Ball valves. For DKW system : ASTM-A-182 F6A (min. 250 HB)	13% Cr Steel as per ASTM-A- 182 Gr. F6 heat treated and hardened(min 250 NB) for cast body and ASTM-A-105 Hard faced with Stellite (min 350 HB) for forged body
5.03.00	Seating surface	13% Cr steel as per IS 1570	For Ball valves PTFE seats and seals.	13% Cr. Steel as per ASTM-A- 182 Gr. F6
6.00.00	End Preparation	Socket welded for size equal to and below 50mm NB and flanged with counter flanges for 65mm NB and above.		
7.00.00	Testing			
	a) Gate	i) As per IS - 780 for 50 mm - 300 mm NB ii) IS-2906 for sizes equal to and above 350 mm NB	As per ANSI B-16.34	API-598
	b) Globe	Hydrostatic Test as per MSS-SP-85		BS-1873
	c) Check	IS-5312/MSS-SP-71		BS--1868



**CUSTOMER SPECIFICATION
FOR VENTILATION SYSTEM
5X800 MW YADADRI TPS**

DOCUMENT NO.: PE-TS-417-554-A001

REVISION 00

DATE: FEB 2020

**SECTION: I
SUB-SECTION: C 2B
CUSTOMER SPECIFICATION-PROJECT SPECIFIC GENERAL
REQUIREMENT**

VOLUME : IIA

SECTION-VII

QUALITY ASSURANCE REQUIREMENTS

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	QUALITY ASSURANCE PROGRAMME
2.00.00	GENERAL REQUIREMENTS QUALITY ASSURANCE
3.00.00	QUALITY ASSURANCE DOCUMENTS
4.00.00	INSPECTION, TESTING & INSPECTION CERTIFICATES

ATTACHMENTS

ANNEXURE-I	FORMAT OF QUALITY ASSURANCE PROGRAMME
ANNEXURE-II	FIELD WELDING SCHEDULE

VOLUME : IIA**SECTION-VII****QUALITY ASSURANCE REQUIREMENTS****1.00.00 QUALITY ASSURANCE PROGRAMME**

1.01.00 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 Owner's site or at any other place or 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 Owner/Authorised representative after discussions before the award of contract. 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) Documentation control system.
- c) Qualification data for Bidder's key personnel.
- d) 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.
- e) System for shop manufacturing and site erection control including process controls and fabrication and assembly controls.
- f) Control of non-conforming items and system for corrective actions.
- g) Inspection and test procedure both for manufacture and all site related works.
- h) Control of calibration and testing of measuring and testing equipments.
- i) System for quality audit.
- j) System for indication and appraisal of inspection status.
- k) System for authorising release of manufactured product to the Owner.
- l) System for handling storage and delivery.
- m) System for maintenance of records.

- n) 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 format enclosed at Annexure-I to this section for Owners approval
- o) Internal standards, if referred in the quality plans shall generally be compatible with National / International standards and shall be mentioned in the quality plans. Alternatively bidder shall furnish extracts of the internal standards detailing out acceptance norm for the product / material.

2.00.00 GENERAL REQUIREMENTS - QUALITY ASSURANCE

2.01.00 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 Owner/Consultant. The detailed Quality Plans for manufacturing and field activities should be drawn up by the Bidder, separately in the format attached at Annexure-I and will be submitted to Owner/Authorised representative for approval. Schedule of finalisation of such quality plans will be finalised before award.

Contractor shall furnish list of Manufacturing Quality Plans of major equipments indicating proposed inspection categorisation indicating items that will be offered for Owner's inspection etc and the Field Quality Plans

2.02.00 Manufacturing Quality Plan for all the major equipment will detail out their respective important components, their in-process various tests/inspection & final inspection / tests, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Contractor's Quality Control organization. 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 are to be comprehensively documented by Contractor.

Manufacturing Quality Plan for all major equipments/ items will be approved by owner. In these approved quality plans, Owner / Authorised representative shall identify customer hold points (CHP), test / checks which shall be carried out in presence of the Owners Engineer or his authorised representative and beyond which the work shall not proceed without consent of Owner / Authorised representative in writing. Inspection/ Test reports are to be submitted to owner as specified in final approved Manufacturing Quality Plans.

2.03.00 Field Quality Plans / Procedures for all field activities shall be submitted to

owner for review / approval. These Quality Plans / procedures will detail out, for all equipment, the quality practices and procedures etc. to be followed by the Contractor's site Quality Control organisation, during various stages of site activities from receipt of materials/ equipment at site.

- 2.04.00 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 Owner's approval without which manufacture shall not proceed. These approved documents shall form a part of the contract. In these approved quality plans, Owner/Authorised representative shall identify customer hold points (CHP), test/checks which shall be carried out in presence of the Owners Engineer or his authorised representative and beyond which the work will not proceed without consent of Owner/Authorised representative in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and major deviations in the form of Non Conformity Report shall be referred to Owner/Authorised representative for approval and dispositioning.
- 2.05.00 No material shall be despatched from the manufacturer's works before the same is accepted subsequent to pre-despatch final inspection including verification of records of all previous tests/inspections by Owner's Engineer/ Authorised representative for "CHP" and "W" points marked in quality plans , and duly authorised for despatch by issuance of Material Despatch Clearance Certificate (MDCC). For items which is not under owner's inspection the contractor shall apply for despatch clearance (MDCC) from owner by submitting their internal inspection reports and quality records
- 2.06.00 All materials used or supplied shall be accompanied by valid and approved materials certificates and tests and inspection report. These certificates and reports shall indicate the sheet serial numbers or other such acceptable identification numbers of the material. The material certified shall also have the identification details stamped on it.
- 2.07.00 Castings and forgings used for construction shall be of tested quality. Details of results of chemical analysis, heat treatment record, mechanical property test results shall be furnished.
- 2.08.00 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section - IX (latest edition) or other International equivalent standard acceptable to the Owner.

All brazers, welders etc. employed on any part of the contract at Contractor's/ Sub-Contractor's works or at site shall be qualified as per ASME Section-IX (latest edition) or equivalent international standard approved by the Owner. Such qualification tests shall be conducted in presence of Owner / his authorised representative or owner approved Third Party Inspection Agency(TPIA). Previously qualified WPS & PQR shall be acceptable if witnessed by owner's approved TPIA.

For welding of pressure parts and high pressure piping coming under IBR purview, the requirements of IBR shall also be complied with.

- 2.09.00 All non-destructive examination (NDT) shall be carried out in accordance with LIST OF STANDARDS FOR REFERENCE as given below in this section.
- The NDT operator shall be qualified as per SNT-TC-IA (of American Society of non- destructive examination). Results of NDT for the list major equipments / items identified for owner's inspection shall be properly recorded and submitted for review and approval. Other items not covered under owner's inspection, contractor shall review and approve the NDT results and such reports shall be submitted to owner in the final documentation of the items / equipments
- 2.10.00 All the sub-vendors proposed by the Contractor for procurement of major bought out items including castings, forgings, semi-finished and finished components/equipment list of which shall be drawn up by the Contractor and finalised with the Owner shall be subject to Owner's approval. Quality Plans of the successful vendors shall be discussed, finalised and approved by the Owner/Authorised representative and form part of the Purchase Order between the Contractor and the Vendor.
- 2.11.00 All the purchase specifications for the major bought-out items, list of which shall be drawn up by the Contractor and finalised with the Owner shall be furnished to the Owner for comments and subsequent approval before orders are placed.
- Owner reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Contractor's or their sub-vendor's quality management and control activities. The Contractor shall provide all necessary assistance to enable the Owner carry out such audit and surveillance.
- Quality audit/approval of the results of tests and inspection will not prejudice the right of the Owner to reject equipment not giving the desired performance after erection and shall not in no way limit the liabilities and responsibilities of the Contractor in earning satisfactory performance of equipment as per specification.
- 2.12.00 Quality requirements for main equipment shall equally apply for spares and replacement items.
- 2.13.00 Repair/rectification procedures to be adopted to make any job acceptable shall be subject to the approval of the Owner.
- 2.14.00 For quality assurance of all civil works refer to the specifications for civil works.
- 3.00.00 **QUALITY ASSURANCE DOCUMENTS**
- 3.01.00 The Contractor shall be required to submit two (2) copies and two (2) sets of microfilms / CDs of the following Quality Assurance documents within three (3) weeks after despatch of the equipment:
- a) Material mill test reports on components as specified by the specification.

-
- b) The inspection plan with verification, inspection plan check points, verification sketches, if used and methods used to verify that the inspection and testing points in the inspection plan were performed satisfactorily.
 - c) Non-destructive examination results /reports including radiography interpretation reports.
 - d) Factory tests results for testing required as per applicable codes and standards referred in the specification.
 - e) Welder identification list listing welder's and welding operator's qualification procedure and welding identification symbols.
 - f) Sketches and drawings used for indicating the method of traceability of the radiographs to the location on the equipment.
 - g) Stress relief time temperature charts.
 - h) Inspection reports duly signed by QA personnel of the Owner and Contractor for the agreed inspection hold points. During the course of inspection, the following will also be recorded :
 - i) When some important repair work is involved to make the job acceptable.
 - ii) The repair work remains part of the accepted product quality.
 - i) Letter of conformity certifying that the requirement is in compliance with finalised specification requirements.

4.00.00 **INSPECTION, TESTING AND INSPECTION CERTIFICATES**

4.01.00 The Owner's Engineer, or his duly authorised representative and/or an outside inspection agency acting on behalf of the Owner shall have access inside the workshops, test labs, establishments at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Contractor shall obtain for the Owner's Engineer and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works.

4.02.00 The Contractor shall give the Owner's Engineer/ Authorized Inspector twenty one (21) days written notice for "CHP" / "W" points of any material being ready for testing by owner' engineer / Authorized inspector. Such tests shall be to the Contractor's account except for the expenses of the Inspector. The Engineer/ Inspector, unless the witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date on which the equipment is notified as being ready for test/inspection. If owner's Engineer / Authorised Inspector fail to attend the inspection, next mutually convenient date for test shall be agreed with Contractor. Contractor shall, in

no case proceed with the test without owner or his authorized inspectors, unless the witnessing is officially waived and advised Contractor to proceed with the test. Contractor shall forthwith forward duly certified completed test report and a product quality certificate in six (6) copies to owner upon completion of such test.

- 4.03.00 The Engineer or Inspector shall within fifteen (15) days from the date of Inspection as defined herein give notice in writing to the Contractor, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract / QAP or other approved quality documents. The Contractor shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall confirm in writing to the Engineer/Inspector giving reasons therein, that no modifications are necessary to comply with the contract / QAP or other approved quality documents.
- 4.04.00 When the factory tests have been completed at the Contractor's or sub-contractor's works, the Engineer/Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests excluding the test completion date subject to submission of all certified documents related to the test, If the tests are not witnessed by the Engineer/Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Contractor's test certificate by the Engineer/Inspector. Failure of the owner's Engineer/Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests, or the issue of the certificates shall not bind the Owner to accept the equipment should it, on further tests after erection be found not to comply with the contract / QAP or other approved quality documents.
- 4.05.00 In all cases where the contract provides for tests whether at the premises or works of the Contractor or any sub-contractor, the Contractor, except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the owner's Engineer/Inspector or his authorised representatives to carry out effectively such tests on the equipment in accordance with the Contract / QAP or other approved quality documents. Contractor and shall give facilities to the owner's Engineer/ Inspector or to his authorised representative to accomplish testing.
- 4.06.00 To facilitate advance planning of inspection in addition to giving inspection notice as per Clause 4.02.00, the Contractor shall furnish quarterly inspection programme indicating proposed schedule dates of inspection at customer hold point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.

LIST OF STANDARDS FOR REFERENCE

- a) International Standards Organisation (ISO).
- b) International Electro-technical Commission (IEC).
- c) American Society of Mechanical Engineers(ASME)
- d) American National Standards Institute (ANSI).
- e) American Society for Testing and Materials (ASTM).
- f) American Institute of Steel Construction (AISC).
- g) American Welding Society (AWS).
- h) Architecture Institute of Japan (AIJ).
- i) National Fire Protection Association (NFPA).
- j) National Electrical Manufacturer's Association (NEMA).
- k) Japanese Electro-technical Committee (JEC).
- l) Institute of Electrical and Electronics Engineers (IEEE).
- m) Federal Occupational Safety and Health Regulations (OSHA).
- n) Instrument Society of America (ISA).
- o) National Electric Code (NEC).
- p) Heat Exchanger Institute (HEI).
- q) Tubular Exchanger Manufacturer's Association (TEMA).
- r) Hydraulic Institute (HIS).
- s) International Electro-Technical Commission Publications.
- t) Power Test Code for Steam Turbines (PTC).
- u) Applicable German Standards (DIN).
- v) Applicable British Standards (BS).
- w) Applicable Japanese Standards (JIS).
- x) Electric Power Research Institute (EPRI).
- y) Standards of Manufacturer's Standardization Society (MSS)

- z) Bureau of Indian Standards Institution (BIS).
- aa) Indian Electricity Rules.
- bb) Indian Boiler Regulations (IBR).
- cc) Indian Explosives Act.
- dd) Indian Factories Act.
- ee) Tariff Advisory Committee (TAC) rules.
- ff) Emission regulation of Central Pollution Control Board (CPCB).
- gg) Pollution Control regulations of Dept. of Environment, Govt. of India
- hh) Central Board of Irrigation and Power (CBIP) Publications

ANNEXURE-I
FORMAT OF QUALITY ASSURANCE PROGRAMME

VENDOR'S LOGO , NAME & ADDRESS		MANUFACTURING QUALITY ASSURANCE PLAN				DOC NO:		XXXXX-CAL-QAP-M-0001					
		ITEM : -				REV NO :		0	1	2	3	4	
						DATE :							
CLIENT :						LOCATION :							
PROJECT :						REFERENCE PURCHASE ORDER NO. & DT :							
VENDOR :						REFERENCE APPROVED DATA SHEET :							
SUB VENDOR :						REFERENCE APPROVED DRAWING. NO. :							
ABBREVIATIONS : QAP - QUALITY ASSURANCE PLAN, CR - CRITICAL, MA - MAJOR, MI - MINOR SPEC - SPECIFICATION, TC - TEST CERTIFICATES P - PERFORM w - WITNESS V - VERIFY CHP - CUSTOMER HOLD POINT						AGENCY : 1 - DCPL/PROJECT AUTHORITY 2 - SUPPLIER 3 - SUB-SUPPLIER 4 - MANUFACTURER 5 - THIRD PARTY INSPECTION AGENCY						GENERAL REMARKS 1 THE ITEMS WHICH ARE FALLING UNDER ANY STATUTORY AUTHORITY'S (LIKE I.B.R. ETC.) SCOPE SHALL BE SUBJECTED TO THAT STATUTORY AUTHORITY'S INSPECTION CLEARANCE.	
NOTES: 1. EXACT MATERIAL / PROCESS / INSPECTION / TESTS FOLLOWED BY THE MANUFACTURER SHALL BE SPECIFIED 2. EXACT REFERENCE DOCUMENT/ACCEPTANCE STANDARD SHALL BE SPECIFIED 3. IN CASE SPECIFIED ACCEPTANCE STANDARD / NORMS IS OTHER THAN NATIONAL / INTERNATIONAL STANDARDS . STANDARD / COPY OF THE ACCEPTANCE NORMS FOLLOWED BY THE MANUFACTURER SHALL BE SUBMITTED FOR REVIEW RECORD 4 FINAL INSPECTION DOSSIER SHALL BE PREPARED BY MANUFACTURER & SHALL BE ENDORSED BY INSPECTIONION AGENCY													
Prepared by				Checked by				Approved By					
Revision	R0	R1	R2	R0	R1	R2	R0	R1	R2				
DATE													

DEVELOPMENT CONSULTANTS
(e-PCT-TS-K-02-2014-15-Vol. IIA-6&7.doc)

ANNEXURE-II

FIELD WELDING SCHEDULE

PROJECT : FWS NO :
 CONTRACTOR : REV NO. :
 PACKAGE : FIELD WELDING CODE :
 SYSTEM : PAGE NO. :

Sl No.	Drawing No. for Weld Locations & Identification mark	Description of parts to be welded	Material specification	Dimensions	Process of Welding	Type of Weld	Electrode Filler Specification	WPS No.	Minimum Pre-heat Temperature	Heat Treatment Temperature [Holding Time in secs]	NDT Method Quantum	NDT Specification Number	Acceptance Norm Ref.	Remarks
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The Field Welding Schedule should be submitted for :

- o Pressure Parts
- o Tanks/Vessels
- o Piping
- o Heavy/Important Structural Steel
- o Heat Exchangers
- o Bus Ducts

VOLUME : X

SECTION - I

PERFORMANCE GUARANTEES

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	PERFORMANCE GUARANTEES, PERFORMANCE/ ACCEPTANCE TESTS & LIQUIDATED DAMAGES FOR SHORTFALL IN PERFORMANCE
2.00.00	START-UP, INITIAL OPERATION, RELIABILITY RUN AND PERFORMANCE TESTS
3.00.00	SCHEDULE OF GUARANTEES WHICH ATTRACT LIQUIDATED DAMAGES [CATEGORY-A]
4.00.00	SCHEDULE OF GUARANTEES WHICH DO NOT ATTRACT LIQUIDATED DAMAGES [CATEGORY-B]

VOLUME : X**SECTION-I****PERFORMANCE GUARANTEES****1.00.00 PERFORMANCE GUARANTEES, PERFORMANCE/ACCEPTANCE TESTS & LIQUIDATED DAMAGES FOR SHORTFALL IN PERFORMANCE**

1.01.00 The Bidder shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in this specification. The guarantees are categorised as:

- a) Those which attract liquidated damages, as listed below (Category-"A"). The Bidder shall furnish signed declarations in the manner prescribed in the bid proposal schedules for these guarantees.
- b) Those which do not attract liquidated damages, as listed below (Category-"B"). This guarantee list indicated in this section is not exhaustive and the Owner reserves the right to call upon the Bidder to demonstrate any parameter, operation, etc. of any equipment as specified and as required to meet the duty conditions.

1.02.00 The guaranteed parameters shall be without any tolerance values. The Bidder shall demonstrate all the guarantees covered in various volumes and sections of this specification during Performance/Acceptance test. In case during tests it is found that the equipment/system has failed to meet the guarantees, the Contractor shall carry out all necessary modification to make the equipment/system comply with guaranteed requirements. However, if the Contractor is not able to demonstrate the guarantees, even after the modifications within ninety (90) days of notification by the Owner, the Owner will at his discretion :

- i. reject the equipment and recover the payment already made or accept the equipment only after levying liquidated damages as identified in this section for those guarantees which are covered under category "A".

OR

- ii. reject the equipment and recover the payment already made or accept the equipment only after assessing and deducting from the contract price an amount equivalent to the deficiency of the equipment/system as assessed by the Owner, for those guarantees which are covered under Category-B.

1.03.00 All guaranteed parameters shall necessarily be quoted by the Bidder based on the established proven results obtained from similar units in successful operation. Evidence for this shall necessarily include the test codes used, acceptance test results, accuracies of various instruments used for the performance test, details of tolerances, if allowed, etc. While quoting the guaranteed parameters, the Bidder shall keep in view the requirements

specified in the specification especially regarding the reliability, operability and maintainability of the equipment proposed. The Owner reserves the right to evaluate the parameters quoted by the Bidder based on his experience and published material available.

1.04.00 The liquidated damages shall be calculated prorata for the fractional parts of the unit unless stated otherwise.

1.05.00 The turbine generator, boiler, auxiliaries, and all other plant equipment and system shall perform continuously without the noise level (individual or collectively) exceeding the values specified in respective equipment specification over the entire range of output and operating frequencies.

1.06.00 **Performance/Acceptance Tests**

1.06.01 The performance/acceptance tests for various equipment and systems shall be carried out as specified under the respective equipment specifications and those specified below shall be specifically applicable. All the guarantees shall be tested together as far as practicable.

1.06.02 In case of systems with stand-by equipment the liquidated damages for non-performance will be levied for normal operating number of equipment only. However, for this purpose all the equipment including standby equipment shall be tested and average values arrived at.

1.06.03 For instrument inaccuracies during PG Test, refer subsequent clauses of this section.

1.06.04 For Total Auxiliary Power Consumption, the transformers listed under the respective clauses, shall be taken together for purposes of guarantee and not individually.

2.00.00 **START-UP, INITIAL OPERATION, RELIABILITY RUN AND PERFORMANCE TESTS**

For the purpose of Taking over of the Plant, the following activities shall have to be completed successfully.

- i) Mechanical Completion
- ii) Preliminary Operation
- iii) Initial Operation
- iv) Reliability Operation
- v) Trial Operation
- vi) Performance Guarantee Tests

2.01.00 **Mechanical Completion**

- (a) Mechanical completion is defined as the state of readiness of works and completeness of Field Quality checks under the scope of contract to undergo the pre-commissioning checks, followed immediately thereafter by commissioning including preliminary operation, initial operation, reliability operation, performance tests including unit characteristics tests for functional or operational occupation of the

works.

- (b) Mechanical completion shall be deemed to occur when the contract erection/installation/construction and Field Quality check works are completed as per specifications for all equipment / systems including standby. It also include but not limited to the following:
 - (i) all installation/erection and Field Quality checks duly carried out and individual protocol viz. erection, FQA (Field Quality Assurance) and commissioning protocol to be signed.
 - (ii) all defects/deficiencies notified by the Purchaser during installation/erection rectified to the satisfaction of Purchaser which, in the opinion of the Purchaser, will not affect the safe operability and maintainability of the works, and
 - (iii) the contract works, in the opinion of Purchaser, subject to sub-clause (ii) above, being fit, sound, safe and operable for undertaking the pre-commissioning checks, preliminary operation, initial operation, reliability operation and performance tests including unit characteristics tests followed by subsequent commercial operation without interruption for reason of defect/deficiency or unfulfilled obligations of the Contractor in the erection/installation work.

2.02.00

Specific Requirements of Mechanical Completion

- (a) Mechanical completion in different disciplines shall be determined based on the following characteristics, signifying the readiness of the works/plants and systems for undertaking the pre-commissioning checks and subsequent preliminary operation, initial operation, reliability operation and performance tests including unit characteristics tests as applicable to the contract works:
 - (i) All plant construction/installation in various disciplines, as detailed under (b) below and as applicable to the contract are completed including aesthetic and workmanship and safety aspects, with all installation/construction checks as per specification, relevant codes, standards and practices ensuring conformity to contract and meeting any applicable statutory requirements.
 - (ii) All contractual obligations up to the stage of completion of construction / installation are fulfilled to the satisfaction of the Purchaser.
- (b) All contract works or otherwise ready to be taken into service, or for functional or operational occupation save pre-commissioning/ commissioning checks, preliminary operation, initial operation, reliability operation, performance tests, unit characteristics tests are to be carried out as per approved commissioning procedure submitted by the contractor including but not limited to the following:

- (i) Areas inclusive of all roads, accesses, structures, housings, platforms, walkways, stairs, ladders, safe approach to equipments, safety/ protective guards, covers, hand rails and such items of work are constructed as per specification and approved for use.
- (ii) Drains, sewers, waste disposal channels, vents, chutes, ducts and such works are constructed and connected to treatment and other disposal systems.
- (iii) Equipment and piping in different systems/disciplines with all appurtenances, auxiliaries and accessories along with supporting structures, hangers, mounts, etc., are erected/ installed, supported, anchored, aligned, grouted and adjusted for operating conditions.
- (iv) Electrical power supply, control, communication and lighting equipment along with control panels, control desks, switchgear, local starters and such accessories along with protective systems, interlocks and integral and auxiliary systems are permanently installed, aligned and adjusted, with megger, continuity and specified installation checks duly carried out.
- (v) Cables are laid, routed, supported, dressed, clamped, tagged, ferruled and terminated with clamp terminals designated and all continuity and megger checks duly carried out.
- (vi) Safety/relief valves are calibrated and set to operating conditions and tried out. All safety systems are installed, calibrated, checked and accepted.
- (vii) Plant identification numbers, colour codes, tags, nameplates are duly mounted / painted/affixed.
- (viii) All painting, lining and insulation works are completed with specified checks to the satisfaction of the Purchaser.

2.03.00 Other Prerequisites for Mechanical Completion

The Contractor shall also meet the following prerequisites for mechanical completion:

- (a) Submit a compilation of all reports of shop tests, material tests and various stage inspection establishing total compliance to contract specification in manufacturing items of supply of contract.
- (b) Submission of a certificate by the Contractor in a format agreed by the Purchaser that the contract works have been designed, selected, manufactured, furnished and installed under the full responsibility of the Contractor.
- (c) All erected plants, structures, equipment and systems are maintained and preserved in sound condition and are fit and sound to undertake

pre-commissioning checks and 'tests before commercial operation' for operational and functional occupation immediately thereafter.

- (d) All areas and constructed works are cleared daily upto the satisfaction of the Owner of all construction materials, temporary works, debris, rubbish water and all such impediments to render the contract works safe, sound and operable.
- (e) All safety features and safety equipment are functional.
- (f) Fire prevention and fire extinguishing system in all fire prone areas are to be made functional.
- (g) Any specific statutory approvals pre-requisite to commissioning of the plant are duly obtained.

2.04.00 Preliminary Operation

Preliminary operation shall mean all activities undertaken as part of commissioning after mechanical completion upto commencement of initial operation and shall include mechanical and electrical checkouts, calibration of instruments and protection devices, commissioning of sub/supporting systems covered under the contract.

2.05.00 Initial Operation

Initial operation shall include all operations undertaken as part of commissioning after completion of preliminary operation upto commencement of reliability operation. It shall be the first integral operation of the complete BOP integrated with Boiler, Turbine Generator package covered under the contract and shall include first light up / initial equipment rolling, equipment stretch-out, dry-out no-load / partial load /full loads runs for mechanical / electrical tryout and gathering of operational data, calibration, setting and commissioning of controls systems; and shutdown inspection and adjustment after running trails of the plant under the contract.

During initial operation each and every activity wise commissioning protocols are to be jointly signed by the Purchaser and Contractor commissioning team.

The auto loop control tuning shall continue upto the commencement of 72 hour full load operation of trial run.

The initial operations shall include operation of unit as a whole under normal operating conditions for twenty four (24) consecutive hours at the 100% TGMCR load or twelve (12) consecutive hours for two (2) consecutive days at the 100% TGMCR load unless otherwise agreed to by the Purchaser or restricted by system load conditions. The completion of initial operation will be certified in writing by the Purchaser.

2.06.00 Reliability Operation

- (a) After the initial operations, the plant shall be on reliability operation. During the reliability operation, the Contractor will be allowed to make

minor adjustments as may be necessary, provided that such adjustments do not interfere with or prevent the commercial use of the plant or result in significant reduction of output. The duration of the reliability operation of plant shall be spread over a period of thirty (30) days. The maximum number of interruption attributable to Contractor shall be of four (4) numbers each not exceeding four (4) hours duration. In case either the number of interruptions, attributable to the Contractor, exceeds four (4) or the duration of any of the four (4) interruptions exceeds four (4) hours the reliability test shall be repeated.

- (b) For the period of reliability operation, the time of actual operation shall be counted. In case the duration of actual continuous operation of any of the above modes is discontinued for reasons, which are not due to Contractor's fault or negligence, that particular test would be deemed to have satisfied the reliability operation test. However, should the test be discontinued due to Contractor fault, the test shall be restarted for that particular case.
- (c) Should any failure (other than of an entirely minor nature) due to or arising out of faulty design, materials, or workmanship (but not otherwise) occur in any item of the plant, sufficient to prevent commercial use of the plant, the reliability test period of thirty (30) days shall recommence for that item after the defect has been remedied by the manufacturer/Contractor. The onus of proving that any failure is not due to faulty design, materials and workmanship will lie with the Contractor.
- (d) A 'reliability operation' report comprising observations and recordings of various parameters measured in respect of the 'reliability operation' shall be prepared and submitted to the Purchaser. This report, besides recording the details of various observations during 'reliability operation' shall also include the dates of start and finish of the reliability operation and shall be signed by the representatives of both the parties. The report shall have recordings of all details of interruptions that occurred, adjustments made and any repairs carried out during the 'reliability operation'.

Also a punch list is to be prepared during the reliability test and the defects are to be rectified by the contractor before commencement of 72 hour operation at full load during trial operation.

- (e) Should any failure or interruption occur in any portion of the tests due to or arising from faulty design, materials, workmanship, omissions, incorrect erection, or inadequate instructions by the Contractor's supervisors, sufficient to prevent safe commercial use of the plant, the reliability operation test at the particular load shall be considered void and the reliability test shall recommence after the Contractor has remedied the cause of the defect.
- (f) During the reliability operation all the equipments, Raw/ DM water system and sub-systems, control loops, interlocks and protection including switchyard installations will be in service and change over to standby equipments are to be done on running condition of the unit.

- (g) The 'reliability operations' shall be considered successful, provided that each item of plant can meet the above requirements.
- (h) Upon the completion of 'reliability operations', as soon as practicable, or at such time as may be otherwise agreed to by the parties concerned, the Contractor shall notify in writing to the Purchaser that the Plant is ready for performance tests.

2.07.00

TRIAL OPERATION:

1. On completion of erection of any major items along with its auxiliaries, the same shall be thoroughly inspected by the Contractor together with the TSGENCO's Engineers for correctness and completeness and acceptability for pre-commissioning tests. Though the TSGENCO's Engineers associate themselves with such inspection, the responsibility for declaration for correctness, completeness and acceptability shall rest with the Contractor and the pre-commissioning tests and inspections shall be carried out after such declaration. The pre-commissioning tests to be performed at site as well as necessary documentation and formats for the protocols to be signed during and after the tests shall be prepared by the Contractor taking into account relevant Indian/International/ Manufacturers standard as applicable and finalized by the TSGENCO sufficiently in advance through mutual discussions. On conclusion of satisfactory pre-commissioning tests of each individual equipment, the trial operation of the unit shall start consistent with parameters of the technical specifications.
2. The duration of trial operation shall be for 14 days during which period the unit shall be run from half to full load or any other load cycle mutually agreed to during which period the unit shall run at full load for 72 hours continuously. However, if required, the Purchaser and the Contractor may mutually agree for economical load operation for 48 hours continuously. Any interruption caused by the Contractor up to 24 hours will not effect the period of 14 days indicated above. In case of such interruption occurring for more than 24 hours, the above period shall be extended correspondingly. During the above trial operation the standby auxiliary equipment shall also be run for a minimum period of more than 72 hours during which period the equipment shall run at its rated capacity for a minimum period of 24 hours. Further the above trial operation shall be carried out in full fledged manner with the associated instruments and controls. The unit is deemed to be commissioned on successful completion of the above trial operation.
3. A document shall be prepared on the results of trial operation. This document besides recording of the details of the various observations during the trial run will also include the date of start and finish of the trial operation and will be signed by the representative of both the parties. The document of the trial operation shall have log sheets and all adjustments, repairs, interruptions etc., shall be recorded therein. If any major adjustment is carried out which has been changed from the initial operation value, then the reason for it is to be furnished in the

report in detail.

The Purchaser and the Contractor will observe the plant overall reliability and shall test the equipment runback, rundown, auto start of equipments, CMC function and its reliability, complete automation of the plant system etc.

4. The readiness of the unit for the trial operation shall be intimated by written notice to the TSGENCO after mutual discussions. After receipt of such notice if the trial operation could not be performed or could not be completed due to any reasons not attributable to the Contractor and if the situation continues, the Contractor shall be absolved of the responsibility for the delay and the plant shall be deemed to have been taken over by the TSGENCO at the end of 60 days after the Contractor's notifications of readiness of the same.
5. The trial operation shall be carried out in compliance with relevant manufacturer's standards and/or relevant Indian/International standards and manufacturer's operation directions before starting them.
6. Defects which are minor in nature and do not endanger the safe operation of the plant, shall not be considered as reasons for not taking over the plant by the TSGENCO. These defects shall be listed in the above mentioned documents and shall be rectified by the Contractor in accordance with the agreement made in this respect.

2.08.00

Performance Tests

- (a) PG test notification to be given by the contractor to the purchaser after COD. The performance tests shall be conducted at site on all major systems by the Contractor. The Contractor's commissioning Engineers shall make the entire plant ready for such tests and assist the Purchaser in operation during the tests. The test shall be commenced after the 'Plant/Equipment' has attained stable operation at the end of 'reliability operation'. The date of commencement of the performance tests shall be as soon as practicable on completion of the 'reliability operation' or as may be mutually agreed upon between the Contractor and Purchaser.

Final trial operation shall be carried out for a period of seventy two (72) hours at 100% TGMCR before 'taking over'.

- (b) **Independent Inspector**

The Purchaser reserves his right to appoint an independent inspector at his own cost as his representative to discuss the test programme, to approve the instrumentation, to witness the tests and to analyze the test results.

- (c) The tests shall be binding on both the parties of the contract to determine compliance of the 'plant'/equipment' with the performance

guarantees.

- (d) The performance tests shall be carried out to prove the guarantees. The purpose of the performance tests is to check whether the plant meets the guaranteed performances.
- (e) The performance test procedure, the instrumentation to be installed, the instrument accuracy classes, including the definition of the calculation method to be used, the areas of responsibility and the items which specifically require preparation and agreement shall be submitted by the Contractor for review and approval during detail engineering phase. The schematics identifying the guarantee test instrumentation shall be submitted along with procedure. It shall be ensured that necessary test points and spool pieces are installed during the detail-engineering phase and also identified in process and instrumentation drawings. Code of the PG test is to be fixed up during detail engineering stage. The Contractor shall furnish detail test programme during detail engineering stage.
- (f) The performance test instruments shall be of precision type with instrument accuracy limits as required and defined in the applicable performance test codes such that measurement uncertainty does not exceed the values agreed to by the Contractor in the Schedule of Performance Guarantees.
- (g) All test instrumentation for the performance tests as required shall be supplied by the Contractor on loan basis. All costs associated with the supply, calibration, installation and return of the test instrumentation are deemed to have been included in the contract price. The test shall be in accordance with those specified or as per agreed performance test codes. Batch calibration shall not be accepted.
- (h) Any special equipment, tools and tackle required for successful completion of the performance tests shall be provided by the Contractor.
- (i) It is Contractor's responsibility to co-ordinate for carrying out the performance tests. The duration of the test shall be in accordance with the agreed test codes. All other tests to prove the guarantees as indicated in the Contractor's offer shall also be conducted.
- (j) The plant parameters during the performance test shall be adjusted as far as practicable to the guaranteed performance test conditions. The tests shall be conducted to provide guaranteed parameters as defined in the contract.
- (k) Category-B tests are to be completed before Category-A PG test. Protocols are to be signed jointly by the Purchaser and Contractor for each Category-B test.
- (l) **Reporting of Test Results**

- (a) Within two weeks after the conclusion of the performance test,

the Contractor shall submit ten (10) copies of test reports to the Purchaser stating whether the plant passed or failed such test(s), accompanied by sufficient test data and calculations to demonstrate the level of performance attained with respect to each of the tested parameters.

(b) The report(s) shall include as a minimum, the following:-

- (i) Scope
- (ii) Various guaranteed parameters & tests as per the contract.
- (iii) Codes/standards used
- (iv) . Description of the test procedures
- (v) Full schematic diagrams with indication of test instruments locations and identification tags of same.
- (vi) Instrumentation details and calibration.
- (vii) Duration of test, frequency of readings and number of test runs
- (viii) Test logs and summary of test readings used for performance calculations.
- (ix) Full set of correction curves.
- (x) Computation of test results.
- (xi) Sample calculation
- (xii) Performance calculation
- (xiii) Computations to prove measurement uncertainty is within acceptable limits.
- (xiv) Acceptance criteria
- (xv) Any other information required for conducting the test
- (xvi) Conclusions of performance tests.

(m) Within fifteen (15) days of receipt of such test report(s), the Purchaser shall submit a notice to the Contractor stating either:-

- (i) That Purchaser concurs with the information provided in the test report(s), or
- (ii) That Purchaser disputes some or all of the information provided

in the Contractor's test report(s), the areas being disputed, and the levels of performance being disputed.

- (n) If Purchaser concurs with the information in the Contractor's test report(s), the Purchaser shall, within fifteen (15) days of receipt of the test report, provide a written notice to the Contractor accepting the results of the tests.
- (o) If Purchaser disputes any or all of the results contained in the Contractor's test report(s), the Contractor and Purchaser shall meet within fifteen (15) days of the receipt of the Purchaser notice at a mutually acceptable location to review and discuss the dispute.

All the category-B test results are to be computed and to be submitted along with the PG test report for detail study by the Purchaser.

2.08.00 **Notice of Tests**

The Contractor shall issue 21 days notice to the Purchaser of the date after which he will be ready to commence the tests and the Contractor shall commence the tests promptly thereafter.

2.09.00 **Delayed Tests**

- (a) If the tests could be carried out but are being unduly delayed by the Contractor, the Purchaser may by notice inform the Contractor to conduct the tests within 14 days after the receipt of such notice. The Contractor shall conduct the tests on such days within that period as the Contractor may fix and of which he shall issue notice to the Purchaser.
- (b) If the Contractor fails to conduct the tests within such notice period, the Purchaser may himself proceed with the tests. All tests so conducted by the Purchaser shall be at the risk and cost of the Contractor and the cost thereof shall be deducted from the contract price or charged to the Contractor. The tests shall then be deemed to have been conducted by the Contractor and the test results shall be binding on the Contractor.

(c) **Facilities for Tests on Completion**

Except where otherwise specified, the Contractor shall provide and bear costs for these items, as may be required to carry out the tests on completion.

(d) **Retesting**

If the plant fails to pass the test (which in the case of performance tests means not achieving the acceptable limits), the Purchaser may require such tests to be repeated on the same terms and conditions save that only reasonable notice of the date and time of such tests shall be required to be given by the Contractor to the Purchaser.

(e) **Disagreement as a Result of Tests**

If the Purchaser and the Contractor disagree on the interpretation of the test results, each shall give a statement of his views to other within 14 days after such disagreement arises. The statement shall be accompanied by all relevant evidence.

3.00.00

**SCHEDULE OF GUARANTEES WHICH ATTRACT LIQUIDATED DAMAGES
[CATEGORY-A]**

Sl. No.	Plant/ System	Parameter for Performance Guarantee	Liquidated Damages
3.01.00	Plant		
3.01.01	Efficiency of steam generator	Efficiency of the steam generator at 100% & 80% TMCR while firing the Design coal at rated steam parameters, rated coal fineness and rated excess air. (Refer Note-1 for estimation of weightage factor.) Design coal shall be blended coal (50% imported coal + 50% indigenous coal).	As per Volume-I.
3.01.02	Steam generating capacity	Steam generating capacity in T/hr of steam at rated steam parameters at superheater outlet (with any combination of mills working) with the coal being fired from within the range specified.	As per Volume-I.
3.01.03	Turbine Cycle Heat rate	Turbine Cycle Heat rate in kcal/kWh under rated steam conditions, design condenser pressure with zero make up at 100% & 80% of rated load (Refer Note-1 for estimation of weightage factor.)	As per Volume-I.
3.01.04	Output	Continuous output (MW) of 100% TMCR at Generator terminals under rated steam conditions at Turbine Inlet (247 kg/cm ² (a), 565°C, 593°C) and CW temperature of 33°C with 0% make-up with excitation power deducted	As per Volume-I.
3.01.05	Condenser Pressure	Condenser pressure in mm Hg (abs) under VVO conditions, 3% make up, design CW temperature and CW flow.	As per Volume-I.

Sl. No.	Plant/ System	Parameter for Performance Guarantee	Liquidated Damages
3.01.06	Total Auxiliary Power Consumption	The total auxiliary power consumption for all the auxiliaries of boiler, turbine Generator and turbine cycle equipments required for continuous unit operation at 100% and 80% of rated load under rated steam conditions and at design condenser pressure with 0% make-up. (Refer Note 1, 2, 3 & 4 for the basis of computation of Auxiliary power)	As per Volume-I.
3.01.07	Cooling Tower Cold Water Temperature	Cooling tower cold water at 100% TMCR under rated steam conditions and at design condenser pressure.	As per Volume-I.

Note :

1. The weightage factor shall be estimated considering the following:
 - a) 80% rating for 2000 hrs in a year,
 - b) 100% rating for 6300 hrs in a year.
2. For computation of Auxiliary Power, output measured at Generator terminals minus sent out power measured downstream of Generator Transformer, applicable Losses (No load loss + Load loss+ auxiliary loss for coolers) for Standby Transformers, Unit Transformers and Bus duct losses shall be considered.
3. The equipment for auxiliary power consumption to be considered by the bidder shall include the equipment as per Annexure-C of Volume-I as minimum.
4. Power consumption for Fire Pumps, Sump Pumps, Elevators, EOT Cranes shall not be considered in the Auxiliary Power consumption estimate.
5. Heat Rate of TG Cycle : Maximum 1850 Kcal/kwh with Steam Turbine driven BFP.
6. Steam Generator Efficiency : Not less than 85%
7. Auxiliary Power Consumption shall be limited to 6% with Steam Turbine driven BFP and NDCT.
8. Normal Availability of the Plant : 98% (2% forced outage)
9. Plant Reliability : Minimum 95%
10. The condenser pressure measurement while conducting the guarantee tests for CI Nos 3.01.03, 3.01.04 and 3.01.05 above shall be measured at 300 mm above the top row of condenser tubes.

4.00.00 SCHEDULE OF GUARANTEES WHICH DO NOT ATTRACT LIQUIDATED DAMAGES FOR VARIOUS EQUIPMENT WHICH INCLUDE BUT ARE NOT LIMITED TO THE FOLLOWING [CATEGORY-B]:**4.01.00 Steam Generator**

4.01.01 Capacity in T/hr of steam at rated steam parameters at superheater outlet (with any combination of mills working as per Owner's discretion) and the coal being fired within range specified, corresponding to 100% BMCR at 33°C CW temperature.

4.01.02 Efficiency in percentage at 100% & 80% TMCR and 27°C ambient air temperature and 60% RH with zero make-up, condenser vacuum of 77 mm Hg(a) or better while firing the Design coal at rated steam parameters at Superheater and Reheater outlet and rated excess air and with any combination of mills working as per Owner's discretion. Design coal shall be blended coal (50% imported coal + 50% indigenous coal).

4.01.03 Air heater air-in-leakage after 3000 hrs. of operation from taking over date. To be demonstrated.

4.01.04 NOx emission

NOx emission from the unit – shall not be more than 365 ppm or 750 mg/Nm³ (equivalent NO₂) at the ESP outlet at 6% excess oxygen.

4.01.05 Mill capacity at rated fineness.

4.01.06 Gas tightness efficiency of Guillotine dampers.

4.01.07 No fuel oil support shall be required above 30% of BMCR.

4.01.08 Performance characteristics of pumps, fans, etc. viz; capacity, head developed etc.

4.01.09 Capabilities of all drives.

4.01.10 Margins on fans. Through operation of single fan at a time.

4.01.11 Equal load sharing of pumps/fans while running in parallel shall be demonstrated.

4.01.12 Run back capabilities.

4.01.13 Ramp/sudden load change withstand capability.

4.01.14 Life of mill wear parts

4.01.15 Furnace Exit Gas Temperature

The Bidder shall demonstrate by direct measurements that the Furnace Exit Gas Temperature (FEGT) at the specified location does not exceed the

specified maximum temperature of BMCR. The test equipment to be used for this demonstration shall be latest, state of the art, to the approval of Owner.

4.01.16 Flue Gas Temperature

The Bidder shall also demonstrate that the flue gas temperature at the entry and exit of various boiler heating surfaces and also the variation across the cross section perpendicular to gas flow do not exceed the values considered for the pressure parts design.

4.01.17 Steam Temperature Imbalance

The Bidder shall guarantee and demonstrate that at SH and RH outlets (in case of more than one outlet) the temperature imbalance between the outlets does not exceed 10°C.

4.01.18 SH/RH Attenuation System

The Bidder shall guarantee and demonstrate that the spray water flow to SH attenuation system does not exceed the value considered for design (to be indicated in the bid) while maintaining the rated SH outlet steam temperature at BMCR. The Bidder shall also guarantee and demonstrate that the RH temperature is maintained at the rated value without any spray water requirement, for the secondary attenuation system, at all loads for which the specified RH steam temperature is required to be maintained at the rated value.

4.02.00 **Electrostatic Precipitator**

4.02.01 Pressure drop across the electrostatic precipitator.

4.02.02 Collection efficiency and outlet dust concentration shall be as per cl. no. 3.01.00 of Section-II in Volume-II-B.

4.03.00 **Turbine Generator**

4.03.01 Turbine Generator-Set Capability

The steam turbine generator unit shall be capable of delivering continuously at generator terminals the output as indicated by the Bidder in the following heat balances detailed out elsewhere with equipment specification submitted along with the bid.

- a) Output corresponding to top HP heaters out of operation.
- b) Output corresponding to all HP heaters out of operation.
- c) Output corresponding to VWO flow, at rated steam conditions with condenser CW temperature 33°C & condenser of vacuum 77 mm HgA or better with 0% make-up.
- d) Output corresponding to overpressure operation of the boiler-turbine-generator set, at rated main steam and hot reheat steam

temperature with condenser CW temperature corresponding to
Condenser vacuum of 77 mm HgA or better with zero percent make-up.

4.03.02 Operating Frequency Range

As per the stipulations of Cl. No. 7.06.00 Vol. II-C, Section-I.

4.03.03 Constant Pressure and Sliding Pressure Operation

The constant pressure operation and sliding pressure operation from 30% turbine MCR to VWO condition of the unit in conjunction with the steam generator, HP-LP bypass system and instrumentation & control system shall be demonstrated.

In sliding pressure mode of operation, during quick load increase the idle control valve (s) must respond rapidly to pick up 20% of operating load, so that immediate increase of boiler pressure is not required. The load response capability shall be demonstrated in steps of 5 %.

Change-over from constant pressure mode to sliding pressure mode and vice-versa shall also be demonstrated.

4.03.04 Start-up, Loading, Unloading and Shutdown Capabilities

Start-up, loading, unloading and shutdown characteristics and startup time and loading capabilities for the steam turbine generator and steam generator both operating as a unit for cold start conditions (greater than 36 hours shutdown), warm start conditions (between 8 and 36 hours shutdown) and hot start conditions (less than 8 hours shutdown) under constant pressure and variable pressure mode and suitability for cyclic operation as indicated by the Bidder in the offer and accepted by the Owner shall be demonstrated ensuring the parameters of vibration, differential expansion, etc.

4.03.05 Vacuum Pulling time

Vacuum pulling time from condenser at atmospheric pressure to rated vacuum compatible to start Steam Turbine

4.03.06 Sudden Total Loss of External Load

On occasions, the steam turbine generator system may experience sudden total loss of all external load. Under these conditions, the steam turbine generator unit shall not trip on overspeed but shall continue in operation under the control of its speed governor to supply power for the plant auxiliary load station transformers, while staying within the prescribed permissible limits of steam metal temperature mismatch, exhaust hood temperature, absolute and differential expansion, vibration and eccentricity acceptable to the Owner.

4.03.07 Capacity with Reduced Hydrogen Pressure

Generator shall be capable of operating at reduced capacity at reduced generator hydrogen pressure in accordance with values furnished by the Bidder in his proposal and accepted by the Owner.

4.03.08 HP/LP Bypass Capabilities

- i. HP/LP bypass capacity and capabilities under various modes of operation shall be demonstrated.
- ii. Condenser performance with HP-LP Bypass operating at rated conditions.

4.03.09 Lube Oil Purification System - Capacity and Purity

Lube oil purification system capacity and the purity of purified oil at the outlet of the centrifuge and the outlet of the polishing filter, shall be demonstrated. If purity check is not possible at site, this shall be carried out at Vendor's works.

4.03.10 Extraction and CRH NRVs

Operation of the valves under turbine trip and high water level in the heaters, shall be demonstrated.

4.03.11 The performance of the condenser, i.e., the back pressure achieved at design CW flow and inlet temp. and cleanliness factors, VWO heat load shall be demonstrated.**4.03.12 Temp. of condensate at outlet of condenser shall not be less than saturation temp. corresponding to the condenser pressure at all loads.****4.03.13 Oxygen content in condensate at hot-well outlet shall not exceed the limit prescribed by HEI over the entire load range and shall be determined according to an internationally approved codes/standard.****4.03.14 When one half of the condenser is isolated, condenser capability shall be demonstrated to take at least 60% T.G. load under TMCR conditions.****4.04.00 Deaerator****4.04.01 The dissolved oxygen content in feed-water measured at deaerator outlet shall not exceed 0.005 cc/litre at all loads from no load to VWO condition with 3% cycle make-up with normal pressure and overpressure with incoming condensate presumed to be saturated with oxygen (without any chemical dosing).****4.04.02 Free carbon dioxide in deaerator effluent shall be non-traceable at all loads from zero to VWO with 3% cycle make-up with normal pressure according to ASTM standards.****4.05.00 Power Cycle Pumps**

Performance of each pump (flow, head, vibration, noise, parallel operation) to be demonstrated.

4.06.00 Automatic On Line Turbine Testing (ATT) System

Demonstrated without disturbing normal operation.

4.07.00 **Coal Handling Plant**

Refer Cl. No. 10.00.00 in Volume-IV-A.

4.08.00 **Water Treatment System**

Performance Guarantee of Chemical Feed System shall be in accordance with Cl. No. 8.04.00 in Section-IV, Volume-II-B of the EPC Bid Specification.

Performance Guarantee of Condensate Polishing System shall be in accordance with Cl. No. 8.04.00 in Section-VI, Volume-II-C of the EPC Bid Specification.

Performance Guarantee of River Water Pre-Treatment System shall be in accordance with Cl. No. 8.04.00 in Section-I, Volume-III-C of the EPC Bid Specification.

Performance Guarantee of Demineralisation System shall be in accordance with Cl. No. 8.04.00 in Section-II, Volume-III-C of the EPC Bid Specification.

Performance Guarantee of Circulating Water Treatment System shall be in accordance with Cl. No. 8.04.00 in Section-III, Volume-III-C of the EPC Bid Specification.

Performance Guarantee of Waste Water Treatment System shall be in accordance with Cl. No. 8.04.00 in Section-IV, Volume-III-C of the EPC Bid Specification.

4.09.00 **Instrumentation and Control**

The Bidder shall demonstrate that the Instrumentation and Control system meets all the functional/performance requirements, specified in technical specifications.

4.10.00 **Noise Level**

The Bidder shall demonstrate Noise Level of various plants/equipments/systems as per Clause no. 17.02.00 in Section-IV of Volume-II-A.

4.11.00 **Air Conditioning & Ventilation system**

The rating and performance figures of the AC & Ventilation system & equipment as indicated in the respective technical specification shall be guaranteed by the Bidder. In the event of any deficiencies in meeting the guarantees as indicated in the technical specification after conducting the performance test, the bidder shall put all his efforts to rectify the deficiencies or will replace the equipment / accessories to achieve the specified performance parameters within a reasonable time.

5 x 800 MW YADADRI TPS

SECTION IA
(GENERAL TECHNICAL REQUIREMENT)



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA

GENERAL TECHNICAL REQUIREMENTS

CONTENT

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GENERAL TECHNICAL REQUIREMENTS (AS APPLICABLE)

1.00.00 CODES AND STANDARDS

1.01.00 Except where otherwise specified, the Plant shall comply with the appropriate Indian Standard or an agreed internationally accepted Standard Specification as listed in the annexure to this Section and mentioned in detailed specifications, each incorporating the latest revisions at the time of tendering. Where no internationally accepted standard is applicable, the Bidder shall give all particulars and details as necessary; to enable the Owner to identify all of the Plant in the same detail as would be possible had there been a Standard Specification.

1.02.00 Where the Bidder proposes alternative codes or standards he shall include in his tender one copy (in English) of each Standard Specification to which materials offered shall comply. In such case, the adopted alternative standard shall be equivalent or superior to the standards mentioned in the specification.

1.03.00 The plant will be designed in compliance with applicable National and International Codes and Standards such as ASME, ASTM, DIN, BS, IEC, IEEE, IS, etc. Wherever specified or required the Plant shall conform to various statutory regulations such as Indian Boiler Regulations, Indian Explosives Act, Indian Factories Act, Indian Electricity Act, Environmental Regulations, etc. Wherever required, approval for the plant supplied under the specification from statutory authorities shall be the responsibility of the Contractor.

1.04.00 In the event of any conflict between the codes and standards referred above, and the requirements of this specification, the requirements, which are more stringent, shall govern.

1.05.00 In case of any change of code, standards and regulations between the date of purchase order and the date the Contractor proceeds with manufacturing the Owner shall have the option to incorporate the changed requirements. It shall be the responsibility of the Contractor to advise Owner of the resulting effect.

1.06.00 Successful Bidder to furnish two (2) sets of latest of national/inter-national codes and standards to owner.

2.00.00 RESPONSIBILITY FOR DESIGN

2.01.00 The Contractor shall assume full responsibility for the design of the whole and every portion of the Plant, whether or not the design work was undertaken specifically in relation to the Contract and whether or not the Contractor was directly involved in the design work.

- 2.02.00 Notwithstanding the Owner's wish to receive the benefits of new, advanced and improved technologies, a prime requirement is that all the systems and components proposed shall have been already adequately developed and shall have demonstrated good reliability under similar, or more arduous conditions elsewhere, at least for continuous 2 years in two different power station.
- 2.03.00 The successful bidder shall have to carry out surge analysis, BFP transient analysis and other transient condition studies as may be necessary and as required by the Owner as per proven engineering practice.
- 2.04.00 The Bid shall include a detailed discussion on the development status of, and the reasons for any changes made in proposed systems or components for the Plant, as compared with similar items previously supplied in other installations cited by the bidder as reference plants.
- 2.05.00 The Bidder may also make alternate offers, provided such offers are superior in his opinion in which case adequate technical information, operating feed back, etc. are to be enclosed with the offer, to enable the Owner to assess the superiority and reliability of the alternatives offered. In case of each alternative offer, its implications on the performance, guaranteed efficiency, auxiliary power consumptions, etc. shall be clearly brought out to the Owner to make an overall assessment. In any case, the base offer shall necessarily be in line with the specifications i.e. Base offer shall be as per the technical specifications and the same will be considered for techno-commercial evaluation.
- 3.00.00 **NAME PLATES (RATING PLATES)**
- 3.01.00 Instruction plates, name plates or labels shall be permanently attached to each main and auxiliary item of plant in a conspicuous position. These plates shall be engraved with the identifying name, type and manufacturers serial number, together with the loading conditions under which the item of plant has been designed to operate.
- 3.02.00 Items such as valves, etc. which are subject to hand operation, shall be provided with nameplates so constructed as to remain clearly legible throughout the life of the plant giving due consideration to the difficult climatic conditions to be encountered. Nameplates shall be securely mounted where they will not be obscured in service by insulation, cladding, actuators or other equipment. Direction of flow is also to be engraved.
- 3.03.00 All trade nameplates and labels shall be in English language. All measurements shall be in M.K.S. Units.
- 3.04.00 The size and location of nameplates shall be subject to Approval of the Engineer.
- 4.00.00 **SAFETY AND SECURITY**
- 4.01.00 The design shall incorporate every reasonable precaution and provision for the safety of all personnel and for the safety and security of all persons and

property. The design shall comply with all appropriate statutory regulations relating to safety. All structures and equipment shall be designed and constructed to withstand every foreseeable static and dynamic loading condition, including loading under earthquake conditions, with an adequate margin of safety.

4.02.00 Ready and safe access with clear head room shall be provided to all parts of the plant for operation, inspection, cleaning and maintenance.

4.03.00 Escape routes and clear ways shall be provided to allow speedy evacuation of the plant in the event of fire or explosion, and the plant layout shall allow for ease of access to all parts of the Works by rescue and fire fighting teams. The plant layout shall be designed to localise and minimise the effects of any fire or explosion. The recommendations of NFPA, OSHA, and TAC etc. as necessary shall be followed in all respects.

4.04.00 The use of corrosive, explosive, toxic or otherwise hazardous materials shall be kept to a minimum during construction and the design of the plant shall minimise the requirement for such materials during operation and maintenance. Where such materials must be used, all necessary precautions shall be taken in the design, manufacture and layout of equipment to minimise the resulting hazard, and all equipment necessary for the protection and first-aid treatment of personnel in the event of accidents shall be provided. Particular attention is drawn to avoid the use of materials containing asbestos in any form.

5.00.00 **GUARDS**

5.01.00 Effective guards and fences must be provided to prevent injury to operators through accident or malpractice.

5.02.00 Mesh guards which allow visual inspection of equipment with the guard in place are generally preferable. The guards shall be constructed of mesh attached to a rigid framework of mild steel rod, tube, or angle and the whole galvanised to prevent loss of strength by rusting or corrosion. The guards shall be designed to facilitate removal and replacement during maintenance.

5.03.00 All drive belts, couplings, gears, sharp metallic edges and chains must be safely guarded. Any lubricating nipple requiring attention during normal running must be positioned where they can be reached without moving the guards.

5.04.00 Guards for couplings and rotating shafts shall be in accordance with BS 5304-1975 or similar approved standard. All rotating shafts and parts of shafts must be covered.

5.05.00 Suitable fencing shall be provided to enclose all openings or doorways used for the hoisting and lowering of machinery etc. This fencing must be securely fixed but quickly detachable when required. A secure hand hold must be provided on each side of the opening or doorway.

LOCATION AND LAYOUT REQUIREMENTS

The majority of plant and equipment (excluding steam generator and some other auxiliaries) shall all be of indoor installation. A broad list of buildings housing such equipment is given elsewhere in this specification. Layout should facilitate access for operation-maintenance and inspection of any one or more equipment/components at a time without disturbing the operation or installation of rest of the plant. Further, Bidder should comply with the criteria given under the various equipment and system specifications as well as those stipulated in Annexure-II attached to this section.

Enclosed General Layout and other tender layout drawings show the location of major installations and auxiliary buildings. The Bidder shall try to retain these locations as far as practicable. The layout of equipment within the power house as shown in the tender drawings is indicative. The Bidder may, subject to Owner's approval alter the same to suit the space requirement of the equipment offered.

Bidder may give as an alternative his own preferred layout clearly indicating the advantages and other implications, if any. Such alternative will not be considered for evaluating the bid, but may be considered with the successful Bidder if Owner/Engineer finds the proposal more attractive in terms of techno-economic consideration.

While developing the layout of buildings the following criteria shall be given effect :

- a) The minimum width of clear access corridors around equipment shall be 1.2 meter.
- b) Each building shall have an identified vacant space for equipment unloading and maintenance and preferably a separate bay altogether in buildings housing heavy equipment. Provision for handling equipment by monorail hoist and/or overhead crane shall be made as specified.
- c) The minimum clear height available between two consecutive floor slabs shall not be less than five (5) meters. A clear head room of 2.5m shall be maintained between the floor and any overhead piping/ cables or other obstruction. Adequate provision for natural ventilation and illumination shall be made as per good engineering practices.
- d) There shall be at least two (2) nos. main access doors, one on either side of each building, of which one shall be minimum 3 meters wide with rolling shutters for equipment entry. For multistoried buildings, at least two (2) nos. regular staircases diagonally opposite to each other shall be provided connecting all the floors and roof. These minimum requirements shall be augmented as required depending on the floor area, statutory requirements and TAC recommendations.
- e) All buildings shall have provision for toilet and associated effluent discharge system together with facility for drinking water. The criteria for ventilation, fire protection and illumination of building spaces specified

elsewhere in this specification shall be complied with.

- f) All rail/road crossings for pipe/cable racks shall be done with minimum 8 meters headroom from top of rail/road to bottom of rack. Similarly top cover over underground pipes/cables shall be minimum one (1) meter. For other detail refer to Annexure-II.
- g) Cubicle for operating personnel shall be located at safe place near the equipment.
- h) Interplant cable routing will be on overhead cable trays on pipe cum cable trestle or on cable trestle except where approved by purchaser/consultant. In exceptional case, small stretch of outdoor run of interplant cable routing may be taken through cable trench only with the Employer's prior approval.
- i) Concept of various mechanical and electrical equipment location and building dimensions (including column-row spacing) as shown in Plot Plan/Floor Plan drawing are to be adhered to. Any departure from this suggestive layout is primarily not recommended.

7.00.00 **OPERATION, MAINTENANCE & AVAILABILITY CONSIDERATIONS**

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

7.02.00 Ample space for ease of operation and maintenance including equipment removal, tube bundle/cartridge/rotor pulling etc. shall be provided. All valves, gates, dampers and other devices shall be located and oriented in such a way that they are accessible from operating floor levels. Where this cannot be adhered to, platforms and walkways with access ladders shall be provided to facilitate operation and maintenance.

7.03.0 Motorised lifting devices, i.e. hoists, chain pulleys, jacks, etc. shall be provided for handling and carrying out maintenance of any equipment and/or part having weight in excess of 3000 Kg. Suitable beams, hooks etc. for this purpose shall be provided in the buildings.

No lifting arrangement is necessary for part having weight less than 500 Kg. Hoist shall be well protected by environment. Suitable painting and coating covering hoist at outdoor shall be provided.

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

7.04.00 All similar parts of the equipment shall be made to gauge and shall be interchangeable with and shall be made of same material and workmanship as the corresponding parts of the equipment. Where feasible common

components shall be employed in different pieces of equipment in order to optimize the spares inventory and utilization.

8.00.00 MATERIALS

8.01.00 In selecting materials of construction of equipment, the Contractor shall pay particular attention to the atmospheric conditions existing at the Site and the nature of material/fluid handled. Wherever deviations are taken in respect of materials specified, the reasons shall be spelt out clearly in the proposal.

All materials shall be new, and shall be of the quality most suited to the proposed application.

8.02.00 In as far as is possible; materials shall be in accordance with Indian or international standard specifications and shall be used in accordance with Indian or international codes of practice. Where such standards or codes of practice are not available sufficient information shall be provided to allow the Owner to assess the suitability of the material for the particular application.

All materials used shall have performed lengthy satisfactory service in similar or more arduous conditions to those proposed by the Contractor.

8.03.00 All parts which could deteriorate or corrode under the influence of the atmospheric, meteorological or soil conditions at the Site, or under the influence of the working conditions shall be suitably and effectively protected so that such deterioration or corrosion is a minimum over the life of the plant.

9.00.00 LUBRICATION

9.01.00 Provision shall be made for suitable efficient lubrication where necessary to ensure smooth operation free from undue wear.

9.02.00 Non ferrous capillary tubing shall be used throughout.

9.03.00 Gear boxes and oil baths shall be provided with filling and drain plugs, both of adequate size. An approved means of oil indication including level switches and temperature indication shall be provided.

9.04.00 All high speed gears shall be oil bath lubricated. Low speed gears shall be lubricated by means of soft grease. Removable and accessible drip pans shall be provided to collect lubricant which may drop from operating parts.

9.05.00 All lubrication points shall be conveniently situated for maintenance purposes. It must be possible to carry out lubrication from a gangway or landing and without the removal of guarding or having to insert the hand into it. Where accessibility to a bearing for oiling purposes would be difficult a method of remote lubrication shall be fitted.

9.06.00 The Contractor shall supply grease gun equipment suitable to service each type of nipple fitted.

10.00.00 **LUBRICANTS AND CONTROL FLUIDS**

- 10.01.00 The Contractor shall provide a detailed and comprehensive specification for all lubricating oils, greases and control fluids required for the entire plant. A sufficient supply of these shall be provided by the Contractor for initial commissioning, first fill and till COD of the unit.
- 10.02.00 The Contractor shall supply a detailed schedule giving the lubricant testing, cleaning and replacement procedures. All equipment and facilities necessary for the testing, cleaning and changing of lubricants and control fluids shall be provided. The Contractor shall endeavor to reduce the varieties and grades of required lubricants and control fluids to a minimum, matching them where possible to those already in use in the generating station in order to simplify procurement and minimise storage requirements. All lubricants and control fluids shall be of internationally recognised standards and shall be easily obtainable from a large number of Indian suppliers. Bidder shall also indicate the equivalent Indian Standard for the above for easy procurement in future.
- 10.03.00 No lubricant or control fluid shall have toxic or other harmful effects on personnel or on the environment.

11.00.00 **OPERATION AND MAINTENANCE**

- 11.01.00 The plant shall be designed and constructed so that operation and maintenance manpower requirements are minimised.
- The design and layout shall facilitate inspection, cleaning, maintenance and repair. The importance of continuity of operation is second only to that of safety.
- 11.02.00 Spare parts for equipment shall be interchangeable with the original components and, so far as possible, be of common design and manufacture.
- 11.03.00 All similar standard components/parts of similar standard equipment provided shall be interchangeable with one another. Further identical equipments shall be provided for similar duties so that the same are interchangeable with one another in totality and component wise.
- 11.04.00 All heavy parts (500 Kg and above) must be provided with a convenient arrangement for slinging and handling during erection and overhaul. Any item of plant normally stripped or lifted during periods of maintenance and weighing one tonne or above, shall be clearly marked with its weight.
- 11.05.00 On completion of commissioning, a complete set of tools for the maintenance of the entire plant shall be provided by the Contractor. This shall include all necessary spanners, special wrenches, extraction equipment and any special tools reasonably required by the Engineer. Tools used during erection and commissioning shall not be accepted except with the specific approval of the Engineer.
- 11.06.00 All equipment and major valves should be provided with adequate maintenance approach and facility.

12.00.00 **PLANT LIFE AND MODE OF OPERATION**

The complete plant including all the equipment and systems individually and collectively shall be designed for continuous operation for an economic service life of thirty (30) years under the prevailing site conditions and for the type of duty intended.

The critical components of the Steam Generator, Turbine-Generator and Auxiliary equipment, the life of which is limited by time and temperature dependent mechanisms such as thermal stress, creep and low cycle fatigue, are to be designed considering expected (hot, warm and cold) start-up, shut-down and cyclic load variations.

The allowable stresses shall be reduced so that life expectancy to minimum 2,00,000 hours of operation can be achieved. The Bidder shall discuss this aspect in his technical proposal.

The unit would be operated on base load with cyclic load variation. The load variation is expected to be as per schedule depending on power demand.

The expected start-ups should be considered as minimum
(Based on HPT metal temperature)

Cold start-up (>72 hrs. shutdown)	:	6 per year
Warm start-up (between 10 to 72 hrs. of shutdown)	:	40 per year
Hot start-up (less than 10 hrs. shutdown)	:	160 per year

13.00.00 **PACKAGING & MARKING**

All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection. While packing all the materials, the limitations from the point of view of availability of railway wagon sizes in India should be taken account of. The details of various wagons normally available with Indian Railways for transportation of heavy equipment shall be considered by the Bidder. The Contractor shall be responsible for all loss or damage during transportation, handling and storage due to improper packing.

As per the information available, the dimensions of OD consignment for transportation of the equipment by rail (if any equipment to be handled through rail transportation) are as below :

- | | | | |
|----|---|---|-------------|
| a) | Width of the Package
(from centre-line of rails
- 1.6 metres on both sides) | : | 3.2 Meters |
| b) | Height of the package from rail top | : | 4.47 Meters |

The above indicates the dimensions which can be normally transported on the

wagons without infringement of the "moving gauge". This is however not indicative of the consignment which can be carried out with infringement of "moving gauge" duly authorised and approved by the Indian Railways. There may be difference between the "moving gauge" and the "fixed structure gauge" and consignments infringing the "moving gauge" can be moved after investigation regarding possible infringement with the fixed structures. As the critical fixed structures in each route are different, consignments infringing moving dimensions have to be individually investigated to select a route and also determine the restrictions under which such movement is to be carried out. Such routes selected or other mode of transport envisaged is to be clearly brought out in the proposal wherever transport of over dimensional equipment is involved.

Bidder to consider unloading of material delivered through rail transportation, at near by railway station/ site unloading siding. The subsequent transportation up to project work place shall be considered by road only. All unloading and handling equipment both at railway station siding and at project site shall be arranged by the Bidder. Necessary arrangement to be organized with the railway authority for such purpose shall also be under the scope of services of the Bidder. Bidder may consider entire material delivered up to site through rail transportation only.

The identification marking indicating the name and address of the consignee shall be clearly marked in indelible ink on two opposite sides and top of each of the packages. In addition the Contractor shall include in the marking gross and net weight, outer dimension and cubic measurement. Each package shall be accompanied by a packing note (in weather proof paper) quoting specifically the name of the Contractor, the number and date of contract and names of the office placing the contract, nomenclature of contents and Bill of Material.

For imported equipment and material, suitable port facilities may be used in which case material may be transported from the port by tractor-trailer. Bidder may consider this aspect.

14.00.00

PROTECTION

Equipment having antifriction or sleeve bearings shall be protected by weather-tight enclosures. Coated surfaces shall be protected against impact, abrasion, discoloration and other damages. Surfaces that are damaged shall be repainted.

Electrical equipment, controls and insulations shall be protected against moisture and water damages. All external gasket surfaces and flange faces, couplings, rotating equipment shafts, bearings and like items shall be thoroughly cleaned and coated with rust preventive compound as specified above and protected with suitable wood, metal or other substantial type covering to ensure their full protection. All exposed threaded parts shall be greased and protected with metallic or other substantial type protectors.

All piping, tubing and conduit connections on equipment and other equipment openings shall be closed with rough usage covers or plugs. Female threaded openings shall be closed with rough usage covers or forged steel plugs. The closures shall be taped to seal the interior of the equipment. Open ends of

pipings, tubing and conduit shall be sealed and taped.

Returnable containers and special shipping devices shall be returned by the manufacturer's field representative at the Contractor's expense.

15.00.00 ENVIRONMENT PROTECTION AND NOISE LEVEL REQUIREMENT

15.01.00 Environment Protection

The plant shall be designed for installation and operation in harmony with the surrounding environment and all measures of pollution control shall be ensured by the Bidder to restrict pollution from the liquid effluent and stack emission within the limits as given below with due consideration of Environment (Protection) Rules 1986 as amended till date.

In case the Ministry of Environment & Forest stipulate any other conditions not specified hereunder while clearing the project shall be complied with the plant by the contractor.

15.01.01 For Liquid Effluent

- a) Provision laid down in schedule-I for Thermal Power Plants and also in Schedule-VI. General Standards for discharge of Environmental pollutants Part-A : Effects of Environmental (protection) Rules 1986, as amended till date.
- b) Any specific requirement of State Pollution Authorities over and above the above stipulation.

15.01.02 For Air Emission

- a) Suspended Particulate Matter i.e. dust burden at chimney outlet - Maximum 50 mg/Nm³ (with worst coal and one field out at TMCR).
- b) NO_x - 365 ppm Max. or 750 mg/Nm³ (Equivalent NO₂).
- c) SO₂ - Concentration based standard 2000 mg/Nm³. Load based standard 0.2 metric tonne /MWe/day (for first 500 MW and 0.1 metric tonne/MWe/day for rest of the capacity above 500 MW)

In absence of Indian Standard for emission from power plants as on date, for certain gaseous effluents, the internationally accepted World Bank Standard is to be followed. Indian Standard for emission of power plants are under formulation. Should this standard is published before finalisation of the contract, the bidder has to comply the more stringent of the above norm or the new Indian Standard.

The bidder shall include in his scope all necessary equipment and measuring instruments to comply with above requirements. Location and accessibility of the instruments shall be properly coordinated.

15.02.00 **Noise Level Requirement**

The plant will be designed, constructed and provided with suitable acoustic measures to ensure the noise level criteria as per the following stipulations.

- a) Maximum noise level shall not exceed 85 dB (A) when measured at 1.0M away from the noise emission source.
- b) Maximum noise level from its source within the premises shall not exceed 70 dB (A) as per Environment (Protection) Rules 1986, Schedule-III, 'Ambient Air Quality Standards' in respect of noise.
- c) Any statutory changes in stipulations regarding noise limitation that may occur in future according to State Pollution Control Board or Central pollution Control Board or Ministry of Environment & Forest regulation during tenure of the contract, the contractor shall comply with the requirement.

An exception will be made for the plant at startup operations and other big pressure reducing devices operating during emergency periods and for the safety valves.

16.00.00 **INSPECTION AND TESTING**

16.01.00 **Inspection and Tests during Manufacture**

16.01.01 The method and techniques to be used by the Contractor for the control of quality during manufacture of all plant and equipment shall be agreed with the Owner prior to the Award of Contract.

16.01.02 The Owner's general requirements with respect to quality control and the required shop tests are set out elsewhere in this specification.

16.01.03 Before any item of plant or equipment leaves its place of manufacture the Owner shall be given the option of witnessing inspections and tests for compliance with the specification and related standards.

16.01.04 Advance notice shall be given to the Owner as agreed in the Contract, prior to the stage of manufacture being reached, and the piece of plant must be held at this stage until the Owner has inspected the piece, or has advised in writing that inspection is waived. If having consulted the Owner and given reasonable notice in writing of the date on which the piece of plant will be available for inspection, the Owner does not attend the Contractor may proceed with manufacture having forwarded to the Owner duly certified copies of his own inspection and test results.

The Contractor shall forthwith forward to the engineer duly certified copies of the Test Certificates in six copies (one to the Purchaser and five to the Consulting Engineer) for approval. Distribution of six (6) copies of Test Certificates for approval will be two(2) copies to owner and four(4) copies to consultant. These four(4) copies will be further distributed by consultant after approval to owner, site and bidder. One copy will be retained with the

consultant for record purpose.

Further, nine (9) copies of Shop Test Certificates shall be bound with Instruction Manuals referred to elsewhere. Distribution of nine (9) copies of Shop Test Certificates for approval will be Two (2) copies to owner, Three (3) copies to site, Two (2) copies to consultant, Two (2) copies to owner's library / record.

16.01.05 Under no circumstances any repair or welding of castings be carried out without the consent of the Owner's Engineer. Proof of the effectiveness of each repair by radiographic and/or other non-destructive testing technique, shall be provided to the Engineer along with Defect Map.

16.01.06 All the individual and assembled rotating parts shall be statically and dynamically balanced in the works.

Where accurate alignment is necessary for component parts of machinery normally assembled on site, the Contractor shall allow for trial assembly prior to despatch from place of manufacture.

16.01.07 All materials used for the manufacture of equipment covered under this specification shall be of tested quality. Relevant test certificates shall be made available to the Purchaser. The certificates shall include tests for mechanical properties and chemical analysis of representative material or any other test as required by approved QAP/ Material specification.

16.01.08 All pressure parts connected to pumping main shall be subjected to hydraulic testing at a pressure of 150% of shut-off head for a period not less than one hour. Other parts shall be tested for one and half times the maximum operating pressure or as required by design code of that part, for a period not less than one hour.

16.01.09 All necessary non-destructive examinations shall be performed to meet the applicable code requirements.

16.01.10 All welding procedures adopted for performing welding work shall be qualified in accordance with the requirements of Section-IX of ASME code or IBR as applicable. All welded joints for pressure parts shall be tested by liquid penetrant examination according to the method outlined in ASME Boiler and Pressure Vessel code. Radiography, magnetic particle examination magnuflux and ultrasonic testing shall be employed wherever necessary/recommended by the applicable code. At least 10% of all major butt welding joints shall be radiographed.

16.01.11 Statutory payments in respect of IBR approvals including inspection for design and manufacturer of equipment shall be made by the Bidder. All payment for erection and testing at site (i.e. under IBR jurisdiction) shall also be made by the Bidder. In such case Contractor's scope shall also be extended to preparation of all necessary documents, co-ordination and follow-up with IBR authorities for above approval.

16.02.00 **Performance Tests at Site**

- 16.02.01 The full requirements for testing the system shall be agreed between the Owner and the Bidder prior to Award of Contract. The completely erected System shall be tested by the Contractor on site under normal operating conditions. The Contractor shall also ensure the correct performance of the System under abnormal conditions, i.e. the correct working of the various emergency and safety devices, interlocks, etc.
- 16.02.02 The Bidder shall provide complete details of his normal procedures for testing, for the quality of erection and for the performance of the erected plant. These tests shall include site pressure test on all erected pipe work to demonstrate the quality of the piping and the adequacy of joints made at site.
- 16.02.03 The Contractor shall furnish the quality procedures to be adopted for assuring quality from the receipt of material at site, during storage, erection, pre-commissioning to tests on completion and commissioning of the complete system/equipment.
- 16.03.00 For details of specific tests required on individual equipment refer to respective section of this specification.

17.00.00 TRAINING OF OWNER'S PERSONNEL

The Contractor shall extend all possible assistance and co-operation to the Purchaser regarding the transfer of technology and developing expertise in the area of engineering operation and maintenance of the Plant.

Number of man-days of training as mentioned below shall be included in his Tender.

17.01.00 Training at Contractor's Premises

The Contractor shall conduct training of sixty (60) engineers of the Owner on engineering, operation and maintenance of the Plant at the Contractor's or Associates or Sub-contractor's premises where adequate training facilities are available during the design and manufacturing stage of the Contractor.

The total man-months for training of engineers shall be maximum sixty (60), having following indicative break-up :

Discipline	No. of Engineers	No. of Man-month
Operation	20 heads	20
Maintenance Boiler, Turbine, Mechanical	20 heads	20
Electrical Maintenance	8 heads	4
Control & Instrumentation	8 heads	4
Maintenance Planning	4 heads	2
	-----	-----

However, the details of the training programme will be discussed and finalised with the successful Bidder.

The training may also be arranged by the Contractor in any Plant where the equipment manufactured by the Contractor or his Associates is under installation, operation or testing to enable the trainees to become familiar with the equipment being furnished by the Contractor. All expenses inherently related to the training shall be borne by the Contractor and shall include but not limited to travel expenses (international and inland fares), lodging and per diem charges as well as medical insurance, instructors fee, programme and miscellaneous cost to be incurred during the training.

The training programme shall be adequate for the trainees to acquire the necessary expertise and competence in the area of engineering, operation and maintenance and as trainers for in-house technology transfer programme of the Purchaser.

The Contractor shall be responsible for the development of the Training Module and Programme Schedule which shall be submitted to the Purchaser for approval.

The components of the training modules shall include but not be limited to the training procedures/methodology, instructional materials such as audio visual materials, CDs and slides and manuals for each trainee.

Three (3) sets of the materials included in the training modules shall be handed over to the Purchaser upon completion of the training. An evaluation shall be jointly undertaken by the Contractor and the Purchaser's representative on the adequacy, appropriateness and relevance of the training and the programme effectiveness after the training. The training material shall be in English language only.

The content of the training programme shall include but not be limited to:

1. Coal fired thermal plant principles in management and practice for operators, technicians and maintenance personnel.
2. Plant operation and systems training for operators including simulator training as applicable.
3. Maintenance training programme covering electrical, mechanical and instrumentation and control.

Said training programme shall be submitted to the Purchaser for approval.

The timing of the training should be such that the participants will be conversant with sufficient know-how to participate in the pre-commissioning and commissioning tests of the Plant.

The Contractor shall provide qualified English speaking instructors and training

coordinator(s) during the tenure of the training programme.

17.02.00 Operation and Maintenance Training at Site

The Contractor shall provide a comprehensive training programme related to design application, plant management, operation and maintenance, including trouble shooting, of the Contractor's supplied system and equipment at the Site starting from Start of Commissioning and thereafter up to the Final Acceptance of the first Unit.

The following instructors shall be at the Site continuously during the training :

- a) One (1) for Steam Generator and Auxiliaries ;
- b) One (1) for Turbine Generator and Auxiliaries ;
- c) One (1) for Electrical Works ;
- d) One (1) for Instrumentation and Control (Boiler and Auxiliaries) ;
- e) One (1) for Instrumentation and Control (Turbine and Auxiliaries).

17.03.00 On-the-Job Training

During the period of pre-commissioning, commissioning and trial operation, the Purchaser shall provide operation and maintenance personnel to assist the Contractor in the operation and maintenance of his supply and work under the direction of the Contractor for the purpose of on-the-job training.

The Purchaser shall have the right to send to the Site his employees later intended to operate and maintain the equipment supplied under this Contract. The Contractor shall, without additional cost, use his site staff to instruct these employees on the operation and maintenance of the equipment. All instructions shall be in the English language.

17.04.00 For detail C&I training refer to Volume-VI, Section-9.

18.00.00 DEVIATIONS

The Bidder is required to submit with his proposal in the relevant schedules a detail list of any and all deviations taken by him clearly without any ambiguity. In the absence of such a list it will be understood and agreed that the Bidder's proposal is based on strict conformance to this specification and no post-contract negotiations would be allowed in this regard.

Unless otherwise specifically indicated in the deviation list, it will be construed and agreed that details indicated in documents & drawings furnished by the Bidder along with the offer is in-line with the specification requirement.

ANNEXURE-I

LIST OF STANDARDS FOR REFERENCE

- a) International Standards Organisation (ISO).
- b) International Electro-technical Commission (IEC).
- c) American Society of Mechanical Engineers (ASME).
- d) American National Standards Institute (ANSI).
- e) American Society for Testing and Materials (ASTM).
- f) American Institute of Steel Construction (AISC).
- g) American Welding Society (AWS).
- h) Architecture Institute of Japan (AIJ).
- i) National Fire Protection Association (NFPA).
- j) National Electrical Manufacturer's Association (NEMA).
- k) Japanese Electro-technical Committee (JEC).
- l) Institute of Electrical and Electronics Engineers (IEEE).
- m) Federal Occupational Safety and Health Regulations (OSHA).
- n) Instrument Society of America (ISA).
- o) National Electric Code (NEC).
- p) Heat Exchanger Institute (HEI).
- q) Tubular Exchanger Manufacturer's Association (TEMA).
- r) Hydraulic Institute (HIS).
- s) International Electro-Technical Commission (IEC) Publications.
- t) Power Test Code for Steam Turbines (PTC).
- u) Applicable German Standards (DIN).
- v) Applicable British Standards (BS).
- w) Applicable Japanese Standards (JIS).

- x) Electric Power Research Institute (EPRI).
- y) Standards of Manufacturer's Standardization Society (MSS).
- z) Bureau of Indian Standards Institution (BIS).
- aa) Indian Electricity Rules.
- bb) Indian Boiler Regulations (IBR).
- cc) Indian Explosives Act.
- dd) Indian Factories Act.
- ee) Tariff Advisory Committee (TAC) rules.
- ff) Emission regulation of Central Pollution Control Board (CPCB).
- gg) Pollution Control regulations of Dept. of Environment, Govt. of India
- hh) Central Board of Irrigation and Power (CBIP) Publications.
- ii) The Air Prevention and Control of Pollution Act.
- jj) The Environmental Protection Act
- kk) The Public Liability Insurance Act.
- ll) The Forest Conservation Act
- mm) The Wildlife protection Act.
- nn) The EIA Notification, 1994.
- oo) IS: 14665-Specification for Electric Traction Lift
- pp) Any other statutory Codes/Standards/Regulations

CRITERIA FOR LAYOUT

PLOT PLAN LAYOUT REQUIREMENTS

ITEM	SPECIFICATION REQUIREMENT
A. Site conditions to be considered	
1. Prevalent wind direction	See wind-rose in plot plan. Also refer Metrological Data.
B. Layout Requirements	
1. Maximum permissible slope in	
a) Rail track	1 in 400
b) Road	1 in 30
c) Sides of unpaved embankment	1 in 2
2. Required road width	
a) Main roads	Refer VII-A, B, C.
b) Auxiliary interconnections	Refer VII-A, B, C.
c) Road to the power house unloading bay :	
• Only for entry to the unloading bay	Yes
• To pass through the unloading bay	No
3. Required minimum horizontal distance between the nearest points of	
a) Plant boundary and the boundary of residential area	(Local municipality/factory rule)
b) Electrical transformer and any other building/facility	As per the Tariff Advisory Committee/ LPA Rules
c) Fire water supply installation and any building/facility subject to fire risk.	As per the Tariff Advisory Committee/ LPA Rules
d) Inflammable liquid (fuel oil, etc.) storage & handling installation and their fencing and other buildings/facilities.	Rules of the Indian Explosive (Indian Explosives Act) and Indian Petroleum Code

4.	Required minimum vertical clearance	
a)	Under pipes/cable racks at road crossings	8.0 Metres
b)	Soil coverage over underground pipes	1.0 Metre (minimum)
5.	Railway Wagon clearance	Rules of the Indian Railways
6.	Minimum Clearance between any road edge and building/structure/ any fixed installation.	3 Metres
7.	Required level, above the local developed grade level, of	
a)	top of all roads	150 mm above FGL
b)	all outdoor paved areas	100 mm above FGL
c)	Temporary storage areas, workshops, offices, residence etc. required at the time of erection work.	Yes
d)	Green belt around power plant area	As per environmental guidelines of MOEF, Govt. of India.

BUILDING/ EQUIPMENT LAYOUT REQUIREMENTS

A.	Minimum clear space required at all working and walking areas for operating & maintenance personnel	
1.	Horizontal, in all directions	
a)	Adjacent to any electrical equipment, electrical cables, running (rotating/reciprocating) equipment, safety valve or vent/drain pipe outlet, pipe/ equipment of surface temperature exceeding 60°C.	1200 mm
b)	Adjacent to any other plant facilities (including walls/structures)	1000 mm
2.	Vertical (head-room clearance)	
a)	Under any pipe/equipment surface of temperature exceeding 60°C and any electrical cables or other electrical items.	2.5 Metre
b)	Under any other plant facilities (including structures, pipes etc.)	2.5 Metre

ITEM	SPECIFICATION REQUIREMENT
3. For all areas where any equipment (including trucks, trolleys and other material handling equipment) will move or maneuver.	Minimum 500 mm clear in all direction from the outer edges of the equipment
4. Minimum clear hand space required for	
a) The application of thermal insulation	100 mm
b) Welding work	150 mm
c) Bolt tightening	150 mm
B. Floors, platforms, staircase, ladders, walls, doors & windows	
1. Statutory Requirement	As per the regulations of Tariff Advisory Committee, Indian National Building Code, Indian Factories Act, Local Municipal Rules, etc.
2. Operation & Maintenance Requirement	
a) Adequate floor space shall be kept to permit dismantling, temporary storing and in-situ maintenance of plant & equipment parts, satisfying the clear space requirements stated above. A separate unloading bay for such purpose is required.	Yes
b) Floors or fixed/portable platforms with stairs/ ladders shall be provided for easy approach to any plant item, including valves, instruments, etc. to be operated, observed and/or to be frequently (more than once a month) maintained.	Yes
3. Plinth level of all buildings, above the finished grade level	500 mm
4. Minimum access opening required (with rolling shutter) for transportation, wherever entry of truck for material handling is envisaged	3.5M wide x 4M high or, more depending upon the equipment size to be handled.

ITEM	SPECIFICATION REQUIREMENT
C. Other Maintenance Requirement	
1. Generator stator handling In case the Generator stator cannot be handled by the turbine house crane, all provisions for its overhauling, including the arrangement to slide the stator on the turbine house floor, the foundation work for stator jacking /lowering assembly, dismantling of building end walls/structures etc. shall be kept.	Yes
2. Maintenance of the internals/impellers of all important equipment, like boiler feed pumps, feed water heaters, Surface Condenser, fans of the boiler draft plant, Intake and circulating water pumps, cooling water pumps, coal mills, compressors, blowers, heat exchangers, fuel oil pumps, filters etc.	Shall be possible without disconnecting or dismantling any piping/ducting.
3. Overhauling and handling of the casings for the above items	Shall be possible without disturbing/dismantling any piping/ducting not directly connected to them.
4. Crane Approach Wherever required the unobstructed approach of the crane hook/other hoisting equipment hook to various plant & equipment shall be possible.	Yes
D. Central Control Room	
All electronic equipment other than those directly associated with control, operation or presentation of displays shall be mounted external to the control room in air conditioned control equipment room.	Yes
The bidder shall describe in his bid the proposed layout philosophy of the Central Control Room and Control Equipment Room and the arrangement of equipment best suited for the system offered by him and as per good ergonomically consideration.	
However, as a guide line, following features are given :	
a) False ceiling and false flooring shall be provided.	
b) Uniform height, colouring schemes for cabinets etc. shall be available.	

ITEM	SPECIFICATION REQUIREMENT
c) The total area of floor space covered by Control Consoles/Panels in the Control Room shall not exceed 15% of floor area.	
d) No opening shall be provided from Boiler side.	
e) Two double leaf doors, suitably located for entering the Control room shall be provided with opening towards the turbine floor.	
f) Cable entry for the panels/consoles shall be from bottom and suitable openings shall be provided.	
g) The Control Room lighting shall be designed to provide a glare free uniform illumination. The level of illumination shall be minimum 400 LUX.	
h) Necessary Air Conditioning shall be provided for Central Control room, Control Equipment Room and SWAS room etc.	
i) Basic amenities like toilet, Tiffin rooms, wash basins, rest rooms etc. shall be provided near the Control Room.	
E. Toilet and drinking water facility	Required in all buildings and on all floors wherever operating personnel are to be deployed.

PROJECT MANAGEMENT AND SITE SERVICES

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	PROJECT MANAGEMENT SERVICES
2.00.00	SITE SERVICES
3.00.00	PROJECT INFORMATION AND MANAGEMENT SYSTEM, INCLUDING DCOUMENT MANAGMENT SERVER (DMS)

PROJECT MANAGEMENT AND SITE SERVICES

1.00.00 PROJECT MANAGEMENT SERVICES

1.01.00 Responsibility

The Bidder shall identify a separate and independent project management team headed by a Project Manager for the execution of this project. Responsibilities of this project Management team shall cover the areas listed below :

- a) Planning and Monitoring
- b) Engineering Management
- c) Contracts Management
- d) Project Safety Management
- e) Quality Assurance, Inspection & Expediting
- f) Construction Management
- g) Spares Management
- h) Erection & Commissioning Management

Detailed responsibilities in the above areas are discussed below :

1.02.00 Organisation

1.02.01 Headquarters

The headquarters of the project management team shall be headed by a senior level executive designated as the Project Manager who shall be responsible to Owner for the execution of the project. He should have adequate financial power and authority to give decision.

Separately, designated leaders shall be identified for each of the areas mentioned under 1.01.00, who, in turn, will report to the Project Manager for all matters relative to this contract.

1.02.02 Central Co-ordination Cell

The central coordination cell shall have sufficient technical personnel to coordinate technical matters and to quickly resolve day to day queries or

references made by Owner and his Consultants without having the need to refer to his headquarters each time.

1.02.03 Site Organisation

The site should have a competent construction manager for all site operations with adequate financial power and sufficient level of authority to take site decisions. The organisation chart for site should indicate the various levels of experts to be posted for supervision in the various fields in civil construction, erection, commissioning etc.

1.02.04 Organisation Chart

The Bidder shall furnish a detailed organisation chart for the project management team, clearly identifying the key personnel in each of the areas mentioned at 1.01.00 above. The expected number of executives at different levels shall also be indicated, separately for headquarters, central coordination cell and site organisation.

1.03.00 **Implementation Schedule**

The schedule for the completion of the Project would be as follows :

Period in Months from Zero date (Taken as advance payment date of EPC Package)

a)	Boiler Hydro-test	By Bidder
b)	Boiler light up	By Bidder
e)	Commercial operation	50

To achieve these targets, the Contractor shall furnish to the Owner, various schedules as defined below:

1.03.01 Engineering Schedules

These schedules shall cover various design submissions indicating different engineering activities to be performed. Such schedules shall be furnished by the Bidder for each and every plant/systems/ equipment item covered in the scope of this specification.

1.03.02 Manufacturing Schedule

The Contractor shall submit to the Engineer his manufacturing and delivery schedules for all equipment within thirty (30) days from the date of issue of the Letter of Intent (LOI). Such schedules shall be in line with the detailed network for all phases of the work of the Contractor. Such schedules shall be reviewed, updated and submitted to the Engineer, once in every two months thereafter, by the Contractor. Schedules shall also include the materials and equipment purchased from outside suppliers.

1.03.03 Erection Schedules

In order to achieve the overall completion schedule, the Contractor shall provide the Owner all the information covering erection sequence, testing and commissioning activities. These schedules may be based on the recommended erection procedures and will be subject to discussions/agreements with the Owner subsequent to the award of contract.

1.03.04 The successful Bidder shall have to provide all the above schedules (i.e. 1.03.01, 1.03.02 & 1.03.03) in a tabular form in addition to that in the form of L2 & L3 networks and these shall necessarily include information not limited to the earliest and latest dates for various activities/submissions and also any related constraints. However, the Bidder shall include in his proposal a Level-1 (L-1) network showing the major activities and various milestones to achieve the above mentioned completion schedule.

1.03.05 The Contractor shall provide the Owner the original disc/software for all such schedules alongwith requisite no. of copies (as required by the Owner) within an agreed time schedule. This time schedule will be agreed between Owner/Bidder at the time of award of contract. The Contractor's project management software shall be compatible with that of the Owner and the input data shall be furnished to the Owner in a manner compatible with Owner's project management software, SAP.

1.04.00 Detailed Responsibilities

1.04.01 Planning & Monitoring

a) Planning

The Bidder shall prepare a Master Network Schedule in the form of PERT network.

The network shall be prepared on a Work Breakdown Structure for the project which sub-divides the project into a set of manageable systems/sub-systems. The master network will identify milestones of key events for each system/package in the areas of engineering, procurement, manufacture and despatch and erection and commissioning. The master network shall represent the Level-I plan and will form the basis for development of detailed second and third tier execution plans. The master network shall conform to the overall schedule prescribed by Owner.

The master network should be submitted along with the bid which would be mutually discussed and finalised before the Award of Contract. This master network would clearly indicate the responsibility of the Bidder and project management team. This master network would form a part of the contract. The master network shall also identify a complete list of inputs to be furnished by the Owner which may be required for proper interfacing and tie-up. Scheduled dates for providing such inputs shall also be indicated, which will be mutually discussed and finalised.

b) Monitoring & Progress Reporting

The progress reports would be emanated every month, one from the head office of the Contractor and another from the site office. The progress report emanating from the head office should necessarily include the following sections:

- i) Report on key milestones.
- ii) Management summary indicating critical areas with details of actions initiated and effect of any on the project.
- iii) Action needing attention of the Owner/Consultant.
- iv) Detailed packagewise status of engineering submissions, quality plan submissions and approval, procurement manufacture and despatch.

The monthly report generated from the site office should necessarily include:

- i) Report on key milestones.
- ii) Management summary indicating critical areas with details of actions initiated and effect if any on the project.
- iii) Action needing attention of the Owner/Consultant.
- iv) This report would also cover the areas pertaining to the receipt of the equipment at the port, port clearance, transport, receipt at site, erection and commissioning.

In addition to the above, as the project execution progresses, the Contractor shall also be responsible for generating more frequent reports in the form of fax/e-mail information on progress in critical areas so that actions can be expedited. The exact format of the progress report shall be finalised after award of Contract.

1.04.02 Engineering Management

Based on the master network for the project (L-1) the Contractor will prepare an exhaustive list of engineering activities for the equipment/systems covered in his scope and a detailed programme of accomplishing the same within the time frame specified in the master network. This schedule will form the Level-2 (L-2) network for engineering activities.

Based on (L-2) network, the Contractor shall further develop the Level-3 (L-3) network for engineering activities which will indicate schedule for data availability, drawing release date and document submission dates.

Detailed (L-2) and (L-3) networks would be submitted sequentially by the Contractor within two months from the date of issue of Letter of Intent and finalised within one (1) month thereafter.

All such networks shall be provided in MS PROJECT software as well as in other format / software suitable to Owner.

The engineering management team should also co-ordinate all interface engineering activity between the Contractor and the equipment sub-vendors so as to ensure the correctness and completeness of related engineering documentation before the same is submitted to the Owner.

TSGENCO is implementing SAP ERP. Hence the bidder apart from submission of the hard copies shall upload all the documents, drawings etc. in soft format in the relevant C- folder environment (web based) and comply with the additional requirements, if any.

1.04.03 Contracts Management

Based on the master network, the Contractor shall submit L-2 programmes of manufacture and despatch. In addition, the master network shall also include periods considered for site activities viz. erection, commissioning etc. These L-2 programmes would be submitted in 2 months time from the date of award of contract and finalised within one (1) month thereafter. The Contractor will also submit site mobilisation plan. This programme would be submitted at the time of finalisation of award of contract and agreed immediately thereafter so that immediate development of the various activities at site could take place.

The Contractor should also submit L-3 programmes for the manufacturing, despatch of the various items. These networks shall also show the customer hold points (CHP) which have to be cleared by Owner or their authorised representative(s) before further manufacture can take place. These L-3 programmes for the manufacture and despatch would clearly identify responsibilities of the Contractor, sub-Contractor and Owner. These networks shall be submitted within one (1) month of the date of finalisation of the various sub-contracts by the Contractor.

In case all the manufacture is being done by the Contractor then the L-2 programmes would be themselves amplified to cover details of the manufacture, inspection, clearance by Owner and despatch.

The Contractor shall also submit the programme for procurement of boughtout items, detailed shipping schedule and cash flow statement for Owner's approval.

1.04.04 Quality Assurance, Inspection and Expediting

The Contractor shall submit the list of manufacturers/sub-vendors from whom the equipment are expected to be procured and the quality assurance plans thereof for the manufacture shall be approved by the QA group of Owner before the manufacture is commenced. The list of major suppliers would be submitted along with the bid and this shall be mutually discussed and approval will be given by the Owner during contract negotiation meeting prior

to placement of Letter of Intent. This approved list will be binding to the bidder. In the said list, Owner reserves the right to include reputed/reliable vendors of his own choice. Regarding the various other sub-vendors, the list would be submitted within six (6) months of the award of the contract that shall be scrutinized by the Owner to accord approval. In such list Owner reserves the right to include vendors of his own choice. No further vendor approval will be given after twelve (12) months. On the quality plans, the customer hold points will also be identified based on which Owner would give clearance for the manufacture to proceed further.

Quality assurance/Inspection group of Owner or its representative would issue a material despatch clearance certificate (MDCC) after the inspection clearance which will enable the Contractor to despatch the equipment and claim the payment. In the despatch programme, the Contractor shall indicate a schedule of estimated programme, tonnages specifically identifying various oversize dimensioned consignments (ODC). Further the Contractor will also be required to ensure at all stages of shipment that packing of all shipments despatched are suitable for ocean freight to India, handling at the port of entry, inland transportation and preservation at site upto erection. All despatch details & item lists shall be made available to both Owner & site immediately after shipping.

The Contractor shall also expedite all despatches from their own works/works of their sub-vendors, so as to match with the various activities mentioned at 1.04.03 above.

1.04.05 Construction Management

Based on the L-1 Master Network Programme, within two (2) months of the issue of Letter of Intent, the Contractor shall submit a programme of construction/ erection/ commissioning, either in continuation with the manufacture and despatch or separately for the implementation. These programmes would be amplified showing when the civil drawings shall be released by him and construction of civil works shall be completed by him to facilitate start of erection and subsequent activities and shall form the basis for site execution and detailed monitoring. The three monthly rolling programme with the first month's programme being tentative based on the site conditions would be prepared based on these L-3 programmes. The Contractor shall also be involved along with the Owner to tie up detailed resource mobilisation plan over the period of time of the contract matching with the performance targets.

The L-3 programme would be jointly finalised by the site in charge of the Contractor with the Owner's project coordinator as well as the site planning representative. The erection programme will also identify the sequential erectable tonnages that are required for various equipment which should be taken care of in the despatch programmes.

Erection and commissioning of the equipment shall also be done under the supervision of experts from the respective equipment/ system supplier.

1.04.06 Spares Management

Alongwith the proposal for the plant and equipment, the Contractor shall also submit proposals/schedule for the following:

- a) Mandatory spares
- b) Recommended spares

While the award for mandatory spares will be finalised at the time of the award of contract, recommended spares will be finalised thereafter.

1.05.00 Project Progress Review Meetings

Keeping in mind the overall responsibility of the Contractor it is intended that periodic progress reviews on the entire activities of execution of the project will be held initially at least once in two (2) months at Hyderabad/site/ at the discretion of the Owner.. During peak period it may be held once in a month. These meetings will be attended by reasonably higher officials of the Contractor and their leading sub- contractors and will be used as a forum for discussing all areas where progress needs to be speeded up. Actions will be placed on the concerned agencies and decisions will be taken to expedite/speed up the progress. Minutes of such meetings will be issued reflecting the major discussions and decisions taken and circulated to all concerned for reference and action. The Contractor shall be further responsible for ensuring that suitable steps are taken to meet various targets decided upon such meetings.

In addition to the above, and to streamline the construction and erection at site, a suitable frequency and forum of periodic meetings between the Contractor and the Owner will be decided upon as part of erection coordination procedure. Site co-ordination meeting may be held on weekly basis.

1.06.00 Owner's Consultant

The Owner would appoint a consultant to assist him in some of the areas mentioned at 1.01.00 above. The details of interaction and procedures for coordination between Owner / Owner's Consultant and Contractor/ Contractor's project management team shall be finalised during contract negotiations.

1.07.00 Commissioning Management

1.07.01 For commissioning of the various equipment/system covered under the scope of contract, Owner will form an organisation structure which may consist of the following committees. The Contractor shall nominate his representative on one or more of the committee as decided by the Owner:

- a) Steering Committee
- b) Commissioning Panel.
- c) Working Parties
- d) Testing Teams.

1.07.02 Commissioning documents shall be prepared by the Contractor in the

following manner and submitted for Owner's approval :

a) Field Quality Plan

This document shall be prepared for the various equipment/ systems under commissioning and shall have the following objectives to fulfill and shall be submitted for Owner's approval at least six (6) months before their actual commissioning :

- i) Establish design data against which Plant Performance will be compared.
- ii) Set-out the testing objectives and proposals.
- iii) Define the documentation required.

b) Testing/Commissioning Schedule

These shall be prepared for the various equipment/systems under consideration and shall contain sections like detailed testing method, programme, safety, individual responsibility and results.

c) Standard Check Lists

Standard check lists are intended for use at the completion of erection to ensure correct erection, testing and to a limited extent operation for repetitive items.

1.07.03 Test Reports

After the completion of commissioning activity of equipment/ systems, the Contractor shall prepare the test reports which shall include all the relevant information related to various commissioning checks, tests carried out, any deviations/commissions noticed with respect to the intended design requirements, sequence of various commissioning activities as actually adopted vis-a-vis as recommended in the procedures, programme schedules achieved and any other such information as required. These test reports shall be submitted in requisite number of copies to the Owner and this should be duly signed jointly by the Owner/Consultant and the Contractor/Equipment supplier, who are involved during the commissioning activities.

2.00.00 **SITE SERVICES**

These services shall be rendered by the Bidder as part of the overall project management service. The services shall broadly include but not be limited to the following :

2.01.00 Arranging material despatch from the shop by rail/road and/or sea as applicable.

2.02.00 Monitoring movement of materials & follow-up as necessary with Railways, road transport, port clearance etc. from the time of despatch F.O.R. works/ F.O.B. port of shipment by Contractor till receipt of the same at site.

- 2.03.00 Unloading of materials at Railway Station/Railway Siding inside project area/ Road Transportation, transportation to site store, assessment of lost/damaged items in transit and arranging insurance claims and replacement of lost/damaged items. The Contractor shall submit to the Engineer a report detailing all the receipts during the week as well as storing, preservation of material at site.
- 2.04.00 Issuing materials from site store/open yard from time to time for erection as per the construction programme. The Contractor shall be the custodian of all the materials issued till the plant is officially taken over by the Owner after complete erection and successful trial run & commissioning.
- 2.05.00 Transportation of materials to their respective places of erection and erection of the complete plant & equipment as supplied under this specification.
- 2.06.00 Trial run and commissioning of individual equipment/sub-systems and the plant as a whole to the satisfaction of the Owner, including supply of temporary equipment & services for chemical cleaning, steam blowing as well as performance guarantee tests.

Apart from Boiler, proper chemical cleaning shall be carried out in following pipe lines/equipment before commissioning

- a) Deaerator
- b) Boiler feed suction, recirculation leak-off lines
- c) Boiler Feed discharge line by passing heaters
- d) Attenuation lines
- e) Condensate suction & discharge piping upto deaerator by passing the feed water heaters.
- f) Fuel oil lines.

Provision for preservation of individual equipment after trial run and commissioning e.g. Nitrogen blanketing etc. as necessary shall also be in the scope of the Bidder.

Safe disposal of effluent after chemical cleaning shall be done by the contractor.

- 2.07.00 Supply and application of the final paints and first fill lubricants on all the equipment to be erected under this specification. Supply of chemicals, lub oils and other consumables upto COD.
- 2.08.00 For the purpose of erection and commissioning the Contractor's scope of work shall include but not be limited to the following :
- 2.08.01 Deployment of all skilled and unskilled manpower required for erection, supervision of erection, watch & ward, commissioning and other services to

be rendered under this specification.

- 2.08.02 Deployment of all erection tools & tackle, construction machinery, transportation vehicles and all other implements in adequate number and size, appropriate for the erection work to be handled under the scope of this specification.
- 2.08.03 Supply of all consumables, e.g. welding electrodes, cleaning agents, diesel oil, grease, lubricant etc. as well as materials required for temporary supports, scaffolding etc. as necessary for such erection work except those listed under exclusion elsewhere in this specification.
- 2.08.04 Construction of all civil/structural/architectural works, including construction of foundation for all equipment supplied as required, grouting of equipment on foundation after alignment, and all other incidental civil activities as detailed elsewhere.
- 2.08.05 All structural steel fabrication and erection work as detailed elsewhere in the specification.
- 2.08.06 Providing support services for the Contractor's erection staff e.g. construction of site offices, temporary stores, residential accommodation and transport to work site for erection personnel, insurance cover, watch & ward for security and safety of the materials under the Contractor's custody etc. as required.
- 2.08.07 Maintaining proper documentation of all the site activities undertaken by the Contractor as per the proforma mutually agreed with the Owner; submitting monthly progress reports as also any such document as and when desired by the Owner; taking approval of all statutory authorities e.g. Boiler Inspector, Factory Inspector, Inspector of Explosives, Electrical Inspector etc. for respective portions of work under the jurisdiction of such statutes or laws.
- 2.08.08 The Contractor shall provide 'Industrial Relations' unit and 'Medical' unit to take care of his erection staff and the Owner shall have no obligation in the regard.
- 2.08.09 The successful Bidder shall arrange for Tower cranes of adequate capacity for speedy erection activities.

2.09.00 **Site Organisation**

The Contractor shall maintain a site organisation of adequate strength in respect of manpower, construction machinery and other implements at all times for smooth execution of the contract. This organisation shall be reinforced from time to time, as required, to make up for slippages from the schedule without any commercial implication to the Owner. The site organisation shall be headed by a competent construction manager having sufficient authority to take decisions at site.

On award of contract, the Contractor shall submit to the Owner a site organisation chart indicating the various levels of experts to be deployed on the job. The Owner reserves the right to reject or approve the list of personnel

proposed by the Contractor. The persons, whose bio-data have been approved by the Owner, will have to be posted at site and deviations in this regard will not generally be permitted.

The Contractor shall also submit to the Owner for approval a list of construction equipment, erection tools, tackle etc. prior to commencement of site activities. These tools & tackle shall not be removed from site without written permission of the Owner.

2.10.00 General Guidelines for Field Activities

2.10.01 The Contractor shall execute the works in a professional manner so as to achieve the target schedule without any sacrifice on quality and maintaining highest standards of safety and cleanliness.

2.10.02 The Contractor shall co-operate with the Owner and other Contractors working in site and arrange to perform his work in a manner so as to minimise interference with other Contractors' works. The Owner's engineer shall be notified promptly of any defect in other Contractor's works that could affect the Contractor's work. If rescheduling of Contractor's work is requested by the Owner's engineer in the interest of overall site activities, the same shall be complied with by the Contractor. In all cases of controversy, the decision of the Owner shall be final and binding on the Contractor without any commercial implication.

2.10.03 The Engineer shall hold weekly meetings of all the Contractors working at Site at a time and a place to be designated by the Engineer. The Contractor shall attend such meetings and take notes of discussions during the meeting and the decisions of the Engineer and shall strictly adhere to those decisions in performing his Work. In addition to the above weekly meeting, Engineer may call for other meetings either with individual contractors or with selected number of contractors and in such a case the Contractor, if called will also attend such meetings.

2.10.04 Time is the essence of the Contract and the Contractor shall be responsible for performance of his Work in accordance with the specified construction schedule. If at any time the Contractor is falling behind the schedule, he shall take necessary action to make good of such delays by increasing his work force or by working overtime or otherwise accelerate the progress of the work to comply with the schedule and shall communicate such action in writing to the Engineer, satisfying that his action will compensate for the delay. The Contractor shall not be allowed any extra compensation for such action.

2.10.05 The Engineer shall however not be responsible for provision of additional labour and or materials or supply or any other services to the Contractor except for the co-ordination work between various Contractors as set out earlier.

2.10.06 The works under execution shall be open to inspection & supervision by the Owner's engineer at all times. The Contractor shall give reasonable notice to the Owner before covering up or otherwise placing beyond the reach of inspection any work in order that same may be verified, if so desired by the Owner.

- 2.10.07 Every effort shall be made to maintain the highest quality of workmanship by stringent supervision and inspection at every stage of execution. Manufacturer's instruction manual and guidelines on sequence of erection and precautions shall be strictly followed. Should any error or ambiguity be discovered in such documents, the same shall be brought to the notice of the Owner's engineer. Manufacturer's interpretation in such cases shall be binding on the Contractor.
- 2.10.08 The Contractor shall comply with all the rules and regulations of the local authorities, all statutory laws including Minimum Wages, Workmen Compensation etc. All registration and statutory inspection fees, if any, in respect of the work executed by the Contractor shall be to his account.
- 2.10.09 All the works such as cleaning, checking, leveling, blue matching, aligning, assembling, temporary erection for alignment, opening, dismantling of certain equipments for checking and cleaning, surface preparation, edge preparation, fabrication of tubes and pipes as per general engineering practice at site, cutting grinding, straightening, chamfering, filling, chipping, drilling, reaming, scrapping, shaping, fitting-up bolting/welding, etc., as may be applicable in such erection and are necessary to complete the work satisfactorily, are to be treated as incidental and the same shall be carried out by the Contractor as part of the work.
- 2.10.10 In case of any class of work for which there is no such specification as laid down in the contract such as, blue matching, welding of stainless steel parts, etc., the work shall be carried out in accordance with the instructions and requirements of the Engineer and as per the Standards.
- 2.10.11 It may sometimes be necessary to remove some of the erected structural members to facilitate erection of bigger/pre-assembled equipment. In such cases, the removal and re-erection of such members, which are essential, and if so agreed by the Engineer, will have to be done by the Contractor.
- 2.10.12 Attachment welding of necessary instrumentation tapping points, thermocouple pads, root valves, condensing vessels, flow nozzles and control valves etc., both for regular measurement and performance testing to be provided on equipment, its auxiliaries or pipelines covered within the scope of this tender, will also be the responsibility of the Contractor and the same will be done as per the instructions of Engineer. The erection and welding of all above items will be the Contractor's responsibility, even if :
- a) Product groups under which these items are re-leased are not covered in the scope of this tender.
 - b) Items are supplied by an agency other than the Contractor.
- 2.10.13 Preservation of all materials/equipment under custody of the Contractor during storage, pre-assembly & erection, commissioning etc., shall be the responsibility of the Contractor. All necessary preservatives and consumables like paints, etc., shall be arranged by the Contractor. Necessary touch up painting, periodic application of preservatives/paints on pressure parts/other equipment even after erection until completion of work shall be carried out by

the Contractor. The Contractor shall fabricate piping, install lub oil systems and carry out the acid cleaning of fabricated piping. The Contractor shall also service the lub. oil system, carryout the hydraulic test of oil coolers, etc.

- 2.10.14 It is responsibility of the Contractor to do the alignment etc. if necessary, repeatedly to satisfy Engineer, with all the necessary tools & tackle, manpower, etc. The alignment will be complete only when jointly certified so, by the Contractor's Engineer & Owner. Also the Contractor should ensure that the alignment is not disturbed afterwards.
- 2.10.15 Additional platforms for approaching different equipment as per site requirement, which may not be indicated in drawings, shall be fabricated and erected by the Contractor. The materials required for these works shall be supplied by the Contractor and he will have to fabricate them to suit the requirement.
- 2.10.16 Equipment and material which are wrongly installed shall be removed and reinstalled to comply with the design requirement at the Contractor's expense, to the satisfaction of the Owner/ Consultant.
- 2.10.17 Before erection of any equipment on a foundation, the Contractor shall check and undertake if necessary rectification of foundation bolts, reaming of holes, drilling of dowels, matching of bolts and nuts, making new dowel pin, etc.
- 2.10.18 Assistance for calibrating/testing the power cylinders, valves, gauges, instruments, etc., and setting of actuators coming under various groups shall be provided by Contractor.
- 2.10.19 It shall be the responsibility of the Contractor to provide ladders on columns for initial works till such time stairways are completed. For this, the ladder should not be welded on the column and should be prefabricated clamping type. No temporary welding on any structural member is permitted except under special circumstances with the approval of Owner.
- 2.10.20 Structural materials required for the supporting/operating platforms required for the valves at various levels for the same operation of valves will be arranged by the Contractor.
- 2.10.21 For civil, structural and architectural works, volume VII-A, VII-B, VII-C may be referred. For Instrumentation and Electrical works Vol. VI, V-A and V-B may be referred.
- 2.11.00 **Safety**
- Safety and overall cleanliness of work site shall be given top priority.
- 2.11.01 The Contractor shall ensure the safety of all workmen, materials and equipment either belonging to him or to others working at site. He shall observe safety rules & codes applied by the Owner at site without exception.
- 2.11.02 The Contractor shall notify the Owner of his intention to bring to site any equipment or material which may create hazard. The Owner shall have the right to prescribe the conditions under which such equipment or material may be

handled and the Contractor shall adhere to such instructions. The Owner may prohibit the use of any construction machinery, which according to him is unsafe. No claim for compensation due to such prohibition will be entertained by the Owner.

- 2.11.03 Storage of petroleum products & explosives for construction work shall be as per rules and regulation laid down in Petroleum Act, Explosive Act and Petroleum and Carbide of Calcium Manual. Approvals as necessary from Chief Inspector of Explosives or other statutory authorities shall be the responsibility of the Contractor.
- 2.11.04 The Contractor shall be responsible for safe storage of his and his sub-contractor's radioactive sources.
- 2.11.05 All requisite tests & inspection of handling equipment, lifting tools & tackle shall be done by the Contractor and certified copies shall be supplied to the Owner. Defective equipment shall be removed from service. Any equipment shall not be loaded in excess of its recommended safe working load.
- 2.11.06 All combustible waste and rubbish shall be collected and removed from the worksite at least once each day. Use of undercoated canvas paper, corrugated paper, fabricated carton, plastic or other flammable materials shall be restricted to the minimum and promptly removed.
- 2.11.07 The Contractor shall provide adequate number of fire protection equipment of the required types for his stores, office, temporary structures, labour colony etc. Personnel trained for fire-fighting shall be made available by the Contractor at site during the entire period of the Contract.
- 2.11.08 All electrical appliances used in the work shall be in good working condition and shall be properly earthed. No maintenance work shall be carried out on live equipment. The Contractor shall maintain adequate number of qualified electricians to maintain his temporary electrical installation.
- 2.11.09 All workmen of the Contractor working in construction site shall wear safety helmets, safety boots and safety belts. The Contractor shall take appropriate insurance cover against accidents for his workmen as well as third party.
- 2.11.10 All the worksites shall be provided with adequate lighting facilities e.g. flood lighting, hand lamps, area lighting etc. by the Contractor for proper working environment during night times.
- 2.11.11 All safety precautions shall be taken for welding and cutting operations as per IS-818.
- 2.11.12 All safety precautions shall be taken for foundation and other excavation marks as per IS-3764.
- 2.12.00 **Taking Delivery & Storage**
- 2.12.01 The Contractor shall arrange issue of all equipment and materials to be erected under the contract from the stores/open yard at site by signing on standard indent forms. After completion of work, detailed auditing of the

materials so issued shall be submitted to the Owner.

- 2.12.02 The Contractor shall arrange for proper and safe storage of materials till the same are taken over by the Owner as per terms of the contract. Manufacturer's instructions for preservation shall be strictly followed.
- 2.12.03 All empty containers, packing materials, gunny bags, transport frames and also surplus and unused materials reconciliation prior to completion of contract shall be the property of the Owner and returned to the Owner by the Contractor.
- 2.13.00 **Site Welding & Heat Treatment**
- 2.13.01 Welding shall be done in accordance with IS-813, IS-816, IS-9595 & other relevant IS/International standards and as per instructions of Contractor. Only those welders, who are qualified as per IS-817 for ordinary welds and as per IBR/ASME Section-IX for high pressure welds, shall be employed in the job.
- 2.13.02 All welders shall be tested and approved by Engineer before they are actually engaged on the work even though they may possess the requisite certificates. The Owner reserves the right to reject any welder without assigning any reason. The welder identification code as approved by the Engineer shall be stamped by the welder on each joint done by them. The Contractor will be responsible for the periodic renewal, re-testing of the welders as demanded by Owner.
- 2.13.03 The Engineer is entitled to stop Contractor's any welder from his work if his work is unsatisfactory for any technical reason or there is a high percentage of the rejection of joints welded by him, which in the opinion of Engineer will adversely affect the quality of welding even though the welder has earlier passed the tests. The welders having passed the tests do not relieve the Contractor from his contractual obligations, to check the performance of the welders.
- 2.13.04 All charges for testing of welders including destructive and non- destructive tests if conducted by Owner or by the inspection authority at site shall have to be borne by the Contractor. The necessary test materials and consumables will have to be arranged by the Contractor and all testing facility made available, as required.
- 2.13.05 All welded joints shall be subject to acceptance by Engineer. Inspection of welds shall be in accordance with IS-822 or equivalent code.
- 2.13.06 Preheating/post heating and stress relieving after welding are part of fabrication and erection work and shall be performed by the Contractor in accordance with the instruction of Engineer. Contractor shall arrange to supply heating equipment with automatic recording devices. Also the Contractor shall have to arrange for the labour, heating elements, thermocouples, compensating cables, insulation materials like mineral wools, asbestos cloth, ceramic beads, asbestos rope, etc. required for the heat-treatment and stress relieving works. During pre- heat/stress relieving operations, the temperature shall be measured at one or more points as required by attaching thermocouples and recorded on a continuous printing

type recorder. All the record graphs for the heat treatment works carried out shall be got signed by the Engineer prior to the commencement of each cycle and handed over to Engineer on completion. The graphs will be the property of Owner. The Contractor has to provide thermo-chalks temperature recorders, thermocouple attachments, units, graph sheets, etc. required for the job and maintain them in good condition.

- 2.13.07 All electrodes shall be baked and dried in the electric/electrode drying oven to the required temperature and for the period specified by the Engineer before they are used in erection work. The electrodes used shall be as per IS-814, IS-815, IS-1442, IS-7280 and other codes as applicable, and shall be of approved reputed manufacture. The electrodes shall meet the requirement of the pipe material. No electrode manufactured more than 12 months ago and the type covered under certificate issued after conducting tests more than 6 months ago shall be used. All electrodes shall be preserved at works and at site as per manufacturer's recommendations.
- 2.13.08 Oxy-acetylene flame or Exothermic chemical heating for stress relieving is not permitted. Heating shall be by means, of electric induction coil or electric resistance coil.
- 2.13.09 It may become necessary to adopt inter layer radiography/MPT/UT depending upon the site/technical requirement necessitating interruptions in continuation of the work and making necessary arrangement for carrying out the above work.
- 2.13.10 Gas tungsten arc welding process (TIG) shall be adopted for all root pass welds except for structural works until 4.75 mm thickness is deposited. Subsequent welding after root pass can be carried out by manual metal arc welding with coated electrodes. For pipes of thickness less than 6 mm the entire welding has to be carried out by TIG welding.
- Fillet weld shall be made by shielded metal arc process as per applicable codes.
- However, the Engineer will have the option of changing the method of welding as per site requirement. The method adopted for manual arc welding shall be weaving technique and the width of weaving shall not exceed 1.5 times of the dia. of the electrode.
- In case of deviation from welding process and electrodes, the Contractor shall take approval of the Owner prior to adoption of same.
- 2.13.11 The root pass for butt joints shall be such as to achieve full penetration with complete fusion of root edges.
- 2.13.12 Each pass shall be cleared and freed of slag before the next pass is deposited.
- 2.13.13 On completion of each run, craters, weld irregularities, slag etc. shall be removed by grinding or chipping.
- 2.13.14 Each layer of welding shall have an even and smooth appearance.

- 2.13.15 Welding sequence shall be adjusted in such a way that distortion due to welding shrinkage is minimised. Further any movement, shock or vibration during welding shall be avoided to prevent weld cracks.
- 2.13.16 Proper protection of welders and the work shall be taken during periods of rain. No welding shall be carried out when surface to be welded are wet from any cause.
- 2.13.17 Following will be stages of inspection during welding :
- a) Two pieces to be joined shall be individually checked for the weld edge preparation and profile dimensionally and to the template. Dye penetrant check shall be carried out on edge prepared surfaces at random. The percentage will depend upon on criticality as specified by Engineer.
 - b) Joint fit up will be a stage of inspection. Misalignment after fit up may vary from 0.3 mm to 1.6 mm depending on outside diameter and thickness.
 - c) All joints shall be offered for visual inspection after root run. Subsequent welding should be made only after the approval of root run.
- 2.13.18 All welded joints shall be painted with anti-corrosive paint immediately on completion of radiography and stress-relieving.
- 2.14.00 For further details on procedures of work at site on civil, architectural, electrical and instrumentation & control services, refer Volume : V, VI & VII of this specification.
- 3.00.00 **PROJECT INFORMATION AND MANAGEMENT SYSTEM, INCLUDING DCOUMENT MANAGMENT SERVER (DMS)**
- 3.01.00 Contractor shall submit as part of its Work Scope detailed documentation as outlined in this section and / or required by the Technical Requirements. The content and format of the documentation to be submitted are subject to Owner's approval.
- 3.02.00 Contractor shall utilise a computer based system for control and management of project documentation. The system must be capable of producing customized reports and information on demand. This control system should have been successfully applied to similar projects and be familiar to the project control personnel selected. Contractor's detailed project documentation plan shall identify all documentation requirements for the project, the party responsible for production of the document, the basic content of the document and the required timing for issue. This plan shall include, but not be limited to the details of all Drawings to be produced, plant specification / definition documentation, equipment orders and manuals. The documentation identified shall be entered into the computer based control system The database thus created shall be capable of being sorted and

ordered on a variety of selected parameters such as document type, subject description, responsible party, start date and finish date, to enable review and update to be conducted only on those documents which are relevant.

3.03.00 Regular documentation control progress reports shall be prepared by the Contractor to record the status of documentation. In the event either Party or Engineer expresses concern with the content of such progress reports, the accuracy of progress reports, status of documentation production and other such matters, the concern will be identified to the Project Manager. Within five days of notification of this concern, the Project Manager will attend a meeting with relevant Owner Representatives and provide details of specific actions to be initiated to satisfactorily overcome the difficulties identified. It will be the Project Manager's responsibility to initiate whatever action is necessary to ensure that the production of documentation is completely in accordance with Project Information Management System (PIMS).

3.04.00 Within 90 days after Effective Date of Contract, the Contractor shall establish an integrated PIMS which will support the needs of Project and management, detail design and engineering, procurement, construction and operation, and maintenance.

PIMS shall utilise software which links various software and database programs to form a composite system. The typical scope of PIMS shall include, but not be limited to, the following:

- (a) Power plant systems and equipment data, from which Project specific flow diagrams, data sheets and other integrated data are derived. The Power plant systems and equipment data, from which Project specific flow diagrams, data sheets and other integrated data are derived. This data shall include, but not be limited to, the following:
 - (i) System descriptions and design requirements and design criteria
 - (ii) Equipment and material technical specifications for all engineering disciplines
- (b) Detail engineering data to create flow diagrams, plant arrangements, piping configurations, equipment layout and design, electrical and instrumentation systems, structures, and other systems. The software tool used shall be capable of manipulation and storage of plant layout and design information. The 3D model of the plant shall also contain details of the various components like pipe, structural steel work, etc., and relevant information shall be available on-line from relevant data base. Software shall be multi-user, multi-access nature allowing the designers of Contractor and major Sub-Contractors, if required, to work in interactive real time environment and software shall be capable of interference checking. The software shall allow access to different types of information held in the database. It shall estimate the type and quantity of materials required to build the plant and it shall be possible for such data to be taken off the system at any time.

- (c) Construction data to monitor and manage site activities, including material control, scheduling and progress, quality control, start-up and testing, operation, maintenance, training, and all other site functions.
- (d) Plant design and construction records to provide data for safe and efficient maintenance and operation. Records to include may be maintenance schedule, man power tracking, tools, spare parts, and test equipment inventory, equipment list, drawing, control, technical specifications, and equipment instruction manuals.

3.05.00 The PIMS shall be installed in a distributed processing array system and operated through personal computer work stations at the Contractor's site office. A complete integrated system shall be implemented. This system shall be utilised by Contractor during the Project execution.