



# TENUGHAT VIDYUT NIGAM LIMITED

2x210 MW Tenughat Thermal Power Station

Jharkhand

Dry Fly Ash Collection & Disposal System



## SECTION – C AIR CONDITIONING & VENTILATION SYSTEM

### 1.0 GENERAL

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of Air Conditioning Systems and Ventilation Systems under Ash Handling System package with all accessories required to be installed to achieve the designed performance in all respects.

Scope of work shall include design and engineering, manufacture, assembly, shop testing, shop painting, packing, transportation to site, unloading and storage at site, erection, site painting, testing, commissioning and performance guarantee tests of all ventilation and air conditioning systems and all related work to complete the systems in all respect on turnkey basis. The erection work includes transportation of material from stores to site, minor civil work to suit equipment installation, grouting of foundation bolts, installation of equipment, piping, ducting and auxiliary items, trial run of equipment, cleaning of debris and waste material, modification & dismantling of any structure and taking care of all preliminary acceptance tests (PAT) points. Watch & ward of equipment shall also be taken care of by the contractor. The contractor shall provide all construction and transport equipment, tools, tackles, consumables, materials, labour, supervisor for erection.

All items and fittings required to complete the equipment / system in all respects shall be provided by the contractor. Any equipment not specifically mentioned in the technical specification, but are required to make the system complete in every respect and are necessary for smooth and safe operation of the system shall also be included by the Tenderer.

Performance guarantees of equipment, individual as well as integrated performance of whole system shall be as follows:

- i) No undue vibration
- ii) Smooth running of rotating parts
- iii) No overheating of bearing
- iv) No leakage in the piping, ducting & equipment
- v) Designed air & water flow at various points of system

In case unit capacities and design parameters guaranteed by the contractor are not established during the performance guarantee



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testing, the owner at his discretion may reject or accept the concerned system after assessing its technical suitability.

## 2.0 DESIGN CONSIDERATION

The following ambient conditions shall be considered while designing the Air-Conditioning & Ventilation Facilities.

Seasons	Ventilation		Air Conditioning	
	Temp °C	RH%	Temp °C	RH %
Summer	42.2	26	45	24
Monsoon	32.2	85	34	65
Winter	10	-	-	-

For design of air conditioning systems, ambient temperature and humidity for summer, monsoon and winter, internal heat load due to equipment, lighting, occupancy and inside design conditions of  $23 \pm 2^{\circ}\text{C}$  in conditioned premises shall be considered. The air-conditioning system will be designed to operate continuously round the clock twenty-four (24) hours a day for all seasons of the year.

Ventilation systems shall be designed to maintain proper working conditions environment compatible with human hygienic requirements and to maintain conditions necessary for proper storage of materials and working of plant and equipment. The ventilation systems generally include one or more items of equipment and accessories such as fans, air filters, duct work, pumps, air washer, air supply grills, dampers, fire dampers, instrumentation and controls, electrics etc. Ventilation systems will be designed considering the climatic condition prevailing in the region and the equipment will be installed either in the wall of served premises or in separate plant room adjacent to served premises.

All the rotating parts shall be statically and dynamically balanced.

The Successful Tenderer should calculate and decide the systems capacities of their own using the standard norms.

## 3.0 FIRE SAFETY

No combustible material will be used anywhere in the entire air-conditioning system. AC system blower, Solenoid operated fire dampers in the duct shall be interlocked with fire detection system to stop airflow. All the systems like refrigerant etc. shall be environment friendly.



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## 4.0 PROPOSED SYSTEMS

Window/ Split type air conditioning system shall be provided for the control room of Ash Handling System pump cum compressor, blower house of utility building. 100% standby provision shall be kept while designing the system.

Exhaust ventilation systems shall be provided with wall mounted TA exhaust fans for MCC room of Ash Handling System, Compressor House and for MCC cum Control Room of Ash Handling System, Silo Utility Building. The pump cum compressor house, pump cum blower house, toilets, stores, of silo building shall also be provided with wall mounted exhaust fans.

A tentative list of systems is given in the table below. This list is only for the guidance of the tenderer. All system capacities have to be calculated by the tenderer and provision of new systems as required have to be provided by the tenderer.

Location	System to be provided
Control room of Ash Handling System pump cum compressor house and 3 blowers	Air conditioning system with 3 star rated split type air conditioner
MCC Room of Ash Handling System pump cum compressor house	Exhaust ventilation system
MCC cum Control Room of Ash Handling System silo utility building	Exhaust ventilation system
Ash Handling System Pump cum blower house and in utility building	Wall mounted Exhaust fans
Toilet & Stores of silo utility building	Wall mounted Exhaust fans

## 5.0 TECHNICAL SPECIFICATIONS

### 5.1.1 Split Type Air Conditioner

The split type air conditioner shall be as per IS 1391 Part II – 1992 and shall be minimum 3 Star rated as per BEE. It shall essentially be housed in two parts, One No. high ceiling mounted Indoor unit & One No. Outdoor unit. Outdoor unit shall comprise of air-cooled condenser, condenser fan, hermetically sealed compressor and controls housed in a weather proof steel cabinet suitable for outdoor installation. Indoor Unit shall comprise of cooling coil, air circulating low noise fan, supply air grill with motorized flow deflector, evaporator drain connection and controls enclosed in a insulated steel cabinet.



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## Outdoor Unit

- a) Air-cooled Condenser having condenser coil internally grooved copper tube with split aluminum fins. The condenser shall be fitted with a fan of propeller type. The condenser shall be built on an air-cooled design using outside ambient air up to 44°C to condense the refrigerant. The condenser coils shall be constructed of integrally enhanced Seam less copper tubes arranged in staggered rows. This shall have a minimum of 2 rows to provide proper heat rejection. It should be able to take an additional load of up to 10% more than the required heat surface area for countering high ambient conditions. The copper tubes shall be mechanically expanded into lanced and rippled Aluminum fins of minimum 0.1mm thick with approx. 10 - 13 fins per inch.
- b) The refrigerant circuit shall consist of rotary / Scroll type compressor with R-22 refrigerant cooled motor, air-cooled condenser, thermostatic/capillary expansion valve, cooling coil, piping etc. The a fan shall circulate ambient air and cool the condenser that in turn will cool & condense the refrigerant vapour flowing through the condenser. The cool refrigerant will reach the cooling coil section via Expansion device as cold liquid vapour mixture at low pressure and will cool the warmer air received in the return air grill from the premises. Then the refrigerant after gaining heat of the circulating air, will return to the compressor via Refrigerant pipe as vapour where it will be compressed and sent to the condenser. Thus the refrigerant will gain heat from the room air in cooling section as well as from compressor drive in the compression process of compressor and will release the total heat to the condenser cooling air at the condenser.
- c) Steel structure with heavy gauge G.I. sheet metal casing and duly powder coated in which the above are mounted. The above enclosure shall be mounted on MS Channel frame structure with ribbed rubber pads for isolation of noise & vibration transmission to the building structure.
- d) Installation  
The wall brackets shall be supplied, grouted in to the walls / laid over chajja of the building and finished.

## Indoor Unit

- a) Cooling coils shall have large diameter copper tubes with aluminum fins firmly bonded to copper tubes assembled in zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and such that the air velocity across each coil shall not



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exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory tested at 21 Kg / Sq. cm. air pressure while submerged in water. Tubes shall be hydraulically expanded for minimum thermal contact resistance with the fins. Fin spacing shall be approx. 13 /15 fins per inch. The units shall be fitted with minimum 2/3 -row coil for giving the desired cooling effect.

- b) The air circulation is achieved by the operation of the blower. The blower shall be low noise, high static – high flow type. This will supply cold air from cooling section of the indoor unit to the premises through the supply air grills provided at the front panel. The cold air supplied will gain the heat of the premises thereby cooling the room and will be sucked into the cooling coil section of the air-conditioner by the same blower through the return air grill provided at the front panel of the unit. Thus the re-circulating room air will remove the excess heat of the premises. There shall be air filter of large area for filtration of the return air into the unit.

This LCD remote/panel controller shall be a part of the factory assembled unit which shall be installed in a separate weather proof panel and remotely located. The panel shall have a soft touch keypad which can be used for setting/altering the unit set points/control commands. There shall be alpha numeric display in English with features illustrating the machine operating status.

- c) Installation

The indoor unit shall be suitable for high ceiling mounting. Necessary refrigerant, condensate drain line and power & control wiring interconnection between outdoor & indoor unit shall be made at site after installation of the indoor unit.

### Safety Devices

The units offered shall be provided with all necessary safety devices, which are essential for proper operation of the equipment. These shall not be limited to the scope of this specification and shall have all safety devices required for optimum operation of the unit. The following minimum safety devices are suggested :

- a. Low voltage cutout
- b. Low evaporating cutout
- c. In-built internal overload
- d. High condensing pressure cutout
- e. Motor overload trip/protection



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## 5.1.2 Window Air Conditioner

Window type air conditioner shall comprise of hermetically sealed rotary compressor, air cooled condenser, refrigerant piping, fan, instruments and controls, supply air grills with direction deflectors etc. enclosed in an insulated steel cabinet. Provision shall be made in the front panel of the unit for controlling room ventilation and fresh air supply. Air filter installed shall be of HDPE easily cleanable type. The front panel shall be suiting to the interior décor of the room. Window air conditioner shall conform to IS:1391-1992 Part I.

## 5.1.3 Ventilation systems

Depending upon the specific requirement the shops/ buildings will be provided with either exhaust ventilation or plenum ventilation. The system design will take into account the requirements of air change as well as excess heat removal, whichever the higher shall be taken into consideration for design. Filters will be provided with plenum system. By plenum ventilation, the served premises will be over pressurized to 2-3 mm WC to avoid ingress of dusty air. Hot work areas will be provided with portable man-coolers for spot cooling. Man-coolers may be provided also in other areas where the premises are manned and have high heat radiation.

The capacity of ventilation systems shall be decided on the basis of total heat dissipated in the premises. However minimum 20 air changes per hour for fresh filtered air supply system and exhaust / general air exchange ventilation shall be maintained. The equipment will have at least 10% reserve capacity.

Fresh filtered air supply system shall consist of fan & motor unit, dry panel type air filter, air intake louvers, ducting, supply air grills, dampers, electrics, instrumentation & controls and multi louver gravity dampers.

Centrifugal fan shall be used for fresh filtered air supply system. However, axial flow (tube axial) fan may be used for system capacity up to 10000 m<sup>3</sup>/hr.

Exhaust ventilation system shall consist of fan & motor unit, out let cowl with bird screen / back draft damper & ducting if any etc.





#### **5.1.4 Axial flow exhaust fan (propeller)**

This is used for general ventilation of premises emitting heat, gases, fumes & dust. This shall be heavy duty and wall mounted type. Fan impeller shall be of aerofoil section blades and mounted directly on the motor shaft. The frame of the fan shall be of pressed sheet steel unit of strong but light design. Air entry shall be from motor side. Louver shutter/butterfly shutter shall be provided at the outlet to prevent back draught and consequent loss in capacity of fan, shall be taken into account while selecting the fan. Special treatment should be given to fan and motor for any special application like exhaust of acid fumes.

#### **5.1.5 Tube Axial Flow Fan**

These fans shall be of heavy duty (continuous) type and of two kinds, as per service requirement as follows:

- a) Wall mounted supply air fan, & b) Wall mounted exhaust air fan.

Axial fan design shall conform to IS:3588–1987 (Reaffirmed 1994).

The fan shall have multi-bladed cast aluminium impeller with short duct casing while the wall exhauster / wall mounted supply air fan shall have cone inlet suitable for ducted / free discharge of air. The 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. The noise level shall not exceed 85dB(A) at 1m distance from fan casing.

The first critical speed of the rotating assembly shall be at least 25% above the operating speed. The speed of the fan shall be limited to 1500RPM for fan with diameter 600mm or less and 960RPM for fans with diameter more than 600mm to limit the noise generation.

##### **Impeller**

The impeller shall be of cast aluminium alloy construction of high efficiency aerofoil section blades. The fan impellers shall be cast in one piece, finished all over and carefully balanced both statically and dynamically as per ISO – 1940. Finally the assembled rotor shall be dynamically balanced.

##### **Casing**

Axial flow fan casing and their components shall be suitable for outdoor



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installation. The casing shall be minimum 3.15 mm thick. The casing shall be provided with flanges at inlet and outlet. All nuts & bolts associated with it shall be of zinc or cadmium plated. Easily removable inspection cover having galvanised fly nut shall be provided. The covers shall be located such that the grease nipple for all bearings, and in particular motor terminals are easily accessible through the cover.

## Installation

All the TA Fans shall be provided with suitable ISMC frame work bracket for fixing with building column / wall openings. In no case fans shall be supported within the brick wall openings alone. Wall bracket shall be fully grouted / welded with wall insert mounted on locally made RCC block within brick wall.

### 5.1.6 Dry panel filter

Dry panel type air filter shall be of high efficiency cleanable type, constructed out of HDPE (6 ply) supported by layers of GI wire gauge. It shall be corrugated to the depth of filter casing in order to increase the ratio of filtration area to frontal area. It shall be covered by strong GI/MS frame and have space to ensure uniform distribution of air. Filtering panel shall be of standard size which can be mounted on angle frame in multiple number as per capacity of the fan. Face velocity of air shall not exceed 1.5 m/sec. The resistance of air filter shall not exceed 10 mmWC when dirty. Efficiency of the filter shall not be less than 90% down to 10 microns. The whole filter and frame assembly shall be mounted at the wall.

### 5.1.7 Centrifugal fan

Centrifugal fan for ventilation shall be of limit load design and shall be complete with suitable electric motor, channel base frame, VIV, V-belt, pulleys, belt guard, belt tensioning device and slide rails.

The fan shall be both statically and dynamically balanced and shall conform to IS: 4894.

The fan shall be heavy duty of rugged steel construction and suitable for Power Plant applications. Fan housing shall be of welded construction and provided with flanges at inlet and outlet sides for duct connections. Fan shall be of split casing construction.

The fan unit shall be reasonably noise and vibration free in operation.





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The fan impeller shall be die formed backward curved and drain connection shall be provided at the lowest point of scroll.

Fan bearing shall be of self aligning, heavy duty type. Bearing shall be selected with ample safety factor for longer life. Sufficient number of suitable vibration isolators of approved make shall be provided to ensure isolation of vibration from the equipment to foundation.

Fabricated steel bracket of M.S. angles, channels and chequered plates shall be provided to take static and dynamic load of the fan and motor assembly.

Anchor bolts, nuts, foundation plates and inserts shall be supplied with the equipment. The equipment shall be designed to permit interchange ability of parts and ease of access during inspection, maintenance and repair.

The first critical speed of the rotating assembly shall be at least 25% above the operating speed.

The housing shall be provided with lifting eye for ease of handling and bolted type access door. Sheet thickness of casing, back plate & impeller shall be minimum 3.15mm respectively.

Dial type (150 mm) pressure gauges shall be provided at the outlet of the pump.

## 5.1.8 Flexible Connection

Suitable flexible connections of tarpaulin shall be provided between adapter section and fan inlet as well as between fan outlet damper and ducting.

## 5.1.9 Adjustable Louvre Grill (Supply Air Grill)

1.25mm MS sheet shall be used for the manufacture of grill. All grills shall be true to shape and shall be checked with a level gauge before being secured in position. No distortion or warping is permitted. All duct mounted grilles shall be complete with rubber gaskets and flanged holding frames of suitable design for the intended installation. They shall be mounted on collar extending from the duct. No part of grilles shall project into the main duct. The adjustable louvre grill shall be provided with volume control damper as well as double deflection flap/ grill for direction control.



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## 5.1.10 Self Acting Damper (Gravity Damper)

Self acting dampers are provided to maintain pressurisation inside the premises. The damper shall be multi-blade type made of Aluminium flaps of not less than 24G thickness and MS frame. These shall be designed such that these shall operate when the pressure inside the premises exceeds 2-3 mm WC. It can operate in fully open or partial open positions.

## 5.1.11 Hand Operated Damper

The hand operated damper shall be multi-leaf opposite acting blade type damper with external operating links provided at the outlet of the fan for controlling air flow. The damper shall be made of MS sheet casing of 1.6mm & MS louvre of 1.25mm. The fully close/ open/ partial closing position shall be marked on the damper casing.

## 5.1.12 Ducts, accessories & supports for ventilation systems

These include duct, bend, tees, reducers, dampers, grills, louvers, diffusers, hoods, manholes, support of various kinds, thermal insulation, flexible connections, and noise dampening devices.

Duct work shall be constructed of galvanized sheet steel of 1.0 mm thickness (minimum). The material and constructional features shall conform to the latest revision of IS: 655 - 1963. GI duct shall be from GI sheet having GI coating as 120 gm/Sq.M.

Velocity of air flow shall not exceed 10 m/sec in main ducts and 8m/ sec. In the branch ducts.

Suitable supports shall be provided for all the ventilation equipment and duct.

Air distribution grills shall be operated with easily accessible lever to duct and control the airflow.

## 6.0 Preferred makes

Air conditioning system	- Voltas, Blue Star, Hitachi, Carrier
Ventilation system	- EFE, Flow Link, Voltas, C.Doctor

## 7.0 Data to be furnished by the tenderer along with the offer

The following data shall be furnished by the tenderer along with the offer



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## 7.1 Split / window Air Conditioners

- (i) Make & model (star rating)
- (ii) Quantity
- (iii) Capacity in Kcal/hr
- (iv) Air flow m<sup>3</sup>/h
- (v) Flow direction & volume control grill
- (vi) Material of construction
- (vii) Compressor type
- (viii) Drive details & total power consumption
  - (ix) Overall dimension of outdoor & indoor unit
  - (x) Refrigerant type & quantity
  - (xi) Filter efficiency
  - (xii) Weight of unit – outdoor & indoor
  - (xiii) Noise level as 1m distance in dB (A)
  - (xiv) Fixing details
  - (xv) Vibration level
  - (xvi) Accessories included.

## 7.2 Ducting including Supply Air Diffusers with Volume Control Dampers

- a) Duct : Material, thickness & quantity
- b) Damper: material, thickness, size, quantity
- c) Supply Air Diffuser: material, thickness, size, quantity

## 7.3 Ventilation Systems

- a) Type of ventilation system
- b) Capacity of each ventilation system
- c) Make of equipment
- d) Design heat load for each premise
- e) Indoor climatic condition to be maintained
- f) Power requirement of each system
- g) Air change/hr
- h) Any specific design consideration
- i) Noise level at 1 m distance from the ventilation equipment



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- j) Noise level at served premises

## 7.4 Centrifugal Fan

- a) Make & Model No.
- b) Quantity, no.
- c) Type of blade
- d) Capacity, m<sup>3</sup>/h
- e) Total pressure, mm WC
- f) Speed, rpm
- g) Shaft power, KW
- h) Total Efficiency, %
- i) Motor rating, KW/ pole
- j) Fan Characteristic Curve
- k) Impeller Diameter, mm
- l) Velocity at inlet & outlet of fan, m/sec
- m) Weight of fan and motor, kg
- n) Coupling details
- o) Vibration isolator type & quantity
- p) Thickness of scroll, blade, Back plate, shaft mm
- q) Noise level at 1m distance
- r) Overall size
- s) Drive Motor rating suggested

## 7.5 Fan Drive Motor Details

- a) Type & make
- b) Voltage, phase & frequency
- c) Rated power
- d) Speed
- e) Starting/ pull out torque
- f) Line current
- g) Starting current
- h) Overall efficiency
- i) Class of insulation
- j) Type of enclosure
- k) Any other information

## 7.6 Exhaust fan / TA flow fan

- a) Make & Model
- b) Capacity in m<sup>3</sup>/h.
- c) Total Pressure, mm WC
- d) Material of construction and its thickness
- e) Speed in rpm.



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- f) Drive details.
- g) Shaft Power consumption.
- h) Wheel diameter.
- i) Efficiency.
- j) Static & Dynamic weight of fan & motor assembly
- k) Critical speed of fan
- l) Noise level at 1m distance in dB(A)
- m) Performance curve.
- n) Air flow direction.
- o) Fixing details.
- p) Vibration level.

## 7.7 Dry Panel type filter

- a) Make & Model.
- b) Capacity in m<sup>3</sup>/h.
- c) Pressure drop in mmWC. – both in clean & in dirty condition
- d) Effective cross sectional area in m<sup>2</sup>
- e) Velocity through filter in m/sec.
- f) Material of filtering panel.
- g) Cleaning efficiency Vs particle size
- h) Methods of surface regeneration.
- i) Filter box construction details.
- j) Overall dimensions & no. of filters.
- k) Fixing frame details.
- l) Total weight.