Bharat Heavy Electricals Limited
(A Govt. Of India Undertaking)

Project Engineering Management

OPEN TENDER ENQUIRY FOR VENTILATION SYSTEM FOR 1X 800 MW GSECL WANAKBORI STPP UNIT 8

Ref No. : PE/PG/WAN/E-5128/2015 **Date: 31.12.2015**

CORRIGENDUM/ ADDENDUM- 1

Tender Enquiry no.: PE/PG/WAN/E-5128/2015
Date: 18.12.2015,

DUE DATE
08 Jan 2016
10:00 AM

Sir,

Please find attached Addendum no. 01 of TECH SPEC No. PE-TS-408-554-A001 of VENTILATION SYSTEM along with this corrigendum. The same is also available at technical specification section of below mentioned websites.

All bidders are requested to visit BHEL websites www.bhel.com (Tender Notifications Section) OR www.bhelpem.com (http://www.bhelpem.com/Tenders_Rev/NewTenders.aspx), all future corrigendum, addendums, amendments, if any, for this tender shall be hosted only on above websites

Thanking you,

Yours faithfully,
For and on behalf of BHEL

SHRI PRAKASH YADAV

Digitally signed by SHRI PRAKASH YADAV
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WANAKBORI STPP
(1 X 800 MW)

ADDENDUM No. 1

(TECH SPEC No. PE-TS-408-554-A001)

VENTILATION SYSTEM

(PAGES ATTACH BELOW SHALL BE CONSIDERED AS PART OF PAGE NUMBER 39 SECTION C2A)

VOLUME: IIK/4

SECTION-II

TECHNICAL SPECIFICATION FOR VENTILATION SYSTEM

CONTENTS

VOLUME: IIK/4

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 (Unit #8 at Wanakbori Thermal Power Station, Gujrat) 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 Turbine Building:

i) TG Hall

ii) MCC, Switchgear rooms and cable spreader rooms

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

i) Battery Rooms

ii) Battery Charger Rooms

iii) Coal Conveyor Tripper floor

iv) Elevator Machine Rooms

v) AC Plant Room

vi) Toilets

1.04.00 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 ESP and AHP Control Building.

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

a) CW Pump House

b) DM Plant

c) Chemical House and Pre-treatment Plant

d) Ozonisation Plant

e) Fuel Oil Pressurizing Pump house

f) Fuel Oil Transfer Pump House

g) Fire Water Pump House

h) HCSD Pump House

i) Clarified Water Pump House

j) Ash Water Pump House

k) Ash Compressor Building

l) DG and Compressor Building

m) Silo Utility Building

n) Effluent Treatment Plant

o) Recycle Water Pump House

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 Turbine 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 overpressure 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 over De-aerator floor and two (2) being located outside A row of TG 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 exhausters 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. All accessories (except water circulation pumps with drive motors, strainers and some portion of piping) shall be placed inside the AWU casing.

Adequate numbers of exhaust fans are to be provided at TG building & other buildings roof with rain water protection cover.

2.02.00 Exhaust (pull type) ventilation system is adopted for the Battery Rooms by providing three numbers (each of 50% capacity) or two numbers (each of 100% capacity) Bifurcated type axial flow exhaust fans 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 third 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.

2.03.00 Coal conveyor floor and Coal Terminal Room 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 Exhaust ventilation system shall be provided in the AC plant room by installing wall mounted type exhaust fans. Air will enter in the AC plant room through inlet louver.

2.07.00 In the MCC/ switchgear room of ESP & AHP Control Building of each unit, washed and filtered air supply will be provided by the Unitary Air Filtration Unit (1 x 100% or 2 x 50% capacity) due to the reasons that the this building is located in a very dusty zone and heat load of this Building is high.

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2.08.00 Ventilation provision for Auxiliary Buildings in various locations shall be done as follows:

Electrical MCC/Switchgear areas of ESP & AHP Control Building.	Washed and filtered air supply from Unitary Air Filtration Unit (UAF) and exhausting it by back Draft Dampers.
CW 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.
Fuel Oil Pressurizing Pump house	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.
Fuel Oil Transfer Pump house	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.
Fire 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.
DM Plant	Wall mounted Exhaust Fans for Plant area and Chemical Storage area and fresh air entry through Inlet Louvers.
Chemical House	Wall mounted Exhaust Fans for toner and Chlorination area and fresh air entry through Inlet Louvers.
Pre-treatmentplant Two storied chemical House	Wall mounted Exhaust Fans and fresh air entry through Inlet Louvers.
Chlorination Plant	Wall mounted Exhaust Fans and fresh air entry through Inlet Louvers.
Ozonization plant	Dry ventilation system shall be envisaged.
Clarified Water Pump house	Wall mounted supply fans for the pump

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	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.
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.
Ash 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.
DG and Compressor Building	Wall mounted exhaust fans for the DG area and fresh 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.
Silo Utility Building	Wall mounted supply fans for the pump area. Hot air will be exhausted through wall mounted louvers. For Electrical room and cable spreader room-Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers.
Effluent Treatment Plant House	Wall mounted supply fans for the pump area. Hot air will be exhausted through wall mounted louvers. For Electrical room and cable spreader room-Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers. Battery room wall mounted exhaust fans

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	with fusible link type fire dampers and air entry through wall mounted louvers shutter.
Recycle Water Pump House	Wall mounted supply fans for the pump area. Hot air will be exhausted through wall mounted louvers. For Electrical room and cable spreader room-Pressurized ventilation with wall mounted fan filter units and air exhaust through back draft dampers. Battery room wall mounted exhaust fans with fusible link type fire dampers and air entry through wall mounted louvers shutter.
Service and Technical Building	For Toilet, Locker Room, Store, Tool Room etc. Wall mounted Exhaust fans and air entry through door grilles / inlet louvers.
HCSD 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.
Toilet	Exhaust Ventilation system shall be provided for the Toilet by installing wall mounted type exhaust fans. Air will enter the toilets through door grilles.

2.09.00 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 their ventilation system.

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.

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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 (wherever required) for air supply to electrical rooms through fan filter unit.

h) Back draft dampers, wherever specified.

i) Protective wire netting inside the room, wherever required.

3.01.03 Roof mounted axial flow fan 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.

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d) Short duct mounting 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 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 air flow.

c) Two numbers Horizontally Split casing type Centrifugal pump sets (one running and one standby) complete with drive motor for circulation of water through the above spray header bank and provided with pot type suction strainer with bypass valves, inlet and outlet pressure gauges and filter back wash arrangement.

d) Fill deck shall be made of impregnated and corrugated cellulose paper sheets bonded together with insoluble anti-rot salts, rigidifying saturants and wetting agents and assembled in self supporting pads of cross fluted configuration with flute angle 45˚/45˚.

e) Two numbers Centrifugal Mono-bloc pump sets (one running and one standby) for circulation of water through the above fill deck and provided with pot type suction strainer with bypass valves, inlet and outlet pressure gauges.

f) Moisture eliminator sets of die-extruded PVC construction.

g) Inspection doors and marine lights for different sections and cat walks as required.

h) 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.

i) Double inlet Double width Centrifugal fans (2 X 50%) each 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.

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j) Air washer casing of 4 mm thick 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 insulated with 25 mm thick expanded polystyrene covered with 500G polythene sheet, chicken wire mesh and 12 mm thick sand cement plaster.

Air Washer Sump made out of 5mm thick MS construction and duly spray galvanized / 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. The sump height shall be at least 600mm.

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 shall be of sheet metal (2mm MS) construction while the water sump shall be constructed from 3mm thick MS sheet. 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. The sump height shall be at least 600mm.

Top Surface of the UAF shall be insulated with 25 mm thick expanded polystyrene covered with 500G polythene sheet, chicken wire mesh and 12 mm thick sand cement plaster.

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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 (1 X 100%) 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.

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) 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) 25 mm thick Self extinguishing grade of Expanded Polystyrene insulation conforming to IS - 4671 shall be provided on all ducting exposed to atmosphere. Such Insulation shall be covered with 500 Gauge Polythene sheet, chicken wire mesh, 12mm thick sand cement plaster and an overall cladding of 28 G GI sheet.

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 control building).

The signal from smoke detectors / thermal sensors (to be provided by purchaser 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.

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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 ± 10% volt, 50 ± 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.

i) Back draft dampers will be provided at the air outlet areas where pressurized ventilation has been envisaged and as mentioned in fan schedule.

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 all 3 phase Ventilation fans except AWU and UAF units.

3.01.10 Switch for Single Phase Ventilation Fans.

3.01.11 Power and Control Cabling and Grounding details.

3.01.12 Installation of all equipment supplied by bidder.

3.01.13 Anchor bolts, nuts and bolts and loose fitting as would be necessary for erection and commissioning.

3.01.14 One complete set of tools and tackles.

3.01.15 One set of recommended spare parts for trouble free operation of the system together with mandatory spare parts as specified.

3.01.16 Cleaning protection and painting as specified herein.

3.01.17 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 plant shall also be included in the scope of the specification.

3.01.18 Provision for Fan/Pump running indication in respective Unit Control Room for Air-Washers located in Power House shall be made available.

3.01.19 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 it's 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 Cell deck pump motor of the AWU and shall be used in electrical areas. Humidity beyond 60% RH in these ventilated spaces shall automatically trip the respective cell deck pump. The pump may be restarted automatically at about 50% RH. However, manual over-ridding facility shall be provided for these humidistat controlled pumps. Selection and starting of stand-by pump shall be manual.

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. PUMP – 3 RUNNING (FOR CELL DECK ARRANGEMENT APPLICABLE TO AIR AWSHER UNIT ONLY).

VIII. PUMP – 3 STOP (FOR CELL DECK ARRANGEMENT APPLICABLE TO AIR AWSHER UNIT ONLY).

IX. PUMP – 4 RUNNING (FOR CELL DECK ARRANGEMENT APPLICABLE TO AIR AWSHER UNIT ONLY).

X. PUMP – 4 STOP (FOR CELL DECK ARRANGEMENT APPLICABLE TO AIR WASHER UNIT ONLY).

XI. FAN MOTOR OVER LOAD TRIP.

XII. PUMP - 1 MOTOR OVER LOAD TRIP.

XIII. PUMP - 2 MOTORS OVER LOAD TRIP.

XIV. PUMP - 3 MOTOR OVER LOAD TRIP (APPLICABLE FOR AIR WASHER UNIT ONLY).

XV. PUMP - 4 MOTOR OVER LOAD TRIP (APPLICABLE FOR AIR WASHER UNIT ONLY).

XVI. RH HIGH.

XVII. RH LOW.

XVIII. SUMP WATER LEVEL LOW.

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 Purchaser's 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 Purchaser's 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.

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5.00.00 **DESIGN CRITERIA**

5.01.00 The weather report of the place shall be considered as follows:

Summer: 43.3 Deg. C (DB), 25.6 Deg. C (WB)

Monsoon: 32.2 Deg. C DB, 28.3 Deg. C WB

Winter: 15.6 Deg. C DB, 10.6 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 5°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 3ºC 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 exhausters wall exhaust fans/louvers/back draft dampers.

In Powerhouse building, where this type of ventilation has been used, actual temperature at the ground floor (0.0 M), mezzanine floor and operating floor level shall be less. The relative humidity should be kept within 50%-60% through proper control of Air Washer pump operation.

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 in line with Clause No. 1.05.00. Areas not covered in these places but require ventilation should also be ventilated.

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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 control building	15
Chemical House	20
DM plant	10
Fuel oil pressurizing pump house	20
Fuel oil transfer pump house	20
Chlorination Plant	20
Stores	2
DG building	10
Compressor house	15
Pump Houses	10
Electrical Rooms associated with the pump Houses	15
Electrical Rooms for all Auxiliary Buildings	15
Toilets	20
Pantries	20
Kitchen	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.

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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 designs 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 exhausters / supply fans and wall exhausters/supply fans are of direct drive axial flow type. Roof exhausters/supply fans shall have multi-bladed impeller with a short duct casing while wall exhausters/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.

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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 exhausters/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 exhausters/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 exhausters/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 exhausters 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 exhausters shall be provided with coned inlet made of M.S.

6.02.14 Inlet Screen

Inlet screen shall be manufactured of min. 14 SWG galvanised 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.

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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 exhausters / 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. multigrooves (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	:	Galvanised 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, tank, associated pumps and fans.

II. The air washer unit shall be designed as Cell 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

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cleanable type Stainless Steel mesh Filters complete with SS / Aluminium frame continuously flooded with water through Stainless Steel water spraying Nozzles, fill deck of cross fluted configuration assembled in self supporting pads made of cellulose paper duly impregnated with insoluble anti-rat salts, rigidifying saturants and wetting agents, Die-extruded PVC 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 within the space shown in the drawing. The outside dimensions are unavoidable restraints and cannot be altered. 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.

VII. To protect the equipment located in the ventilated space from effects of high humidity, control device using Humidistat interlocked with the Pump Motor of the Fill Section shall be used in the electrical areas. Humidity beyond 60% RH in these ventilated spaces shall automatically trip the respective Pump set. The pump may be restarted automatically at about 50% RH. However, manual over riding facility shall be provided for humidistat controlled Pump sets of the air Washer Unit. At least two (2) nos. Humidistat (RH High and Low) shall be provided for each Air Washer Unit.

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 a spray header bank in the direction of airflow. The water will be collected in a MS fabricated 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. The arrangement of spray nozzles for all Air Washer shall be with direct spray on the flooded type Stainless Steel Filters. 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 Fill Section

The fill section consists of a perforated Fiber glass Reinforced Plastic (FRP) trough over the fill deck covering the top surface of the fill section (Maximum allowable height of each Fill section will be 2000 mm) for proper distribution of water through cellulose fills. These fills should be of specially impregnated and corrugated cellulose paper sheets bonded together with flute angle $45^0/45^0$. In case the height of the Fill Section exceeds 2000 mm, double deck arrangement with a separate water trough shall have to be provided. The air velocity through the Fill Section will be limited to of 2.25 M / Sec (maximum).

The required quantum of water will be taken to the trough with the help of a Mono-bloc Centrifugal Pump set and medium class internal GI piping.

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6.03.05 Pumps (for filter washing & fill section)

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

The required quantum of water will be taken to the trough with the help of a Mono-bloc Centrifugal Pump set and medium class internal GI piping.

Details on pumps are furnished under separate clauses.

6.03.06 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 30^0 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.

6.03.07 Centrifugal Fans

Details of fans are furnished under separate clauses.

6.03.08 Casing & Tank

The equipment shall be located within the sheet metal fabricated casing (4mm thick) 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 the 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 insulated with 25 mm thick expanded polystyrene covered with 500G polythene sheet, chicken wire mesh and 12 mm thick sand cement plaster.

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This air washer tank shall be common for both the Filter section and Fill 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 also shall be made from minimum 5 mm thick MS sheet duly 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 2 mm thick 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 sump made from minimum 3 mm thick MS casing duly painted with epoxy resin based paint and bled off to the drain in small quantity.

Top Surface of the AWU shall be insulated with 25 mm thick expanded polystyrene covered with 500G polythene sheet, chicken wire mesh and 12 mm thick sand cement plaster.

6.04.06 The drain pan shall be provided with overflow pipe terminating to the nearest drain point (provided by the Purchaser). 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.

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6.05.00 **Water Pump**

6.05.01 Each water circulating pump set shall be of horizontal split casing, centrifugal type, directly coupled to electric drive motor and mounted on a common base plate. However, pumps having motor of 5 HP capacity 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 & 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 for Horizontal Split casing Pump sets. 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.

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- 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 100 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.

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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 ±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.

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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.

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	40mm x 40mm x 6mm 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.

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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.

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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 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 for Air Washer unit is required to be insulated with 25 mm thick self extinguishing type Expanded Polystyrene or equivalent insulating material conforming to IS-4671.

6.10.02 Insulation shall be lined as per manufacturing recommendation. Insulation roll or slab shall be attached with ducting with bitumen (85/25 or 85/40) or CPRX sticking compound of Shalimar Tar Products or approved equivalent. Insulation clips shall be used as necessary.

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6.10.03 The insulation shall be covered with 500 gauge polythene sheet, G.I. chicken wire mesh and 12mm thick sand cement plaster and an overall cladding of 28 SWG GI Sheet.

6.10.04 Extra insulation thickness shall be provided at the duct hangers and special care shall be taken to seal the insulation and hanger member penetration and instruments and accessories tapping.

6.10.05 Insulated duct crossing the floor, if any, shall have to be normally protected from damage and water splashing by providing suitable cladding up to 300 mm from the floor level.

6.10.06 Top Surface of the AWU & UAF shall be insulated with 25 mm thick expanded polystyrene covered with 500G polythene sheet, chicken wire mesh and 12 mm thick sand cement plaster.

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.
- All motors shall have 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 up to 250 watts and up to 160 KW shall be suitable for 415V±10%, 3-Phase, 50Hz±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.

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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 SFU for incoming power supply, AL Bus Bars , outgoing SFU 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, controls and interlocks for Humidistat etc.
- Stop P.B. shall be pressed to latch and turn to release type.
- Control Voltage at LSCP shall be 240V, 1Ph, 50HZ.
- 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.
- Auto-manual selector switch, auxiliary relays/contactors as required for RH control shall be provided in each LSCP. However manual overriding facility shall be provided for Humidistat controlled spray pumps
- 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 motorised 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 Turbine 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 SFU for incoming power supply, AL Bus Bars , outgoing SFU 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 by the purchaser from their nearest Distribution board.

V. Cabling and Grounding.

All power and Control Cabling and Grounding will be provided for the ventilation system. All LT cables shall be FRLS type.

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.

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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.

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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 IS0–1940.

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 hall 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.

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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

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Painting of all surfaces shall be checked for shade, surface finish, uniformity, coating thickness (DFT) and adhesion test/peal 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 as specified in the specification.

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

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.

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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 Turbine Building, ESP & AHP 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.

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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.

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