

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

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

3.01.06 GI sheet steel fabricated ducting including the following:

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

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

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

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

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

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

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

4.00.00 **CONTROL PHILOSOPHY**

4.01.00 Ventilation fan motors

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

4.02.00 Air Washer / UAF Units

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

a) Humidity Control (applicable for Air Washer)

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

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

b) AWU / UAF Unit Sump Water Level Control

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

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

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

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

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

d) Motorized Fire Dampers

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

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

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

5.00.00 **DESIGN CRITERIA**

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

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

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

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

5.02.00 **Inside Design Condition**

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

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

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

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

Note:

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

6.00.00 **DESIGN AND CONSTRUCTIONAL REQUIREMENT**

6.01.00 **General**

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

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

6.02.09 Impeller

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

6.02.10 Casing

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

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

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

6.02.11 Bearing

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

- 6.02.12 Roof extractors/wall mounted fans (if located on the exposed wall) shall be provided with hood for protection against rain and other contingencies. It must ensure no dripping of rainwater under any circumstances and will have low-pressure drop of air. The hoods shall be provided with a heavy gauge expanded metal bird screen. Axial flow fans should be fitted with protective screens from inside of room.

Rain protection cowls will be designed to suit wall mounted exhaust/supply fans for protecting fans from rain. The cowls will be provided with bird screen of heavy gauge expanded metal netting.

A typical sketch enclosed herewith shows arrangements for both roof extractors and rain protection cowl. Any other approved design for the hoods and cowls can be considered. Grouting frames for the cowls if required shall be included in the supply along with nuts and bolts.

- 6.02.13 Coned Inlet

Wall mounted exhaust fans shall be provided with coned inlet made of M.S.

- 6.02.14 Inlet Screen

Inlet screen shall be manufactured of min. 14 SWG galvanized wire knitted in 1" square mesh. Suitable flanges to protect the edges of the screen shall be provided.

- 6.02.15 Vibration Isolator

Double deflection rubber in shear or rubber in compression type vibration isolators shall be provided with each centrifugal fan and each axial flow fan. Rubber bushes, washers, wherever needed for the vibration isolators shall be included in the supply. Sufficient number of such isolators shall be provided to ensure isolation of foundation from vibration of the equipment.

- 6.02.16 Fans For Special Application

Fans for battery room, oil rooms and fuel stores shall be of spark proof construction. These axial flow type fans shall be bifurcated type construction with motor away from air stream. Motors for these fans shall be of flameproof construction.

All fans for special application shall have all accessories as mentioned in the Specification.

- 6.02.17 Fan Drive

- a) Centrifugal fans shall be provided with V-belts and sheaves. All belts shall be sized with minimum 1.5 service factor. All V-belt drives shall be equipped with removable guards that do not impede the air flow to the fan inlet. There shall be a minimum of two belts per drive. All pulleys should have threaded puller holes for the ease of their extraction.

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

6.02.18 Materials of Construction

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

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

6.03.00 **Air Washer Units**

6.03.01 General

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

6.03.02 Filter Section

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

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

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

6.03.03 Spray Arrangement

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

6.03.04 Pumps

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

Details on pumps are furnished under separate clauses.

6.03.05 Moisture Eliminator Sets

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

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

6.03.06 CENTRIFUGAL FANS

Details of fans are furnished under separate clauses.

6.03.07 CASING & TANK

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

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

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

6.04.00 **UNITARY AIR FILTRATION UNIT**

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

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

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

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

Details on pumps are furnished under separate clauses.

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

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

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

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

Details of fans are furnished under separate clauses.

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

6.05.00 **WATER PUMP**

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

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

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

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

Pump shall be rated for continuous operation.

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

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

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

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

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

6.05.08 Each pump shall be complete with the following accessories:

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

- Non-return (check) valve at the discharge side of the pump set.
- Base plate, coupling, coupling guard, anti-vibration mountings and foundation bolts.
- All integral piping required for sealing, cooling, casing, drains and vent connections.

6.05.09 The design of the pumps shall conform to the relevant IS Code, Standards of Hydraulic Institute of U.S.A. or approved equivalent.

6.05.10 Pump motor will be selected on the basis of 15% margin over the shaft power consumption or more than the limit load of the pump which ever is higher. For other electrical particulars of the motor refer detailed specification of the motors.

6.05.11 Major rotating components of the pumps like impellers, balancing drums etc. shall be individually balanced statically and finally each pump shall be dynamically balanced.

6.05.12 The critical speed of the pump shall be at least 20% above the operating speed.

6.05.13 All pumps and motors shall be aligned properly, and bolted and doweled to a common base frame.

6.06.00 **WATER PIPING**

6.06.01 Water piping for 150 NB or below GI-Heavy Class conforming to IS-1239, Part-I. For higher sizes black steel pipe, heavy grade conforming to IS-3589, Fe 410 grade shall be supplied. Drain water piping shall be of M.S. heavy grade.

6.06.02 The piping shall be so designed that the water velocity through the piping shall not exceed 2.5 m/sec and also the piping friction drop shall be limited to 4 m per hundred meter of pipe length. Pipe sizes, if indicated in tender drawings shall be followed.

6.06.03 The pipes shall be of plain end in case of M.S. Pipes (i.e., suitable for welded connections) as far as possible.

6.06.04 Counter-flanges for connecting to flanges on valves or equipment shall be made of IS-2062 or superior and shall preferably be slip on type, suitable for welding on the piping in case of M.S. Piping.

6.06.05 All bolts and nuts for flange connection shall be hexagonal carbon steel type as per IS-1363 and with the material and other requirements as per IS-1367. All threaded valves shall be provided with nipples and flanged pairs on both sides to permit flanged connections for ease of removal / replacement of valves.

6.06.06 Bends, fittings fabricated at site is not acceptable. The Contractor shall use the standard fittings / bends, as per IS-1239, Part-II.

- 6.06.07 Spacing and location of hanger shall conform to preferred engineering practice. Hangers and supports shall be made up of structural steel sections. The design of the hangers and supports shall provide for suitable protection to insulation on the pipes, wherever applicable. All materials for anchoring the hangers with reinforced concrete work or building structural beams and columns shall be furnished by the Bidder. The supports within the plant room shall be of structural / pipe supports from the floor and is to be provided by the Contractor.
- 6.06.08 The flanged joints for water line will use canvas, impregnated rubber gasket. Compressed fiber gaskets shall be used with flat face flanges and raised face slip-on flanges. Spiral wound gaskets shall be used with raised face flanges, except for raised face slip-on flanges. Gaskets containing asbestos are not acceptable.

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

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

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

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

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

6.06.11 Piping arrangement and alignment shall be as per layout.

6.07.00 **VALVES & ACCESSORIES**

6.07.01 General

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

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

6.07.02 Gate Valves

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

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

6.07.03 Wafer Type Butterfly Valves

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

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

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

6.07.04

Globe Valves

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

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

6.07.05

Check Valves

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

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

6.08.00 DUCT WORK

6.08.01 Duct Fabrication

I. General

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

II. Joints

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

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

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

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

- d) RIVETING AND SEALING

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

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

III. HANGERS AND SUPPORTS

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

IV. ACCESS DOORS

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

6.08.02 FLEXIBLE CONNECTION

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

6.08.03 VOLUME CONTROL DAMPER

I. SPLITTER DAMPER

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

II. OPPOSED MULTIPLE LOUVER DAMPER

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

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

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

III. GRAVITY OPERATED DAMPER

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

6.08.04 GRILLES & DIFFUSERS

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

6.09.00 DRY FILTER

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

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

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

6.10.00 **THERMAL INSULATION**

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

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

6.11.00 **Electrical items shall consist of:**

I. **DRIVE MOTORS**

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

- All motor enclosures located indoors shall conform to the degree of protection IP-55 unless otherwise specified. Motor for outdoor or semi-outdoor service shall be weather-proof construction.

II. Local Starter cum Control Panels (LSCP) for AWUs and UAF Units

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

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

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

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

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

V. Cabling and Grounding.

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

7.00.00 **SPECIAL TOOLS**

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

8.00.00 **TESTING & INSPECTION AT MANUFACTURER'S WORKS**

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

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

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

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

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

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

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

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

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

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

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

8.02.00 Routine Tests

8.02.01 Centrifugal Fan

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

8.02.02 Axial Flow Fan

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

8.02.03 Centrifugal Pump

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

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

8.02.04 Air Distribution System & Air Filter

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

8.02.05 Pipe and Fitting

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

8.02.06 Valve

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

8.02.07 Insulation

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

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

8.02.08 Air Washer Unit

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

8.02.09 Electric Motor

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

8.02.10 Local Starter cum Control Panel / Local Starter Panel

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

8.02.11 Cable Tray and Galvanizing Structure (if applicable)

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

test and Uniformity of Zinc coating as per relevant IS shall be conducted on cable tray and accessories.

8.02.12 Gauges, Switches, Instruments, etc.

Accuracy, calibration, repeatability, material, dimension, functional tests and other checks as applicable shall be checked.

8.02.13 Painting

Painting of all surfaces shall be checked for shade, surface finish, uniformity, coating thickness (DFT) and adhesion test/peel off test.

9.00.00 **FIELD TEST**

9.01.00 **Type Tests**

Bidder should have performed the applicable type tests as per the IS / applicable standards on various components of each type and rating. Reports not older than five years shall be submitted to this effect. All such type test reports shall be subjected to the approval of Purchaser. In case the bidder has to carry out these type tests, all such tests shall be done at bidder's risk and cost within the schedule specified herein. No deviation in this regard is acceptable.

9.02.00 **Field Test**

Overall performance of the ventilation system shall be tested after complete installation at site. This test shall be carried out to determine whether the plant meets the performance requirements specified here in and shall include measurements of all parameters under various outside conditions and establishment of correct supply of equipment. All testing and calibrating instruments required for this purpose shall be supplied by the contractor.

10.00.00 **PERFORMANCE GUARANTEE, TOLERANCE, PENALTY AND TEST RECORD**

10.01.00 The Tenderer shall have to guarantee the performance of individual equipment. The Tenderer shall also guarantee maintenance of the inside conditions and the minimum air changes as indicated under "design criteria".

10.02.00 The test shall be conducted at the manufacturer's works / site in accordance with the specification and if the shop / site performance tests indicate the failure of the guaranteed performance for the equipment concerned, it would be necessary for the manufacturer to make good the deficiency at its own cost by incorporating the necessary modification, alteration and replacement.

10.03.00 The additional test required to show the effect of such alteration shall be performed by the manufacturer at no expense to the purchaser.

10.04.00 **TEST RECORDS**

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

11.00.00 SPECIAL CLEANING, PROTECTION & PAINTING

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

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

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

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

12.00.00 DOCUMENTS, DATA TO BE FURNISHED WITH TENDER PROPOSAL

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

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

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

12.03.00 Characteristic curve of each pump.

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

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

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

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

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

14.00.00 LIST OF DRAWINGS

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



TECHNICAL SPECIFICATION
**1X800 MW KOTHAGUDEM
VENTILATION SYSTEM**

SPECIFICATION No: PE-TS-410-554-A001

VOLUME II B

SECTION C2-B

REV. 00

DATE: APRIL 2015

SECTION: C2-B

GENERAL TECHNICAL REQUIRMENT


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GENERAL TECHNICAL REQUIREMENTS

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SECTION-IV

GENERAL TECHNICAL REQUIREMENTS

1.00.00 CODES AND STANDARDS

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

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

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

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

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

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

2.00.00 RESPONSIBILITY FOR DESIGN

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


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

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

- 4.02.00 Ready and safe access with clear head room shall be provided to all parts of the plant for operation, inspection, cleaning and maintenance.
- 4.03.00 Escape routes and clear ways shall be provided to allow speedy evacuation of the plant in the event of fire or explosion, and the plant layout shall allow for ease of access to all parts of the Works by rescue and fire fighting teams. The plant layout shall be designed to localise and minimise the effects of any fire or explosion. The recommendations of NFPA, OSHA, and TAC etc. as necessary shall be followed in all respects.
- 4.04.00 The use of corrosive, explosive, toxic or otherwise hazardous materials shall be kept to a minimum during construction and the design of the plant shall minimise the requirement for such materials during operation and maintenance. Where such materials must be used, all necessary precautions shall be taken in the design, manufacture and layout of equipment to minimise the resulting hazard, and all equipment necessary for the protection and first-aid treatment of personnel in the event of accidents shall be provided. Particular attention is drawn to avoid the use of materials containing asbestos in any form.

5.00.00 **GUARDS**

- 5.01.00 Effective guards and fences must be provided to prevent injury to operators through accident or malpractice.
- 5.02.00 Mesh guards which allow visual inspection of equipment with the guard in place are generally preferable. The guards shall be constructed of mesh attached to a rigid framework of mild steel rod, tube, or angle and the whole galvanised to prevent loss of strength by rusting or corrosion. The guards shall be designed to facilitate removal and replacement during maintenance.
- 5.03.00 All drive belts, couplings, gears, sharp metallic edges and chains must be safely guarded. Any lubricating nipple requiring attention during normal running must be positioned where they can be reached without moving the guards.
- 5.04.00 Guards for couplings and rotating shafts shall be in accordance with BS 5304-1975 or similar approved standard. All rotating shafts and parts of shafts must be covered.
- 5.05.00 Suitable fencing shall be provided to enclose all openings or doorways used for the hoisting and lowering of machinery etc. This fencing must be securely fixed but quickly detachable when required. A secure hand hold must be provided on each side of the opening or doorway.

LOCATION AND LAYOUT REQUIREMENTS

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

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

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

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

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

elsewhere in this specification shall be complied with.

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

7.00.00 **OPERATION, MAINTENANCE & AVAILABILITY CONSIDERATIONS**

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

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

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

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

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

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

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

8.00.00 **MATERIALS**

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

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

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

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

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

9.00.00 **LUBRICATION**

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

9.02.00 Non ferrous capillary tubing shall be used throughout.

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

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

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

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

10.00.00 **LUBRICANTS AND CONTROL FLUIDS**

10.01.00 The Contractor shall provide a detailed and comprehensive specification for all lubricating oils, greases and control fluids required for the entire plant. A sufficient supply of these shall be provided by the Contractor for initial commissioning, first fill and till COD of the unit.

10.02.00 The Contractor shall supply a detailed schedule giving the lubricant testing, cleaning and replacement procedures. All equipment and facilities necessary for the testing, cleaning and changing of lubricants and control fluids shall be provided. The Contractor shall endeavor to reduce the varieties and grades of required lubricants and control fluids to a minimum, matching them where possible to those already in use in the generating station in order to simplify procurement and minimise storage requirements. All lubricants and control fluids shall be of internationally recognised standards and shall be easily obtainable from a large number of Indian suppliers. Bidder shall also indicate the equivalent Indian Standard for the above for easy procurement in future.

10.03.00 No lubricant or control fluid shall have toxic or other harmful effects on personnel or on the environment.

11.00.00 **OPERATION AND MAINTENANCE**

11.01.00 The plant shall be designed and constructed so that operation and maintenance manpower requirements are minimised.

The design and layout shall facilitate inspection, cleaning, maintenance and repair. The importance of continuity of operation is second only to that of safety.

11.02.00 Spare parts for equipment shall be interchangeable with the original components and, so far as possible, be of common design and manufacture.

11.03.00 All similar standard components/parts of similar standard equipment provided shall be interchangeable with one another. Further identical equipments shall be provided for similar duties so that the same are interchangeable with one another in totality and component wise.

11.04.00 All heavy parts (500 Kg and above) must be provided with a convenient arrangement for slinging and handling during erection and overhaul. Any item of plant normally stripped or lifted during periods of maintenance and weighing one tonne or above, shall be clearly marked with its weight.

11.05.00 On completion of commissioning, a complete set of tools for the maintenance of the entire plant shall be provided by the Contractor. This shall include all necessary spanners, special wrenches, extraction equipment and any special tools reasonably required by the Engineer. Tools used during erection and commissioning shall not be accepted except with the specific approval of the Engineer.

11.06.00 All equipment and major valves should be provided with adequate maintenance approach and facility.

12.00.00 PLANT LIFE AND MODE OF OPERATION

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

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

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

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

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

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

13.00.00 PACKAGING & MARKING

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

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

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

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

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

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

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

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

14.00.00

PROTECTION

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

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

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

piping, tubing and conduit shall be sealed and taped.

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

15.00.00 ENVIRONMENT PROTECTION AND NOISE LEVEL REQUIREMENT

15.01.00 Environment Protection

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

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

15.01.01 For Liquid Effluent

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

15.01.02 For Air Emission

- a) Suspended Particulate Matter i.e. dust burden at chimney outlet - Maximum 50 mg/Nm^3 (with worst coal and one field out at TMCR).
- b) NO_x - 365 ppm Max. or 750 mg/Nm^3 (Equivalent NO_2).
- c) SO_2 - Concentration based standard 2000 mg/Nm^3 . Load based standard 0.2 metric tonne /MWe/day (for first 500 MW and 0.1 metric tonne/MWe/day for rest of the capacity above 500 MW)

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

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


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15.02.00 Noise Level Requirement

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

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

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

16.00.00 INSPECTION AND TESTING

16.01.00 Inspection and Tests during Manufacture

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

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

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

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

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

consultant for record purpose.

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

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

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

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

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

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

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

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

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

16.02.00 **Performance Tests at Site**

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

17.00.00 **TRAINING OF OWNER'S PERSONNEL**

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

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

17.01.00 **Training at Contractor's Premises**

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

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

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

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

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

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

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

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

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

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

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

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

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

The Contractor shall provide qualified English speaking instructors and training

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

17.02.00 Operation and Maintenance Training at Site

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

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

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

17.03.00 On-the-Job Training

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

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

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

18.00.00 DEVIATIONS

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

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

ANNEXURE-I

LIST OF STANDARDS FOR REFERENCE

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

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

ANNEXURE-II

CRITERIA FOR LAYOUT

PLOT PLAN LAYOUT REQUIREMENTS

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

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

BUILDING/ EQUIPMENT LAYOUT REQUIREMENTS

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

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

ITEM

SPECIFICATION REQUIREMENT

C. Other Maintenance Requirement

1. Generator stator handling

In case the Generator stator cannot be handled by the turbine house crane, all provisions for its overhauling, including the arrangement to slide the stator on the turbine house floor, the foundation work for stator jacking /lowering assembly, dismantling of building end walls/structures etc. shall be kept.

Yes

2. Maintenance of the internals/impellers of all important equipment, like boiler feed pumps, feed water heaters, Surface Condenser, fans of the boiler draft plant, Intake and circulating water pumps, cooling water pumps, coal mills, compressors, blowers, heat exchangers, fuel oil pumps, filters etc.

Shall be possible without disconnecting or dismantling any piping/ducting.

3. Overhauling and handling of the casings for the above items

Shall be possible without disturbing/dismantling any piping/ducting not directly connected to them.

4. Crane Approach

Wherever required the unobstructed approach of the crane hook/other hoisting equipment hook to various plant & equipment shall be possible.

Yes

D. Central Control Room

All electronic equipment other than those directly associated with control, operation or presentation of displays shall be mounted external to the control room in air conditioned control equipment room.

Yes

The bidder shall describe in his bid the proposed layout philosophy of the Central Control Room and Control Equipment Room and the arrangement of equipment best suited for the system offered by him and as per good ergonomically consideration.

However, as a guide line, following features are given :

- a) False ceiling and false flooring shall be provided.
- b) Uniform height, colouring schemes for cabinets etc. shall be available.

ITEM**SPECIFICATION REQUIREMENT**

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



TECHNICAL SPECIFICATION
**1X800 MW KOTHAGUDEM
AIR-CONDITIONING SYSTEM**

SPECIFICATION No: PE-TS-410-553-A001

VOLUME II B

SECTION C2-C

REV. 00

DATE: APRIL 2015

SECTION: C2-C
PERFORMANCE GUARANTEE


VIVEK KUMAR SA Khan Praveen Kishore

PERFORMANCE GUARANTEES

CONTENT

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


VIVEK KUMAR SA Khan Praveen Kishore

PERFORMANCE GUARANTEES

1.00.00 PERFORMANCE GUARANTEES, PERFORMANCE/ACCEPTANCE TESTS & LIQUIDATED DAMAGES FOR SHORTFALL IN PERFORMANCE

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

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

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

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

OR

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

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


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

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

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

1.06.00 **Performance/Acceptance Tests**

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

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

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

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

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

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

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

2.01.00 **Mechanical Completion**

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

works.

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

2.02.00

Specific Requirements of Mechanical Completion

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

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

2.03.00

Other Prerequisites for Mechanical Completion

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

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

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

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

2.04.00 **Preliminary Operation**

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

2.05.00 **Initial Operation**

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

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

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

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

2.06.00 **Reliability Operation**

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

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

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

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

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

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

2.07.00

TRIAL OPERATION:

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


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report in detail.

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

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

2.08.00

Performance Tests

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

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

- (b) **Independent Inspector**

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

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

guarantees.

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

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

- (b) The report(s) shall include as a minimum, the following:-
- (i) Scope
 - (ii) Various guaranteed parameters & tests as per the contract.
 - (iii) Codes/standards used
 - (iv) . Description of the test procedures
 - (v) Full schematic diagrams with indication of test instruments locations and identification tags of same.
 - (vi) Instrumentation details and calibration.
 - (vii) Duration of test, frequency of readings and number of test runs
 - (viii) Test logs and summary of test readings used for performance calculations.
 - (ix) Full set of correction curves.
 - (x) Computation of test results.
 - (xi) Sample calculation
 - (xii) Performance calculation
 - (xiii) Computations to prove measurement uncertainty is within acceptable limits.
 - (xiv) Acceptance criteria
 - (xv) Any other information required for conducting the test
 - (xvi) Conclusions of performance tests.
- (m) Within fifteen (15) days of receipt of such test report(s), the Purchaser shall submit a notice to the Contractor stating either:-
- (i) That Purchaser concurs with the information provided in the test report(s), or
 - (ii) That Purchaser disputes some or all of the information provided

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

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

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

2.08.00 **Notice of Tests**

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

2.09.00 **Delayed Tests**

- (a) If the tests could be carried out but are being unduly delayed by the Contractor, the Purchaser may by notice inform the Contractor to conduct the tests within 14 days after the receipt of such notice. The Contractor shall conduct the tests on such days within that period as the Contractor may fix and of which he shall issue notice to the Purchaser.

- (b) If the Contractor fails to conduct the tests within such notice period, the Purchaser may himself proceed with the tests. All tests so conducted by the Purchaser shall be at the risk and cost of the Contractor and the cost thereof shall be deducted from the contract price or charged to the Contractor. The tests shall then be deemed to have been conducted by the Contractor and the test results shall be binding on the Contractor.

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

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

(d) **Retesting**

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

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

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

3.00.00

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

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


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

Note :

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

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

4.01.00 **Steam Generator**

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

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

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

4.01.04 NOx emission

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

4.01.05 Mill capacity at rated fineness.

4.01.06 Gas tightness efficiency of Guillotine dampers.

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

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

4.01.09 Capabilities of all drives.

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

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

4.01.12 Run back capabilities.

4.01.13 Ramp/sudden load change withstand capability.

4.01.14 Life of mill wear parts

4.01.15 Furnace Exit Gas Temperature

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

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

4.01.16 Flue Gas Temperature

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

4.01.17 Steam Temperature Imbalance

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

4.01.18 SH/RH Attenuation System

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

4.02.00 **Electrostatic Precipitator**

4.02.01 Pressure drop across the electrostatic precipitator.

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

4.03.00 **Turbine Generator**

4.03.01 Turbine Generator-Set Capability

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

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

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

4.03.02 Operating Frequency Range

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

4.03.03 Constant Pressure and Sliding Pressure Operation

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

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

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

4.03.04 Start-up, Loading, Unloading and Shutdown Capabilities

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

4.03.05 Vacuum Pulling time

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

4.03.06 Sudden Total Loss of External Load

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

4.03.07 Capacity with Reduced Hydrogen Pressure

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

4.03.08 HP/LP Bypass Capabilities

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

4.03.09 Lube Oil Purification System - Capacity and Purity

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

4.03.10 Extraction and CRH NRVs

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

4.03.11 The performance of the condenser, i.e., the back pressure achieved at design CW flow and inlet temp. and cleanliness factors, VWO heat load shall be demonstrated.

4.03.12 Temp. of condensate at outlet of condenser shall not be less than saturation temp. corresponding to the condenser pressure at all loads.

4.03.13 Oxygen content in condensate at hot-well outlet shall not exceed the limit prescribed by HEI over the entire load range and shall be determined according to an internationally approved codes/standard.

4.03.14 When one half of the condenser is isolated, condenser capability shall be demonstrated to take at least 60% T.G. load under TMCR conditions.

4.04.00 **Deaerator**

4.04.01 The dissolved oxygen content in feed-water measured at deaerator outlet shall not exceed 0.005 cc/litre at all loads from no load to VWO condition with 3% cycle make-up with normal pressure and overpressure with incoming condensate presumed to be saturated with oxygen (without any chemical dosing).

4.04.02 Free carbon dioxide in deaerator effluent shall be non-traceable at all loads from zero to VWO with 3% cycle make-up with normal pressure according to ASTM standards.

4.05.00 **Power Cycle Pumps**

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

4.06.00 **Automatic On Line Turbine Testing (ATT) System**

Demonstrated without disturbing normal operation.

4.07.00 Coal Handling Plant

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

4.08.00 Water Treatment System

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

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

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

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

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

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

4.09.00 Instrumentation and Control

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

4.10.00 Noise Level

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

4.11.00 Air Conditioning & Ventilation system

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

PROCEDURE FOR CONDUCTING PG TESTS

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	STEAM GENERATOR
2.00.00	MILL PERFORMANCE WARRANTY
3.00.00	ELECTROSTATIC PRECIPITATOR
4.00.00	TURBINE GENERATOR
5.00.00	STATUTORY REQUIREMENTS
6.00.00	REMAINING PLANT AND EQUIPMENT


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PROCEDURE FOR CONDUCTING PG TESTS

1.00.00 STEAM GENERATOR

The performance tests shall be conducted in accordance with the latest version of ANSI PTC 4.0 except for the specific requirements brought out herein below. This test shall be done simultaneously with PG test of Turbine Generator set. During this test, Boiler unit shall be fully on automatic control under steady load condition.

1.01.00 The efficiency tests shall be carried out with the steam generator operating at the guaranteed point condition i.e. corresponding to 100%, 80% Turbine rated loads, or at the agreed loads as near these as possible, with the boiler operating at the rated excess air, rated SH/RH attemperation flows, flue gas temperature, coal fineness, etc. corresponding to the loads on boiler. At control load, the stable and efficient operation of the unit with the rated excess air, rated mill outlet coal fineness, while achieving the rated S/H, R/H steam parameters shall be demonstrated by the Contractor to the satisfaction of the Owner.

1.02.00 For finding out the performance values, two sets of consistent reading shall be taken and the average of the above values shall be considered for the guarantee purpose.

1.03.00 Corrections shall be applied to the tested efficiency, to correct it to the design conditions, for variations in the following parameters only :

- a) Feed water temperature at economiser inlet.
- b) Ambient air temperature
- c) Relative humidity of ambient air.
- d) Hydrogen in coal.
- e) Moisture in coal.
- f) Gross calorific value of coal.

The Bidder shall furnish correction curves, for Owner's approval, covering the expected ranges of variations for all these parameters for the range of coals specified.

1.04.00 In all other aspects, not spelt out above, or in specifications, where ANSI code stipulates agreement between the parties concerned before the test, Bidder shall get these approved by the Owner.

1.05.00 No negative tolerance on account of instrument in-accuracies or otherwise shall be allowed on the guaranteed values.

1.06.00 Performance tests shall also be conducted to prove the steam generating capacity of the steam generator at rated parameters at stipulated loads.

1.07.00 Necessary write ups, schemes, instrument schedules, detailed procedures clearly indicating periods of tests, frequency of observations, etc. shall be prepared and submitted for all the tests for Owner's review and shall be got specifically approved from the Owner within one year of LOI issue.

2.00.00 **MILL PERFORMANCE WARRANTY**

2.01.00 Performance testing shall be done on the mill towards establishing its capacity specified at the specified fineness applying corrections for the variations in coal characteristics i.e. HGI, moisture, etc.

2.02.00 The Bidder shall guarantee a capacity output not less than the offered value, at each mill outlet, with coal fineness of not less than 70% through 200 mesh and not less than 98% through 50 mesh screen, when grinding coal having specified grindability index, total moisture content including surface moisture, etc. Bidder shall guarantee that the above capacity will be maintained and demonstrated with the originally installed grinding elements in nearly wornout condition as mutually agreed for the purpose of ascertaining wear life of any of the wear parts or when pulveriser grinding elements have successfully completed the specified guaranteed hours of operation as mentioned by the Bidder, whichever is earlier. During the above mentioned operating period of the mill, manufacturer's operation instructions will be followed and mill will be operated with the specified range of coal without any such readjustment that requires a shutdown of the mill or reduction of the load and/or any replacement of any mill wear parts.

For the purpose of testing to demonstrate the capacity, if grindability and surface moisture vary from those given above, the pulveriser measured capacity shall be corrected using the capacity correction curves furnished by the Bidder alongwith the offer. HGI vs grindability factor curve shall be furnished for HGI variations upto a value above which the capacity remains constant.

Capacity guarantee shall be conducted on all the mills. However, should the results of test as conducted above indicate that deficiency in capacity guarantee is observed in case of one or two mills only and that Owner is further, convinced that such deficiency does not occur out of reasons attributable to mill manufacture and supplier, Owner may waive off the requirement of demonstration of capacity guarantee for such mills only.

2.03.00 Mill Wear part life guarantee

The Bidder shall guarantee the wear life of all wear parts of the mill when grinding the specified range of coals. For this purpose the wear parts shall be defined as those parts of the mill which are in contact with coal or coal dust and are likely to wear out during the operation of the mill (except for the grinding

media balls). The guarantee shall be demonstrated on each mill during the guarantee trial period (GTP) commencing after establishing successful operation of the mill continuously for a period of not less than 24 hours at or near its guaranteed rated capacity. The guarantee trial period shall be at least five years or the wear life of any wear part, whichever is higher. The establishment of the guarantee will be based on actual total hours of operation of the mill regardless of the specified range of coal or fuel loading. The mill wear parts shall be considered to have passed their guaranteed operating life when they have demonstrated their capability to meet the full load rated capacity of the mill at the rated power consumption at the end of the guarantee trial period. In case any of the wear parts has worn out to such an extent that either the normal and safe operation of the mill is jeopardised if it is not replaced/repared or its continued use may lead to exposure or wear of other parts which are not meant for the purpose, that part shall be deemed to have completed its life for the purposes of checking the short fall in wear life even if there is no reduction in mill rated capacity and rated power consumption shall be as quoted by the Bidder when grinding the coal having parameters specified in Section-V and achieving the grind fineness of not less than 70% through 200 mesh and 98% through 50 mesh.

The Contractor shall provide to the Owner so as to compensate for the shortfall in wear life for a plant life of 30 years as has been established or the cost of such wear parts based on the prices quoted by him in his offer for spares escalated as applicable for respective items at the discretion of the Owner.

3.00.00 ELECTROSTATIC PRECIPITATOR

- 3.01.00 The performance test on electrostatic precipitator will commence after completion of reliability run along with the testing of Boiler and Turbine. During the interval between the commencement of trial operation and the commencement of performance test only routine maintenance shall be carried out. No physical or chemical cleaning of ESP shall be permitted during this period or immediately before the conductance of the performing tests.
- 3.02.00 The test efficiency shall be based on the overall performance of the electrostatic precipitator over a mutually agreed period of operation under the conditions given in this specification and following the normal operation of the unit including rapping and normal soot blowing and/or warm up guns. Outlet dust concentration of ESP shall be as specified in relevant section under Steam Generator subject to applicable modification adopted by Environmental Department, Government of India, at the time of project execution.
- 3.03.00 The performance tests shall be carried out in accordance with Method-17 of EPA (Environmental Protection Agency of USA) code. The details of the tests shall, however be mutually agreed upon between the Owner and the Contractor.
- 3.04.00 All calibration procedures and standards shall be subjected to the approval of the Owner. The protecting tubes, pressure connections and other test connections required for conducting guarantee test and maintenance testing shall conform to the relevant codes. The Bidder shall fully elaborate, in his proposal, the provisions made to this effect. Method of measurement for all air

leakage test and power consumption test proposed by the Bidder shall be clearly indicated in his offer, and shall be subject to Owner's approval.

4.00.00 TURBINE GENERATOR

4.01.00 The performance test for the turbine generator set will be conducted in accordance with the latest edition of ASME-PTC-6.

For determination of primary flow to the turbine, low beta ratio throat tap nozzle assembly including required machined straight length meeting the requirements of ASME-PTC-6 shall be provided.

4.02.00 The performance tests shall be carried out to determine compliance with the following heat balance conditions :

- a) 100% output under rated steam conditions at condenser CW temperature 33° C and condenser vacuum 77 mm HgA with zero make-up.
- b) 80% MW output under rated steam conditions at condenser CW temperature 33° C and condenser vacuum 77 mm HgA with zero make-up.

4.03.00 The test heat rate under the above load conditions shall be computed as per relevant clause of T.G. Specification.

The performance test shall be carried out with Turbine driven BFPs in service. To account for the conditions during the conductance of the test which do not correspond to the specified conditions, necessary corrections shall be applied.

4.04.00 No tolerance shall be applied to the final test results for testing inaccuracy. For measurement inaccuracies (including instrument tolerance) as ascertained by the Owner from the codes/standards, the test heat rates will be corrected upwardly reflecting the same (e.g. in case of any inaccuracy of 0.1%, the test heat rate will be corrected by 0.1% upwardly).

4.05.00 The tests shall be arranged in a manner such that the Owner's operation is not disrupted. Duplicate test run will be performed at the 100% and 80% unit loads. The test results of corrected heat rate of the duplicate test runs shall agree within 0.25%. If they differ by more than 0.25% a third test shall be run at the same test points. Corrected results of anyone of the three test runs which deviates from the corrected average heat rate of all the runs by more than 0.25%, shall be eliminated, otherwise the results of the test with the highest heat rate figure will be considered.

The test for TG test capacity shall be carried out alongwith the heat rate test. Instrumentation and other details shall comply as above.

4.06.00 Condenser

Performance test for the condenser shall be conducted in accordance with the latest edition of ASME PTC-12.2. The condenser pressure shall be measured at 300 mm above the top row of tubes under VWO condition, 3% make-up and

design CW flow and CW inlet temperature corresponding to guranteed vacuum. The cleanliness factor shall be determined in accordance with the latest edition of ASME PTC-12.2.

4.07.00 Feed Water Heaters and Drain Cooler

Performance test for feed water heaters shall be conducted in accordance with the latest edition of ASME PTC-12.1.

4.08.00 Deaerator

Performance test for deaerator shall be conducted in accordance with the latest edition of ASME PTC-12.3.

The dissolved oxygen content in feed water at outlet of deaerator shall be determined by ASME-D 888. Reference Method A and any recognised modification thereof.

Free carbondioxide content of deaerator effluent shall be measured by APHA method.

5.00.00 STATUTORY REQUIREMENTS

All parameters of plant, equipment & facilities which are under jurisdiction of Statutory Authorities, like MOEF, TPCB etc., shall be guaranteed. Conformance to the performance parameters under statutory requirement is mandatory.

6.00.00 REMAINING PLANT AND EQUIPMENT

For other equipment, plants and systems, the performance test shall be carried out as per the respective equipment specification and the applicable codes.



TECHNICAL SPECIFICATION
**1X800 MW KOTHAGUDEM
VENTILATION SYSTEM**

SPECIFICATION No: PE-TS-410-554-A001

VOLUME II B

SECTION C2-D

REV. 00

DATE: APRIL 2015

SECTION: C2-D
QUALITY ASSURANCE


VIVEK KUMAR

SA Khan Praveen Kishore

QUALITY ASSURANCE REQUIREMENTS

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