TENDER DOCUMENT

NIT No.: DLI/C&E/WI-675/258

FOR


VOLUME – 4

General Technical Specification of Bhilai Steel Plant, SAIL

ENGINEERING PROJECTS (INDIA) LIMITED
(A GOVT. OF INDIA ENTERPRISE)
Core-3, Scope Complex, 7, Institutional Area, Lodhi Road, New Delhi-110003
TEL NO: 011-24361666 FAX NO. 011-24363426
1.0 SYSTEM SPECIFICATION OF AIR CONDITIONING SYSTEM (SS1)

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of Air Conditioning System with all accessories required to be installed for HVAC application to achieve desired performance in all respect. Specific technical requirement of Air Conditioning System if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Air Conditioning System is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02. Description

This specification specifies general requirement of refrigeration and air-conditioning system for different application.

In general following types of air – conditioning units and accessories are required to be installed:

- AIR HANDLING UNIT – ES1
- CENTRIFUGAL FAN – ES4
- CENTRIFUGAL PUMP – ES5
- VAPOUR ABSORPTION M/C (VAM) – ES6
- CENTRALISED AIR CONDITIONING SYSTEM – ES7
- COOLING TOWER – ES9
- DAMPERS – ES11
- DUCTING NETWORK FOR HVAC SYSTEM – ES13
- FILTER DRY TYPE – ES15
- PACKAGE TYPE A/C SYSTEM – ES19
- PROPELLER FAN – ES20
- THERMAL & ACOUSTIC INSULATION FOR HVAC APPLICATION – ES17
- TUBE AXIAL FAN – ES23
- VALVES – ES24
- WINDOW & SPLIT TYPE A/C SYSTEM – ES25

Design Consideration:

For Design Ambient Temperature, internal heat load due to equipment, lighting, solar radiation, occupancy and inside design conditions refer job requirement of technical specification. 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.

Following Indian Standards shall be followed for designing Air Conditioning System:

<table>
<thead>
<tr>
<th>IS-655-1963 (RA-1999)</th>
<th>HVAC System duct</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS-659-1964 (RA-1991)</td>
<td>Safety code for A/C system</td>
</tr>
<tr>
<td>IS-778-1984 (RA-1995)</td>
<td>Copper Alloy Gate, Globe, Check Valves</td>
</tr>
<tr>
<td>IS-1239-1990 (RA-1998 Part-1)</td>
<td>MS Tubes &amp; Pipes</td>
</tr>
<tr>
<td>IS-1391-1992 Part-1</td>
<td>Unitary (Window) A/C Unit</td>
</tr>
<tr>
<td>IS-1391-1992 Part-2</td>
<td>Split A/C Unit</td>
</tr>
</tbody>
</table>
The following design data shall be considered for selecting and sizing various equipment for chilled water plant, air conditioning and ventilation systems:

<table>
<thead>
<tr>
<th>SEASON</th>
<th>TEMPERATURE 0C (DBT)</th>
<th>RELATIVE HUMIDITY (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUMMER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot Zone side (20 m from hot metal/liquid steel handling)</td>
<td>60</td>
<td>26</td>
</tr>
<tr>
<td>Other zones</td>
<td>45</td>
<td>26</td>
</tr>
<tr>
<td>MONSOON</td>
<td>33</td>
<td>70</td>
</tr>
<tr>
<td>WINTER</td>
<td>10</td>
<td>-</td>
</tr>
</tbody>
</table>

In general the different air conditioned served electrical premises shall be maintained at 23±2 °C and 55±5 % RH.

All glasses in Air-conditioned served premises shall be double glass type with airtight double door entry provision.

For improved water quality in refrigeration system chemically treated water shall be considered as make-up for corrosion protection. Alternatively soft water plant shall be installed for make-up water supply to A/c system.
Chilled water pipe line shall be laid over ground.

For better distribution of chilled water in the network, ring main shall be considered. Alternatively reverse return line shall be considered for vertical chilled water distribution at different floor. At the end of main supply and return chilled water line provision shall be kept with isolation valve for hooking up with adjacent plant chilled water network. Interfacing of chilled water network form one plant to other shall be done by Purchaser separately depending upon requirement.

Preferable Exhaust fan rpm shall not exceed 900. All pumps (above 15m³/hr capacity) shall be horizontally split type with maximum RPM of 1,500. Monoblock pump can be used for capacity less than 15m³/hr.

Remote monitoring from central control room through main automation system for all critical areas under AC systems shall be provided. Provision for monitoring of chilled water flow quantity, temperature and served premises temperature shall be kept from central control room station.

Chilled water plant shall be selected such that it shall have 20% more capacity rating than design calculation for future scope and interconnection with other adjacent plant.

The following velocities will be maintained in duct line for different air conditioning systems.

i) Main header ducting 6 to 8m/ sec.
ii) Branch ducting 5 to 7m/ sec.
iii) Supply air grill 2 to 3m/ sec.
iv) Return header ducting 5 to 6m/ sec.

Noise level generated in Central plant, Package AC plant, AHU and duct line shall not be transmitted to the served premises. Noise level in the served premises will not exceed 65 dB (A).

For control of temperature and dehumidification of the conditioned premises, thermostat and humidistat will be provided in the package A.C. plant room/ AHU Room.

High efficiency filter and strip heater will be installed in the supply air duct at the discharge end of blower and the strip heater will be interlocked with the blower to prevent independent control/swITCHING of heaters. Pan humidifier shall be installed in the Air Handling Unit Plant Room if required for critical control of R.H. Level.

Make up air supply to AHU / package AC plant room shall be provided with filter and damper.

**Filter:** Efficiency of pre filter will be 90% down to 10 micron and fine filter will be 99% down to 5 micron. High efficiency filter will be installed in the supply air duct at the discharge end of blower in line with job specification requirement. For details refer ES16.

Local control of fan, pump, blower shall be provided near installation area for ON/OFF operation as required.

**Humidity Control:**

The strip heater will be installed in the supply air duct at the discharge end of blower for dehumidification purpose and the strip heater will be interlocked with the blower unit to prevent independent control/
switching of heaters. Safety thermostat shall be installed in the duct line near strip heater for safety precaution.

Pan type humidifier shall be installed in the air handling plant room for adding moisture if required for critical control of R.H. Level. Safety thermostat shall be installed in the pan humidifier chamber near immersion heater for safety precaution. In Pan humidifier chamber make–up water line, overflow, drain provision with gate and float valve arrangement shall be provided.

Condenser cooling circuit.

Centrifugal pump and cooling tower for condenser cooling shall be supplied in line with job specification requirement for water-cooled type condensing unit. For air cooled condenser unit selection maximum ambient temperature factor shall be considered for capacity selection

Rubber/Neoprene gaskets will be used on all bolted joints as a seal against water leakage.

Water pipe line will be of MS Heavy (C) Class and as per IS 1239 - 1990, (part I) (RA – 1998), upto a size of 150 NB, IS 3589-2001 for sizes beyond 150 NB MS, spirally welded, 6mm thick & conforming to IS:3589. Pipe fittings up to 150 NB will be as per IS 1239-1992. (Part II), Amendment 2000. Fabricated fittings manufactured from pipes may be provided for pipes of size 200 NB & above.

Velocity of water in pump suction line and delivery line will be within 1.25 and 2 m/sec respectively.

Pot /Duplex strainer will be provided in suction line of pump and ball valve/ butterfly valve will be provided in the delivery side of pump.

Butterfly valve/ ball valve will be provided in water pipeline at condenser inlet & outlet, AHU cooling coil inlet & outlet, pump inlet & outlet.

For better distribution of chilled water in the network in vertical line reverse-return line shall be provided for balancing of water flow at consumer points. However for multiple consumer points in horizontal line balancing valve shall be provided at chilled water return branch line.

Insulated drain piping network is to be included as required for steam condensate drain, with isolation valves at proper places.

Pipe supports will be steel, adjustable for weight and coated with rust preventive primer and finish coated with Aluminum paint. Where pipe and clamp are of dissimilar material a gasket will be provided in between.

All piping will be tested to hydrostatic test pressure of at least one and half times the maximum of operating pressure for period of not less than 2 hours.

Thermal and acoustic insulation:

For details refer ES22. Thermal and acoustic insulation for air conditioning systems shall be considered in line with job specification requirement. However, following minimum insulation work shall be considered.

a) Inside surface of the packaged a/c blower/AHU Blower section.
b) Supply air tail end duct to prevent condensation
c) All supply air and return air duct line passing through non-air conditioned premises.
d) Acoustic insulation of duct line at blower outlet up to 5 m length minimum.
e) Steam condensate drain
f) Under deck insulation of sunlit exposed roof

g) Chilled water pump, chilled water pipeline, valves, chiller, expansion tank as per job specification requirement.

**Fire safety**

No combustible material, lining like insulating material will be used anywhere in the entire air-conditioning system of shop. AC system blower, motorized fire dampers / Solenoid operated fire dampers in the duct shall be inter locked with fire detection system to stop air flow.

**Control & Instrumentation**

The following instrumentation and necessary interlock and controls to be provided for air conditioning system:

i) HP/LP cutout switch.

ii) Cooling thermostat, heating thermostat, Operating and antifreeze thermostat & Humidistat.

iii) Pressure gauge & temperature gauge (150-mm dial type)

iv) Water flow switch /differential pressure switch with interlock and signal.

v) Dry bulb & wet bulb thermometer for all air conditioned premises.

vi) Thermostatic expansion valve, sight glass, refrigerant strainer,

vii) Steam pressure and flow control of Vapor Absorption based system.

viii) Chilled water flow and condenser cooling water flow rate

Any other instrumentation required for the system will be indicated & provided by the Tenderer.

**Guidelines to eliminate interference between ducts, lighting and false ceiling**

Minimum clearances for duct routing will be as follows:

A minimum clearance of 100 mm will be provided between beam bottom and top of duct to take care of duct fabrication, flanges, insulation and allowances for civil construction.

Minimum clearance of 200 mm will be provided between duct bottom and false ceiling to take care of collar fitting, variation in levels of false ceiling and floor levels, if any.

The successful Tenderer will study the false ceiling drawing. Additional grid work, if found necessary, based on diffuser sizes, shall be carried out. Size of the diffuser color will match with false ceiling grid. For served premises, return air recess may be provided at the periphery all around.

**Sequence of preparation of drawings**

i) Duct routing drawing will be prepared based on air conditioning requirement.

ii) Duct routing and diffuser locations will be checked for interference if any with light fittings and false ceiling grid as per the Architectural/Electrical drawings. The diffusers and light fittings will be in different rows, as far as possible.

iii) The finalised duct/diffuser layout drawing will be drawn on the false ceiling grid drawing before submission for approval.
Construction supervision

Interference during construction stage due to lack of supervision and co-ordination etc., will be corrected during erection by the AC system Successful Tenderer. The false ceiling Tenderer will draw the grid on the ceiling. The AC system Successful Tenderer will make the exact location of diffusers on the ceiling. Similarly, locations of light fittings on the ceiling shall be considered. AC system Successful Tenderer will co-ordinate in this regard with other Contractors to avoid any interference at a later stage. By using plumb, from locations of diffusers drawn on ceiling, the duct fabricator will erect the main and branch ducts. However, collars should be cut only after the false ceiling is properly leveled.

Suggested sequence of operation

i) Under deck insulation shall be completed.
ii) Main duct will be erected by the Successful Tenderer.
iii) Hangers for false ceiling & lighting etc., will be placed.
iv) Skeleton false ceiling with grid main runners will be erected.
v) Branch duct to be erected as per center lines of grid/main runner.
vi) False ceiling to be leveled and grid to be provided for lights and diffusers.
vii) Collars to be cut by the Tenderer to match the false ceiling grid and level.
viii) Fixing of diffusers on to the collars after leveling the false ceiling.
ix) The diffuser level and false ceiling level will be properly matched for good aesthetic appearance. The false ceiling panel opening will be done by the Tenderer for diffuser fixing.
x) The AC system Tenderer will plan the activities of duct erection in consultation with other Tenderers, (namely, Electrical and Civil) so as to avoid delays and extra work by all concerned.
xii) Concerted efforts will be made by the AC system Tenderer together with other agencies for proper erection of ducting and diffusers avoiding any interference with electrical works and false ceiling grid.

03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The following data shall be furnished by the tenderer along with the offers.

1. Type of refrigeration / air conditioning system
2. Total capacity of air conditioning system
3. Make of equipment
4. Design cooling load
5. Indoor climatic condition shall be maintained
6. Total power requirement
7. Total water requirement
8. Any specific design consideration
9. Noise level at 1m distance from the AC equipment
10. Noise level at served premises
2.0 DUST EXTRACTION SYSTEM SPECIFICATION (SS2)

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of Dust Extraction System with all accessories required to be installed to achieve desired performance in all respect. Specific technical requirement of Dust Extraction System if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Dust Extraction System is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02. Description Of The Dust Extraction Systems

Dust extraction systems shall comprise of suction fan, dust extractor, ducting network, dust disposal system, electrics, instruments & controls.

This specification specifies general requirement of Dust Extraction system for different application.

In general following equipment specification (ES) shall be referred

- BAG FILTERS – ES3
- CENTRIFUGAL FAN – ES4
- CENTRIFUGAL PUMP – ES5
- DUCTING NETWORK FOR DE SYSTEM – ES12
- CYCONES, MULTI-CLONES, PRE-COLLECTOR – ES10
- ELECTROSTATIC PRECIPITATORS – ES14
- SCRUBBER – ES21
- THERMAL INSULATION FOR HOT APPLICATION – ES18
- VALVES – ES24

DESIGN CRITERIA

1. All the rotating parts shall be statically and dynamically balanced. Monitoring ports in ducting and stack with platforms, approach ladders/stairs and other requirements shall be strictly as per the latest emission standards published by Central Pollution Control Board.

2. The efficiency of the dust cleaning equipment shall be such that the emission from stack should not be more than 50 mg/Nm$^3$ unless other wise specified in the job specification. The average inlet air dust concentration may be taken as 10~15 gm/Nm$^3$ unless otherwise specified in the job specification.

3. The dust extraction systems shall be such that the work zone dust concentration Respirable Particulate Matter ( RPM ) less than 10 micron should be limited to 1mg/Nm$^3$ over back ground level unless otherwise specified in the job specification.

4. The capacities of the dust extraction systems shall be selected considering at least 10% for safety over the calculated values.

5. Following Indian Standard may please be followed as design guidelines:
i) IS-638-1979 : Rubber Gasket sheet jointing
ii) IS-800-1984 (RA 1998) : Use of structural steel
iii) IS-822-1970 (RA 1997) : Inspection of welds
iv) IS-875-1987 (RA 1997) : Structural design
v) IS-1239-1990 (RA 1998) : Pipe & pipe fittings
Part I & Part II amendment 2000
Part I to Part 15
vi) IS-2062-1999 Amendment 2001 : Steel for general structure
vii) IS-2309-1989 (RA 1995) : Lighting code practice
viii) IS-2712-1998 : CAF gaskets
ix) IS-4894-1957 (RA 1994) : Centrifugal fan
x) IS-6392-1971 (RA 1998) : Design of Steel Chimney
Part I & Part II
xi) IS-8183-1993 (Amendment 1997) : Mineral wool insulation
xii) IS-14164-1994 (Amendment 2000) : Thermal insulation for 80°C to 750°C
xiii) IS-11304-1985 (RA 1993) : Air Pollution Control in steel plants

6. The duct lines shall be designed self balanced. Successful tenderer has to furnish pressure drop calculation and system capacity selection calculation before carrying out detail engineering of DE system.

7. The dust extraction system shall be designed based on norms specified in the Hand Book of American Conference of Governmental Industrial Hygienists (ACGIH) with fines factor and to meet the required fugitive emission standard based on the party’s experience.

The Successful Tenderer should calculate and decide the systems capacities of their own using the standard norms. However, in no case, the systems capacities should be less than as specified in job specification.

7. The dust extraction equipment shall be located near to the building. Approach, handling and hoisting facilities shall be provided for the equipment. Monitoring port holes of 100mm diameter with plug, platforms, approach ladders/ stairs, power socket of single phase, 50 Hz, 230 V, 15 A and monitoring equipment lifting facilities shall be provided as per the emission standards published by Central Pollution Control Board.

8. All stacks for discharge of clean air from dust extraction systems shall have a minimum height of 30m or 3m above top of roof of the tallest adjacent building / structure whichever is higher or as specified in the job specification. The efflux velocity from the stacks for dust extraction systems shall be maintained 15m/ sec.(approx.). For rain protection concentric duct to be provided on the top of stack shall be designed such that it restricts rain water entry into stack but allows the gases to move vertically upward with the above mentioned efflux velocity.

9. Generally the following air velocities shall be considered for the dust extraction systems.

At hood inlet 1.5 m /sec (max)
Ducting 18-25m/ sec
10. Suction hood for the dust extraction systems shall not be less than 5 mm thick MS sheet. The ducting shall be of circular cross section.

11. Duct lines shall have cleaning hatches of size 100mm x 75mm with air tight seals for easy cleaning of accumulated dust near bends & inter connections.

12. Horizontal duct shall be avoided as far as possible. Vertical/ inclined ducting shall be provided.

The Successful Tenderer shall include duct supports in their scope as follows:-

a) In-house ducting shall be suitably supported at approx. 3m intervals.

Ducting inside the building shall be supported on the floor or from the column/ civil beam/building structure/technological structure etc. as applicable. The location and type of supporting arrangement shall be decided by the Successful Tenderer in consultation with purchaser/or purchaser’s consultant.

b) Trestle supports shall be provided on ground for the ducting outside the building.

13. The dust extraction system shall be interlocked with the technological equipment/ conveyors. The sequence of operation shall be such that the dust extraction system shall start 5 minutes before start of the technological equipment and shall stop 5 minutes after stoppage of the technological equipment.

14. Dust Disposal System

Dust disposal system including chain / screw conveyors, double cone valve/rotary air lock valve, Dust moistener, dust storage hopper / Rotary feeder etc.

a) Chain Conveyors and Double Cone Valves

b) Chain /screw conveyors and double cone valves will be provided below the dust extraction equipment hoppers for disposal of dust. Chain / screw conveyors will have bearings with outside greasing terminal, protected from dust by packing around the glands. All the vulnerable parts requiring frequent attention will be readily accessible. If two flights of a screw coupled then, overlapping of each flight at center point shall be made for smooth flow of material.

c) Double cone valves will be made of cast iron with the carrying side hard faced. The double cone valve will be complete with shaft of EN8, cast iron housing, geared drive, geared box/geared motor etc.

d) Chain conveyor of following specification will be supplied.

- Forge link chain material = 16 Mn Cr5
- Strength of link (Breaking load) = 20 t.
- Length to suit design requirement
- Hardness of chain link - 55-60 HRC.
- Flight thickness - 10 mm.
- Bottom Plate - IS-2062-A-1999 - 8 mm thick with 10 mm SAIL HARD Liner.
- Side Plate - IS 2062-A-1999 - 6mm thick with 10mm SAIL HARD Liner.
- Top cover - IS 2062-A -1999 - 3.15 mm thick.
e) Zero speed switches will be provided for all dust disposal system drives.

e) Compensator between rotary feeder and the chain conveyors, between two conveyors and between dust moistener and rotary feeder will be provided to facilitate maintenance. Slide gates will be provided before all the double cone dust valves/rotary feeder. For calculation and design of structural members, accidental fill up of dust up to top of hoppers in worst case will be considered by Successful Tenderer.

g) **Dust hopper/ Holding hopper**

A dust storage hopper for each dust collector cell shall be provided. A pyramidal hopper with 65° valley angles shall be installed to collect the settled dust. The hopper shall have a 2 days dust storage capacity. Rack and pinion sliding gate (motorised) arrangement shall be provided at the hopper discharge. Dust conditioner of double screw type / disc palletizer with controlled moisture addition shall be provided at storage hopper outlet as defined in the Project specific TS. Vibrator if required in the hopper is to be provided. Disposal of dust to the closed truck / pneumatic system shall be done through telescopic chute as defined.

h) **Rotary Air Lock Valve**

Rotary air lock valve shall be made of cast iron with the carrying side hard faced. The rotary air lock valve shall be complete with shaft of EN8, cast iron housing, geared drive, geared box/geared motor.

15. **Instrumentation**

a) High level/ Intermediate level switch in hopper.
b) Hopper heating units as required.
c) Temperature and pressure transmitter as required,
d) Pressure gauge at inlet and outlet of dust extractor.
e) Differential pressure switch across dust extraction equipment.
f) Master controller and solenoid valve for each module as required.
g) Sequential Timer for bag filter application as required.
h) Compressed air pressure gauge and pressure regulator as required.
i) U – Tube manometer across dust extraction equipment.
j) Continuous pollutants (Particulate matter , SO\textsubscript{x}, NO\textsubscript{x} level monitoring as required.
k) Dry running protection of wet system.

16. **Platforms and access stair case**

The minimum platform width shall be 1.2 meters. The platforms shall be located at the top of hoppers, level, at the top of the gas cleaning equipment, and at the different levels required for maintenance and operation of the equipment and dampers. A safe guard rail should be provided on the platform. Safe and easy access to the platform shall be provided by providing stairways and railing. Intermediate platforms shall be provided for the bag filters. Following minimum structural member shall be considered.

Hand rail : 25 NB, IS:1239-1990
Operating Criteria

1. **As the technological equipment starts dust generation starts at material handling / transfer points.**

2. Duct isolation dampers to activate duct routes as per active technological equipment.

3. Adjust the manual butterfly balancing damper connected to the suction hoods for adequate suction of dusty air from all the hoods as per design requirement so as to control the escaping of dusts at the dust generation points.

4. **Electrical Interlocking for starting of dust extraction system:**

   Interlocking to be considered in the MCC to make sure the following sequential starting before the start of technological equipment:

   a) Rotary Airlock Valve/double cone valve.
   b) Activate dust extraction system
   c) Start Fan Motor.
   d) Open Fan Inlet Damper after appropriate time delay of fan motor starting.
   e) Activate duct line Isolation Damper in ducting network to minimise idle suction from non-operating points as per system requirement.

5. In normal condition, switching off operation of DE system should be followed as per following sequence:

   a) Stopping of Technological Equipment
   b) Fan Motor.
   c) Fan inlet damper.
   d) Rotary Air Lock / Double cone valve after appropriate time delay.
   e) Deactivate Dust Extraction Equipment

**Note:** In case the RAL/Double Cone Valve trips the fan motor should also trip to avoid uncontrolled accumulation of collected dust in Dust Extraction Equipment hopper which otherwise may result into choking/clogging of Dust Disposal System.

The Successful Tenderer will examine the above logic and operating principle of the DE system and changes, if any, necessary for trouble free operation of the system being offered by the party shall be indicated.
DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The following data shall be furnished by the tenderer along with the offers.

11. Type of dust extraction system
12. Total capacity of dust extraction system
13. Make of equipment
14. Design suction quantity
15. Outlet emission quantity
16. Work zone dust concentration
17. Total power requirement
18. Total water requirement
19. Any specific design consideration
20. Noise level at 1m distance from the dust extraction equipment
21. Space requirement (L x B x H)
22. Support / Structure / Weathering shed DE system

13. Dust Disposal Arrangement
   Conveyor, Type, nos. capacity tph
   - Rotary air lock valve capacity tph & nos.
   - Slide gate (Manual)
   - Expansion joint at outlet of RAL
   - Rotary feeder
   - Dust moistener
   - Water requirement m3/h at kg/cm2
   - Dust bin
   - Storage Hopper
     a) Volume in m3
     b) Type
     c) Size (L x B x H)
     d) Motor rating kW & Pole of rack and pinion type discharge gate.
     e) Material / thickness of hopper
   - Zero speed switch of drives

14. Instrumentation
   Bearing & winding temperature monitor of fan & motor
   Pressure transmitter
   Temperature transmitter
   Level switch
   Thermostat for heaters

15. Weight of Dust Extraction Equipment & structure
   - Structures
   - Dust Extraction Equipment - casing, hopper, internals, Insulation & cladding as applicable, storage hopper, expansion joints & dust disposal equipment
   - Fan with drive & accessories
   - Duct, suction hood & duct line damper
   - Steel stack
   - Auxiliary equipment as per job specification requirement
3.0 DUST SUPPRESSION SYSTEM (SS3)

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of Dust Suppression System with all accessories required to be installed to achieve desired performance in all respect. Specific technical requirement of Dust Suppression System if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Dust Suppression System is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02. Description Of The Dust Suppression System

There are essentially three types of dust suppression system applied to control pollution in bulk material handling. They are spraying of only water at material transfer points, spraying a solution of water & chemical compound at material transfer points, a dual fluid water and compressed air supplied through nozzle for production of ultra fine water particles, i.e. fog at material transfer points.

02.1 Plain water type dust suppression system

In plain water dust suppression system in general plain water at high pressure is sprayed over stockpile area. This type of system is envisaged for the stockpile area to suppress the generated dust due to stacking / reclamation. Spray water header will be provided along the stockpiles. Dust suppression system is to be designed to prevent lift of dust from stockpiles. Water spray over the stockpile area is produced by sufficient number of sprinklers suitably installed in a header to cover the entire stockpile area. Plain water may be sprayed at transfer station as per job specification requirement.

The sprinklers should be of swiveling type. Each sprinkler operation cycle is to be controlled by a sequential timer to have optimum consumption of water. Water will be stored in a feed water tank. In the supply waterline to feed water tank float valve shall be provided. One additional quick fill line to water storage tank shall be provided. Water from feed water tank shall be supplied to different spray header by a high-pressure pump. Sprinkler post of approx. required height should be installed on the spray header along one/ both side of ores/ coal stockpile area. Before each sprinkler globe valve & solenoid valve shall be provided for manual control and automatic control respectively. The water pump is interlocked with low level switch of feed water tank to prevent the pump from dry running. A pressure switch at the pump discharge line shall be provided to by pass water to storage tank. A solenoid valve in by pass line shall be energized by high-pressure signal from pressure switch.

02.2 Chemically treated water type dust suppression system

Chemically treated dust suppression system work on the principle of agglomeration. Dust particles released from material handling become air borne, are made to pass through a blanket of extremely fine water droplets. The dust particle and the droplets collide and adhere to each other, thus increasing their mass. After a series of such collision the dust particles mass become heavy. The system implies spraying of chemical compound wetting agent and water mixture in certain ratio at each material transfer points. Chemical solution at the pressure of 4 Kg/cm2 supplied at the atomising nozzles. The wetting agent (chemical compound) from drum is transferred to solution tank with the help of metering pump (one working and one reserve). Chemical compounds is added in measured quantity in the feed water line to solution tank. The tank is provided with high, low and very low level switch.
There are two-solution pumps (one working and one reserve). Any one of the solution pump can be started if the tank is filled above the low level switch of solution tank and any one of the solenoid valve at spray point is energised. Feed water pump will start when solution level in solution tank reaches low level. Metering pump operation is interlocked with feed water pump. Feed water pump will stop when water level in solution tank reaches high level. In case of very low level in solution tank solution pump will stop. In case of low level in water storage tank feed water pump will stop. A pressure switch at the solution pump discharge line shall be provided to by pass water to solution tank. Solenoid valve in by pass line shall be energised by high-pressure signal from pressure switch. Solenoid valve shall be installed in pipeline in a box at each junction house point to cater solution spray at belt discharge point and belt receiving point. Solenoid valve operation should be interlocked with conveyor motor and load sensor unit. Conveyor motor running under load will draw high current compare to conveyor running under no load. A current transformer located in the power cable circuit will monitor conveyor motor current and shall be interlocked with the operation of solenoid valve.

Chemically treated dust suppression system should be provided for the material transfer points in junction houses.

### 02.3 Dry Fog Dust Suppression System

The Dry Fog dust Suppression (“DFDS”- water atomization with compressed air) system works on the principle of agglomeration. Water and compressed air are mixed in atomizing nozzles which produces an ultra fine droplets size fog when sprayed and achieve dust suppression through agglomeration. Dust particles released from a material handling or processing plant which becomes airborne, are made to pass through a blanket of extremely fine fog. The dust particles and the micronic sized fog droplets collide and adhere to each other, thus increasing their mass. After a series of such collisions, the mass becomes heavy enough to cause settlement of the agglomerates on to the larger mass of the material being handled.

The System uses an air Driven Acoustic Oscillator Nozzle which is capable of producing supper fine atomization of water droplets that greatly increase the dust particle to water droplet contact resulting in settlement of dust. The fine droplets evaporate before wetting anything but the dust. The approximate water addition is 0.1% of the weight of material being handled.

#### Description of Scheme

The DFDS system comprising main equipment installed at the application points and auxiliary equipment installed at central water and compressed air supply point. Brief components of both type of equipment are mentioned below:

- **Main Equipment**

  The Main Equipment will include Spray Bar Assemblies fitted with Dual-fluid air Driven Acoustic Oscillator Atomizing Nozzles, Pressure Regulating Units and Flow Activation Stations for ON-OFF Control of the System and Instrumentation for Auto Operation.

- **Auxiliary Equipment**

  The Auxiliary Equipment will include Water Storage and Pumping Unit with duplex Water Filter Compressors with air receivers and Associated Electrical Works, Air and Water Piping, Enclosures etc.
02.4 Elements of dust suppression system

In general following elements specification shall be considered as described in respective equipment specification.

- CENTRIFUGAL PUMP – ES5
- VALVES – ES24

Spray nozzles

Spray nozzles for dust suppression systems shall be of fog-jet type and shall have a solid cone spray pattern with a round impact area and minimum spray angle of 60°.

The nozzles should produce spray distribution of fine sized droplets at the given flow rate and pressure and should provide complete coverage of the spraying area or zone.

The nozzle housing shall be made of cast aluminium alloy and the tip shall be of stainless steel conforming to AISI-410 or SS-304 with SS strainer.

The nozzles should be of self cleaning type with in-built filters made of brass.

Sprinklers

Circular swiveling type sprinklers shall be provided for dust suppression system of stockpiles to spray water and prevent fugitive dust emission.

The brief specification of the sprinklers is as follows.

<table>
<thead>
<tr>
<th>Size of inlet connection</th>
<th>To suit stand-post pipe size and fittings.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprinkler type</td>
<td>Circular swiveling type</td>
</tr>
<tr>
<td>Material</td>
<td>Cast Iron swiveling arm</td>
</tr>
<tr>
<td></td>
<td>Cast aluminum alloy body</td>
</tr>
<tr>
<td></td>
<td>SS nozzle</td>
</tr>
</tbody>
</table>

This specification specifies general requirement of dust suppression system for different application.

02.5 DESIGN CRITERIA

1. The dust extraction systems shall be such that the work zone dust concentration Respirable Particulate Matter (RPM) less than 10 micron should be limited to 1mg/Nm³ over ambient unless otherwise specified in the job specification.

i. The capacities of the dust suppression systems shall be selected considering at least 10% for safety over the calculated values.

ii. Following Indian Standard may please be followed as design guidelines:

a. IS-638-1979 : Rubber Gasket sheet jointing
b. IS-800-1984 (RA 1998) : Use of structural steel
### General Technical Specification

**c.** IS-822-1970 (RA 1997) : Inspection of welds  
**d.** IS-875-1987 (RA 1997) : Structural design  
**e.** IS-1239-1990 (RA 1998) : Pipe & pipe fittings  
   Part I &  
   Part II amendment 2000  
**f.** IS-1364-1992 (RA 1998) : Hexagonal nuts & bolts  
   Part I to Part 15  
**g.** IS-2062-1999 Amendment 2001 : Steel for general structure  
**h.** IS-2712-1998 : CAF gaskets  
**i.** IS-11304-1985 (RA 1993) : Air Pollution Control in steel plants  
**j.** IS-10221 – 1982 (RA 1997) : Wrapping and coating of underground MS Pipe

**iii.** The pipelines shall be self balanced without use of valves.

The Successful Tenderer should calculate and decide the system capacities on their own using the standard norms. However, in no case, the system capacities should be less than as specified in job specification.

**iv.** The dust suppression equipment shall be located near to the application area. Approach, handling and hoisting facilities shall be provided for the equipment.

**v.** Generally the water line velocity shall be considered for the dust suppression system 0.75 to 1.5m/sec.

**vi.** Pipeline shall be of heavy class construction.

The Successful Tenderer shall include pipe supports in their scope as follows-

**a.** In-house piping shall be suitably supported at approx. 2.5m intervals. piping inside the building shall be supported on the floor or from the column/ civil beam/building structure/technological structure etc. as applicable. The location and type of supporting arrangement shall be decided by the Successful Tenderer in consultation with purchaser/or purchaser’s consultant.

**b.** Outdoor piping may be required to be led through underground trench work with wrapping coating arrangement

**vii.** **Instrumentation**

**a.** High level/ Intermediate level switch in water tanks.

**b.** Pressure gauge at pump outlet of dust suppression system

**c.** Pressure/ flow switch at pump outlet

**d.** Sequence timer for sprinkler operation control as required.

**e.** Load monitoring switch for noting conveyor running on load

**f.** Flow meter at pump discharge line for large DS system or as specified in the job specification.
03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The following data shall be furnished by the tenderer along with the offers.

23. Type of dust suppression system
24. Total capacity of dust suppression system
25. Make of equipment
26. Design water flow quantity
27. Work zone dust concentration
28. Total power requirement
29. Total water requirement
30. Any specific design consideration
31. Noise level at 1m distance from the dust suppression equipment
32. Space requirement (L x B x H)
33. Support / Structure / Weathering shed DS system
34. List of drive
35. Spray nozzle make rating, quantity
36. Spray nozzle material of construction
37. Sprinkler make, rating, quantity
38. Sprinkler material of construction
39. Load monitoring switch type, quantity and rating
40. Sequence timer type, quantity and rating
41. Solenoid valve type, quantity and rating
4.0 SYSTEM SPECIFICATION OF VENTILATION SYSTEM (SS4)

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of Ventilation System with all accessories required to be installed for HVAC application to achieve desired performance in all respect. Specific technical requirement of Ventilation System if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Ventilation System is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02. Description

Ventilation system shall be provided 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 system generally include one or more items of equipment and accessories such as fans, air filters, duct work, pumps, air washer, air supply grills, dampers, insulation, instrumentation and controls, electrics, etc.

Ventilation system will be designed considering the climatic conditions prevailing in the region and the plants will generally be installed in separate plant rooms independent of the served premises. The plant rooms will be provided integral with and adjacent to the served premises at proper locations on considerations of convenience of routing of ducts/pipes, availability of fresh uncontaminated air and creating least disturbance to the adjacent premises in terms of vibration and noise.

Ventilation system will be provided with adequate measures for safety and fire fighting for fire hazardous areas and shall be of flame proof/explosion proof construction.

Detail item specification of following accessories for HVAC System is mentioned in the respective Equipment Specification.

- Centrifugal Fan – Reference ES4
- Tube Axial Fan – Reference ES23
- Propeller Fan – Reference ES20
- Ducting network for HVAC system – Reference ES13
- Air Washer - Reference ES2
- Thermal insulation for HVAC Application – Reference ES17.
- Damper – Reference ES10.
- Filter Dry Type – Reference ES15.
- Filter Viscous Oil Type – Reference ES16.

Ventilation facilities

Buildings and shops will generally be provided natural ventilation. Mechanical ventilation will be provided for premises where adequate ventilation cannot be provided by natural means alone. 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. Filters will be provided with plenum systems. By plenum ventilation, the served premises will be pressurised to 2-3 mmWC to avoid ingress of dusty air. Hot

Ventilation facilities for different premises
Location/Shop Facilities

<table>
<thead>
<tr>
<th>Location/Shop</th>
<th>Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical premises, Switch gear rooms, Cable basements of Electrical sub stations</td>
<td>Pressurised ventilation with or without air washer as per job specification requirement</td>
</tr>
<tr>
<td>Compressed air stations</td>
<td>Exhaust ventilation</td>
</tr>
<tr>
<td>Battery rooms</td>
<td>Exhaust ventilation</td>
</tr>
<tr>
<td>Pump houses</td>
<td>Air cooled type ventilation</td>
</tr>
<tr>
<td>Toilets/Stores rooms</td>
<td>Exhaust ventilation</td>
</tr>
<tr>
<td>Hot working spots</td>
<td>Portable ventilation</td>
</tr>
</tbody>
</table>

Work areas will be provided with portable man-coolers for spot cooling. Man-coolers will be provided also in a few other areas where the premises are manned and have high heat radiation. General details and types of system to be considered is mentioned below. However, specific requirement of ventilation system shall be provided in line with job specification requirement.

The temperature of the Electrical premises and other sub-stations shall be maintained at in the range of 35 ~ 37 deg C right through the year by the provision of suitable air-cooling system. Air changes for air-cooling system shall be considered minimum 15 and for dry ventilation minimum system 20. Water eliminator in air washer shall be made of PVC.

The temperature of the areas being exhaust ventilated shall not exceed 3 deg C above the ambient at any part of the year.

Following Indian Standard may please be followed as design guidelines:

i) IS-638-1979 : Rubber Gasket sheet jointing
ii) IS-800-1984 (RA 1998) : Use of structural steel
iii) IS-822-1970 (RA 1997) : Inspection of welds
iv) IS-1239-1990 (RA 1998) : Pipe & pipe fittings
   Part I & Part II amendment 2000
   Part I to Part 15
vi) IS-2062-1999 Amendment 2001 : Steel for general structure
vii) IS-2712-1998 : CAF gaskets
viii) IS-4894-1957 (RA 1994) : Centrifugal fan
ix) IS-3588-1987 (RA 1994) : Tube Axial Fan
   Part I & Part II
x) IS-8183-1993 (Amendment 1997) : Mineral wool insulation
xiii) IS-2312-1967 (RA 1994) : Propeller fan
DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The following data shall be furnished by the tenderer along with the offers.

42. Type of ventilation system
43. Total capacity of ventilation system
44. Make of equipment
45. Design cooling load
46. Indoor climatic condition shall be maintained
47. Total power requirement
48. Air change/hr
49. Total water requirement
50. Any specific design consideration
51. Noise level at 1m distance from the ventilation equipment
52. Noise level at served premises
5.0 ES1 - AIR HANDLING UNIT/FAN COIL UNIT

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of Air Handling Unit (AHU)/Fan Coil Unit (FCU) with all accessories to make operation of Air Handling Unit (AHU)/Fan Coil Unit (FCU) complete in all respect. Specific technical requirement of Axial Flow Fan if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of the Air Handling Unit (AHU)/Fan Coil Unit (FCU) is given below under clause No. 02. The equipment-wise list of data to be furnished by the tenderer along with the offer is shown below under clause No. 03.

Job specification of the project shall be referred for any specific requirement.

02 Description

Air handling units / fan coil units (FCUs)

The Air handling unit / FCU shall be of Fabricated construction, comprising of the following sections:

The air handling unit comprising of fan section, cooling coil section and pre-filter section. The AHU shall be of double skin panel construction. Double skin sandwich panels shall be fabricated from 22 gauge GI sheet. Minimum zinc deposition shall conform to Grade 275 of IS 277,1992. AHU casing shall be thermally insulated with 25 mm thick PUF board in between the outer and inner skin. The unit sections are mounted on galvanized sheet steel channel & aluminium die cast legs. Panels shall be fitted to Al frame work with neoprene gaskets & screws. The framework of AHU casing shall be assembled by means of reinforced nylon corners. The fan section of the casing shall be provided with access door. Aluminium die cast hinges & handles shall be used in access door. Fan impeller shall be of backward curved blade centrifugal type. Impeller shall be of double width double inlet. Impeller blades shall be fabricated from heavy gauge galvanised sheet steel or MS with spray galvanized. Fan rpm shall not be more than 750 rpm. Flexible connection & volume control damper (opposed blade type) shall be provided at fan outlet.

Blower fan shall be statically and dynamically balanced as per ISO1940 Gr 2.5. The first critical speed of the rotating assembly shall be at least 25% above the operating speed. The motor & blower assembly shall be isolated from the main frame by means of spring. Motor & fan assembly shall be mounted on base frame made of aluminium profiles and fixed on antivibration rubber mounts. Motor shall be mounted on a slide rail to adjust the belt tension. Fan shall be coupled to motor by V belts. V belts shall be provided with guards that do not impede the air flow to the fan inlet. Make of AHU fan
will be Nicorta/ Kruger/ Comferi. Fan static pressure shall be 65 mmwc or more (as required based on pressure drop calculation).

Chilled water cooling coils shall be constructed with copper tubes with fins of aluminium. Thickness of Cu tubes shall be minimum 0.75 mm thick and fins spacing shall be minimum 10 fins per inch. Cooling coil header shall be of GI. Chilled water coils shall be provide with suitable vent and drain connections. Drain pan shall be fabricated from minimum 22 G stainless steel sheet and stainless steel nipple for drain connection. The entire assembly shall be mounted on PUF insulated bottom panel. Condensate drain pipe of required length with sealing loop shall be provided and be insulated. The drain from drain pan shall be connected to floor drain. Air velocity through cooling coil shall not exceed 2.5 m/sec. Water pressure drop through cooling coil shall be limited to 5 mwc. Rows of cooling coil of AHUs shall be 6, however for 100% fresh air application Rows of cooling coil of AHUs shall be 8.

Chilled water flow through AHU will be controlled by 3 way mixing valve. A bypass line around 3 way valves shall be provided. Make of 3 ways valve shall be Honeywell/ Johnson/ Siemens/ Sauter.

Temperature switch and transmitter for monitoring of chilled water and served premises temperature shall be provided.

Fan coil units (FCUs) shall be wall mounted or ceiling suspended type and shall be installed inside the served premises for small isolated cabins / rooms.

03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The following data shall be furnished by the tenderer along with the offer for Air handling unit/fan coil unit.

A. General

a) Make & Model No.
b) Type of unit (Horizontal/vertical)
c) Overall dimensions (mm)
d) Weight (kg)
e) Noise level at 1 meter distance in dB(A)
f) Vibration level
g) Vibration isolations details

B. Fan Section

a) Air quantity (m$^3$/hr)
b) Total/static pressure (mmWC)
c) Fan speed (RPM)
d) Fan dia (mm) & number
e) Balancing (Static and dynamic)
f) Fan motor (KW)
g) Type of fan/size/make
h) BHP
i) Type of starter

C. Cooling coil
   a) Coil fin materials
   b) Tube dia (mm) and thickness
   c) Fin size (mm)
   d) No. of fins per inch
   e) Outside coil surface (m^2)
   f) Face area (m^2)
   g) Row deep
   h) ADP (deg C)
   i) Bypass factor
   j) Selected air velocity across coil (m/sec)
   k) Make of cooling coil
   l) Water through coil in m^3/hr.
   m) Water velocity through coil in m/sec.
   n) Water coil pressure drop in kg/cm²
   o) Water temperature in/out in degree C.

D. Filter section Pre filter
   a) Type & make
   b) Gross filter area (m^2)
   c) Velocity through filter (m/sec)
   d) Pressure drop through filter when dirty & when clean (mmWC)
   e) Efficiency
   f) Filter box construction details
   g) Overall dimensions & No. of filters
   h) Fixing frame details
   i) Recommended methods of cleaning
6.0  (ES2) AIR WASHER UNIT

01  General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of Air Washer Unit with all accessories required to be installed for HVAC application to achieve desired performance in all respect. Specific technical requirement of Air Washer Unit if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Air Washer Unit is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02  Description of air washer unit

Air washer unit comprises of intermediate chambers at inlet and outlet, air washing chamber with water tank. The water tank. Adapter section shall be provided for connecting air washer unit with other equipment. Description of these items are given below:

**Air washing chamber with water tank**

The air washer is used for evaporative cooling of air. The air washer shall be complete with headers, spraying brass nozzles, air distributors, water droplet eliminators, make up water connection with float valve, strainer, overflow connection, quick filling connection, drain connection and other standard accessories. The number of nozzles, size, headers and their disposition shall be suitable for the saturation efficiency of not less than 90% for air washer. The door with viewing port shall be provided for servicing the chamber. The lower portion of the air washer shall serve as tank.

Water of the air washer tank shall be recirculated through pump ( 1 W + 1 S ) & piping network consisting of suction pipes, pot strainers, valves, delivery pipes with branches and spray nozzles etc. The air distributor (perforated plate) shall be provided at the inlet of spray chamber for proper distribution of air to the spray chamber. The PVC droplet eliminator shall be provided at the outlet of spray chamber to arrest/prevent the water droplets from the air going out of the spray chamber. Water loss in the air washing unit shall be filled by the make up water. Make up water from separate source shall be taken to the air washer tank through necessary make up water pipe line with float and globe valves. Another quick fill water pipe line also shall be provided with gate valve for the air washer tank filling. Temperature gauges, pressure gauges, water proof lights, manometer shall be provided at the air washer chambers. Dry running protection of re-circulating pump with water flow switch / tank level switch shall be provided. Drain connections with valves shall be provided for all the three chambers of air washer equipment. The over flow pipe shall also be provided for air washer tank which shall be connected to its drain pipe after/below the valve of the drain pipe.

The casing and tank shall be made of mild steel plate with black bituminous protective paints. The distributor and eliminators shall be made of galvanised sheet steel.

The sheet thickness for air washer tank shall be 6mm and for the body of the air washer shall be 4 mm unless otherwise specified in the TS.
The water proof lights shall be provided inside the chambers of the air washer with lead wiring and switches. Low level switch at air washer tank & interlocked with the re-circulating pump shall be provided.

Air washing chamber shall be provided with drilled flanges at both ends to connect with intermediate chambers on both sides. Rubber gaskets shall be provided at the connection point of intermediate chambers and at inspection window to prevent water leakage.

Water Eliminator shall be PVC baffle arranged such that no water droplets are carried away with the air stream.

The water pipelines shall be of galvanised iron pipes. The nozzles shall be made of brass or gun metal unless otherwise mentioned in the TS.

The face velocity shall not be more than 2.5 m/sec.

Resistance to air flow in washing chamber shall not exceed 15 kgf/m².

The air washer with the tank shall be mounted on a foundation made on the floor of the ventilation room.

**Masonry construction air washer chamber may be required to be installed as per job specification requirement.**

**Intermediate chamber**

Intermediate chamber shall be fabricated out of heavy gauge steel sheet (not less than 4mm thick) with drilled flanges at both ends. Water proof light with lead wiring and switches, air-tight door, coupling for installing check instruments, drain connection etc. shall be provided with the intermediate chambers.

**Adapter section**

Connecting box/transition piece/reducer shall connect the intermediate chamber with fan inlet through flexible connection. It shall be fabricated out of heavy gauge steel sheet with drilled flanges at both ends of minimum thickness 3.15 mm.

**Supports for intermediate chamber**

Triangular leg type (Δ shaped) supports shall be provided on the floor for supporting the intermediate chambers.

**01.02 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER**

The following data air washer unit shall be furnished by the tenderer along with the offer.

a) **Air washing chamber with water tank**

1. Make & Model No.
2. Type of unit (Horizontal/vertical)
### General Technical Specification

**3.** Overall dimensions (mm)  
**4.** Weight (kg) with and without water  
**5.** Air flow capacity in m$^3$/h.  
**6.** Air flow velocity  
**7.** Total Pressure drop, kgf/ m$^2$  
**8.** Material of construction, diameter and numbers of spray header pipes  
**9.** Material of construction, diameter and number of nozzles  
**10.** Make up water requirement  
**11.** Details of make up, over flow, drainage, supply and return water pipe lines  
**12.** Saturation efficiency  
**13.** Amount of water and its pressure at the nozzle  
**14.** Material of construction and thickness of casing, tank, air distributor plate  
**15.** Water tank capacity  
**16.** Mounting supports  
**17.** Details of mist /droplet eliminator : material of construction, material thickness and depth.

---

#### b) Intermediate chamber

1. Size  
2. Material of construction  
3. Thickness of material

#### c) Adaptor section

1. Size  
2. Material of construction  
3. Thickness of material

#### d) Re-circulating water system

1. Pump capacity & head, motor KW  
2. Re-circulating piping & fitting;  
3. Strainer & valve  
4. Instruments – pressure gauge, temperature gauge, water flow switch, manometer
7.0 ES3 - BAG FILTER

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of Bag Filter with all accessories required to be installed for Dedusting System application to achieve desired performance in all respect. Specific technical requirement of Bag Filter System if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Bag Filter System is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02. Description of bag filter system

Constructional Features

The bag filter assembly shall generally consist of the following:

- Module shell.
- Hopper for each module with RAVS/Screw conveyor with RAVS.
- Storage hopper with rack & pinion gate valves
- Housing and roof panels.
- Tube plate.
- Compressed air distribution system.
- Access doors.
- Filter bags and cages.
- Inlet and outlet manifolds.

The bag filter shall have a plenum chamber, which distributes the incoming gas onto an array of fabric filter bags. Dust particles shall be entrapped on the filter fabric, cake lining the bag surface by straining, impingement, interception and electrostatic attraction. Rotary air lock valves shall be provided at the bottom of bag filter hopper for dust removal and air sealing.

Normally bag filter casing thickness shall be 5 mm with sufficient stiffener to withstand design static pressure inside Bag filter chamber.

The inlet air plenum for the fabric filter should feature a tapered feed duct in order to ensure uniform gas flow distribution to all cells.

Air entry to the cells should be directed uniformly by angles deflection louvers to ensure complete bag usage within the cell. Cross horizontal flows shall not impinge on the bags in any area.

The bag fixing arrangement shall be such so as to enable easy and quick changing of bags.

Bags shall be hung as near as practicable to vertical so that the bags are not touching anywhere along their length. The Bag filter shall have antistatic Bags and spark proof design for the coke/coal application.

Particular attention shall be paid to the layout of the bags. A minimum distance of 75 mm between the bags and the closest fabric surface such as walls or columns of the casing shall be provided. The spacing between the bags shall be 50 mm (minimum).
**Required Air/cloth ratio**

The contractor should design the pulse-jet fabric filter dust collector to operate under design flow conditions with a gas/air to cloth ratio as 1.4 m$^3$/min/m$^2$ unless otherwise specified in the project specification. However, the same can vary from 1.0 to 1.8 depending on fabric and dust material to be handled.

**Bag Cleaning**

The bag filters shall be of on line / off line cleaning pulse-jet type as specified in the job specification. Material of construction of bags shall be selected based on operating temperature, dust quality, quantity and composition and air quality. The cleaning of bags shall be carried out in a predetermined cycle by high-pressure pulse of compressed air by automatic operation of solenoid valve with timer.

A differential pressure measurement system shall be provided across the bag house. As the dust collects over the bags, the pressure drop shall be sensed by this system. As this drop exceeds a preset value the differential pressure measurement system shall send a pulse to start the bag cleaning operation.

Compressed air shall be the cleaning medium and this shall enter the bags in short surges thus inflating the bags. The dust shall collect in the hoppers provided and shall be transferred by conveyor/ RAVS to holding hopper. In general centralized Compressed air network with air drier shall be provided to ensure supply of dirt and moisture free compressed air for bag cleaning as per job specification requirement.

The successful tenderer shall supply compressor along with drive and accessories safety valve, pressure gauge, air filter cum moisture separator unless otherwise specified in the job specification.

**Dust hopper/ Holding hopper**

A dust storage hopper for each fabric filter module shall be provided. A inverted pyramidal hopper with 65° valley angles shall be installed to collect the settled dust. Vibrator if required in the hopper is to be provided. For hot gas cleaning system hopper heater with thermal insulation shall be provided to reduce chance of condensation in hopper. Normally storage hopper thickness shall be 8mm unless defined in the TS.

**Platforms and access stair case**

The minimum platform width shall be 1.2 meters. The platforms shall be located at the top of hoppers, level, at the top of the gas cleaning equipment, and at the different levels required for maintenance and operation of the equipment and dampers. A safe guard rail should be provided on the platform. Providing stairways and railing shall provide safe and easy access to the platform. Intermediate platforms shall be provided for the bag filters. Following minimum structural member shall be considered.

<table>
<thead>
<tr>
<th>Part</th>
<th>Thickness, Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand rail</td>
<td>25 NB, IS:1239-1990</td>
</tr>
<tr>
<td>Post</td>
<td>32 NB, IS:1239-1990</td>
</tr>
<tr>
<td>Access grating</td>
<td>40 depth, 6 thick</td>
</tr>
<tr>
<td>Stair</td>
<td>40 C/C, 38° slope</td>
</tr>
</tbody>
</table>
Electrics For Bag Filter System of Each DE System

The Electrics for bag filters of D.E. system will consist of pressure switches cum indicator in the compressed air line, differential pressure switches, solenoid valves, control panel and all other associated equipment. The brief specification of the major components will be as given below:

Control panel for Bag filter

The control panel will be free standing, floor mounting, fabricated from 2.0 mm thick CRCA sheet steel on a base channel of size 77 mm x 40 mm (ISMC - 75) provided with cable gland plates, having synthetic rubber gasketting, provided with double door & canopy and enclosure conforming to IPW-55. The control panel will be factory assembled, wired with 1.1 kV grade PVC flexible wire of copper conductor (minimum size 2.5 sq.mm), factory painted. The control panel will be provided with following major equipment:

a) Incoming switch (minimum 32A, AC23 duty) with operating handle interlocked with the door, HRC fuses, contactors, MCBs in the various circuits.

b) Control transformer of required VA rating having +/-5 percent and +/- 2.5 percent tappings in the primary side of the control transformer with Isolating switches/MCBs in the primary & secondary sides.

c) 24V DC full wave power pack complete with filter and protective elements and also isolation cum short circuit protection both at AC and DC sides for power supply to solenoid valves.

d) Auxiliary contactor for control power supply monitoring, interlocking, and controls etc.

e) Auto-manual selector switches, push button switches, indication lamps, various monitoring devices, terminals (with 20 percent spare terminals) and other circuit elements required for control and monitoring.

f) Solid state Bag filter timer.

The bag filter timer will be solid state device suitable for dusty, tropical and specified aggressive environment. The bag filter timer will be provided with internal semi-conductor fuse protection and will have provision for pulse frequency setting and pulse duration setting through independent operating knobs. The number of contacts in the timer will be equal to number of solenoid operated valves so that the timer will energise only one solenoid valve at a time and shall operate in sequence.

The Bag Filter Timer will provide timed sequential energisation of 24V DC operated solenoid valves of bag filters. LEDs for each solenoid energisation, power ON in PCB, feed back relay will be provided with potential free contacts which will close under following conditions:

i) Fault in the PCB.

ii) Open contact in the output side connected to individual solenoid valves. The contact will not close in the event of power failure to the controller.

iii) The sequential control (i.e. process) will start when the Differential Pressure (DP) switch is actuated at the first set point for normal operation. The process will continue till the pressure differential drops below the set value. When again the DP
switch is actuated the process will continue from the previous position (i.e. next solenoid valve). However, when the power supply to sequential controller trips, the process will stop and sequential controller is reset to first load position enabling the process to start from the beginning.

iv) Sufficient space will be provided for installation of bag filter panel with required front clearances for operation and maintenance including side and back clearances as required.

**Differential Pressure Switch**

i) The differential pressure switch will have two sets of independent micro-switches. The first set will be used for normal sequential cleaning operation of the bag filters as per lower set value of differential pressure. This set point will be independently adjustable.

ii) The second set of N.O. contact will close at upper set value of differential pressure representing clogged condition of bag filter and will be used for signaling and monitoring. This set point will also be independently adjustable. The contacts will be rated for 5 Amp, 240V AC.

iii) The DP switch will be suitable for outdoor installation. The DP switch casing will be made of pressure die cast Aluminum with enclosure conforming to IP-66.

iv) One number differential pressure switch with two set points will be provided for each module of the Bag filter. Alternatively, two numbers of DP switches may be provided for each module one for initiation of bag cleaning operation and other for signaling and monitoring of clogged condition.

v) Manometer across filter.

**Solenoids**

i) The solenoid coil will have encapsulated coil (class F’ insulated with a water proof (IP-65) plug-on connector. The coil will be suitable for 24V DC having + 10 % to -15 % voltage variations. The coil will be made of copper conductor.

**Air Pressure Switch cum indicator**

i) One number compressed air pressure switch cum indicator will be provided for each bag filter system in the incoming compressed air pipeline of the bag filter. The pressure range will match with the operating pressure. The switches will be snap action type with 1 NO + 1 NC contacts of 5A, 240 V AC. These contacts will be wired up to terminals in the bag filter control panel. The enclosure of the air pressure switch will be pressure die cast aluminum conforming to IP-65.

**GENERAL ELECTRICAL LOGIC AND OPERATING PRINCIPLE OF THE BAG FILTER SYSTEM**

A. Mainly the differential pressure will govern the Dedusting Bag Filter system across the Dedusting Modules.

The total electrical logic will be controlled by the Devices like Differential Pressure Switch (DPS), solid-state sequential multi channel timer, solid-state master card, solenoid operated Diaphragm valves, inlet compressed air line pressure switch (P.S.) etc. DPS will be connected across the clean and dirty Air Chamber of the Bag Filter Module to measure the Pressure
Differential. As the Filtration process commences, there is a gradual build up of dust on the Filter Bags which generates Differential Pressure. When this Differential Pressure attains a Pre-set value based on inlet dust concentration, type of dust and its particle size distribution, the differential pressure switch will get energized and send signal to the master card located in the control panel.

The master card will actuate the timer whose channels are connected with solenoid valves mounted on the compressed air header-Air Manifold Tank. Through the timer, the solenoid coil gets magnetized and makes an opening for the compressed air to flow from air manifold tank to pulse header pipe.

The pulse duration time will be adjustable. During this time the solenoid coil will remain energised allowing pulse air to flow. Energisation of other solenoid will take place in sequence one after the other. The time gap between the two-solenoid energisation will also be adjustable.

The process continues till the pressure differential drops below the set value. The D.P. Switch then gets de-energised which in turn cuts off the timer resulting in de-energisation of solenoid valves. The process will repeat again from the next solenoid valve based on the pressure differential switch and signal from the master card.

A pressure switch mounted on the compressed air line will sense the available pressure and dedusting system/centrifugal fan will switched off in case the available pressure falls below the specified pressure in compressed air line.

B. Following sequential steps of operation will be followed before actually switching on the main technological equipment to be dedusted:

1) Screw conveyor drives along with rotary air lock drive will be started first.

2) a) Setting differential pressure in differential pressure switch at the initial time of commissioning and for re-commissioning after long gap with clean Filter bags.

   b) Power to timer to be switched ON

3) Fan motor to be started in the inlet Damper closed condition. After appropriate time delay fan inlet damper to be opened.

DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER:-

The tenderer along with the offer shall furnish the following data:

Bag filter

1. Make, type and quantity
2. Model No.
3. Type of bag filter
4. Capacity in m$^3$/hr
5. Filtering area in m$^2$
6. Fabric type
7. No. of bags
8. Diameter & length of bags in mm
9. Filtering velocity m/sec.
10. Pressure drop in mm WC
11. Weight of bag filter in kg (without dust)
12. Weight of bag filter in kg (with dust)
13. Efficiency of bag filter Vs particle size
14. Material / thickness of bag filter casing in mm.
15. Material / thickness of bag filter hopper in mm.
16. Compressed air requirement m$^3$/hr.
17. Compressed air pressure
18. Compressed air quality
19. Velocity of air at inlet / outlet in m/sec.
20. Fixing arrangement of filter bags
21. Space requirement (L x B x H)
22. Rotary Air Lock Valve details
   a) Quantity
   b) Capacity in m$^3$/hr (at 50% filling)
   c) Speed in rpm
   d) Motor rating kW & Pole.
23. Storage Hopper
   f) Volume in m$^3$
   g) Type
   h) Size (L x B x H)
   i) Motor rating kW & Pole of rack & pinion type discharge gate.
   j) Material / thickness of hopper
24. Support / Structure / Weathering shed for bag filter
8.0 **ES4 - CENTRIFUGAL FAN**

01 **General**

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of different type of Centrifugal Fan required to be installed for HVAC, Dust Extraction, Combustion System process application with all accessories to achieve desired performance. Specific technical requirement of Centrifugal Fan if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of different type of Centrifugal Fan is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02 **Description of Centrifugal Fan**

Generally the fans shall be of limit load design. Centrifugal Fan design shall conform to IS 4894 – 1987 (Reaffirmed 1991).

The fan shall be of rugged steel construction, industrial duty type and suitable for the proposed project/plant. Fan housing shall be of welded construction and provided with flanges at inlet and outlet sides for duct connections.

The fan unit shall be free from undue noise and vibration during operation; normally the fan speed shall not be more than 1500 RPM, preferably less than 1000 RPM.

The fan shall be both statically and dynamically balanced as per ISO:1940. In general HVAC system application balancing grade shall be of 6.3 and for process application balancing grade shall be of 2.5 .

The fan impeller may be backward curved / backward inclined/forward curve/radial job specification as per requirement.

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 as per requirement.

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.

Electrically operated / manually operated inlet vane damper shall be provided as a regulating device for control of fan flow volume as per TS requirement. The air stream shall be caused to rotate through alteration of the pitch of guide vanes.
Manually/electrically operated fan outlet damper shall be provided as per TS requirement.

Fan inlet and outlet flexible connections shall be provided as per TS requirement. Guide plate shall be provided to prevent direct contact of flexible fabric with air flow.

Anchor bolts, nuts, foundation plates etc. as required shall be supplied with the equipment. The equipment shall be designed to permit 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.

The noise level of fan shall not exceed 85dB(A) at a distance of 1 m when running at full load. Material of construction, capacity and static pressure of fan shall be as per TS requirement.

The fan shall have following minimum thickness of materials for different parts unless otherwise specified in TS for HVAC application:

a) Capacity below 20,000 m$^3$/hr:
   - Casing : 3.15 mm
   - Back plate : 4 mm
   - Impeller : 2.5 mm

b) Capacity above 20,000 m$^3$/hr and below 50,000 m$^3$/hr:
   - Casing : 4 mm
   - Back plate : 6 mm
   - Impeller : 3.15 mm

c) Capacity above 50,000 m$^3$/hr upto 1,00,000 m$^3$/h:
   - Casing : 6 mm
   - Back plate : 8 mm
   - Impeller : 6 mm

However for different process application depending upon specific requirement material of construction shall be defined in TS.

The fan shall be provided with drive motor, drive coupling/V-belt, belt pulley, belt guard, fan inlet and outlet flexible connections, variable inlet vane, fan outlet damper, slide rails, foundation plates, gaskets, base frame, vibration isolators, foundation bolts and nuts, fan inlet protection screen and other standard accessories unless otherwise specified in the TS. All these items/materials and accessories shall be supplied with the fan.
The following data shall be furnished by the tenderer along with the offer.

a) CENTRIFUGAL FAN

1. Make & Model No.
2. Quantity, no.
3. Type of blade
4. Capacity, m³/h
5. Static pressure and total pressure, mm WC
6. Operating speed, rpm
7. Critical speed, rpm
8. Shaft power, kW
9. Total Efficiency, %
10. Motor rating, kW/ pole
11. Fan Characteristic Curves
12. Impeller Diameter in mm
13. Impeller weight in kg.
14. GD² value
15. Velocity at inlet & outlet of fan, m/sec
16. Static weight & dynamic weight of fan and motor, kg
17. Coupling details/V-belt details
18. Vibration level
19. Vibration isolator type & quantity.
20. Outlet damper size
21. Material of construction & thickness of scroll, blade, shroud, back plate, shaft diameter in mm
22. Noise level at 1m distance in dB(A)
23. Bearing details
24. Acoustic lagging / silencer, if included :
   i) Material of construction
   ii) Insertion loss
25. Overall size
26. Drive Motor rating suggested
27. Special constructional feature, if any

a) FAN DRIVE MOTOR DETAILS

1. Type & make
2. Voltage, phase & frequency
3. Rated power, kW
4. Speed, RPM
5. Starting/ pull out torque
6. Starter details
7. Line current
8. Starting current
9. Overall efficiency
10. Class of insulation
11. Type of enclosure
12. Any other information
b) **VIV Damper**

1. Make, model and type
2. Diameter of VIV
3. Type of actuator, if applicable
4. Motor kW/pole
5. Material of construction and thickness
9.0 **ES5 - CENTRIFUGAL PUMP**

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, testing and supply/fabrication of Pumps with all accessories required to be installed to achieve desired performance in all respect. Specific technical requirement of Pumps if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Pumps is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned under clause No. 03.

02 Pumps

The pumps shall be designed, manufactured and tested as per IS:1520-1980 (R.A. 1993), IS:5120.1977 (R.A.1997) Amendment 2000, IS:9137-1978 (R.A. 1993), IS6595-1993 (Part II) or as per other international standards acceptable to the Purchaser and shall be suitable for the duty conditions and capacities as indicated in this specification.

The centrifugal pumps along with their auxiliary equipment shall be suitable for the required duty conditions and shall be designed and manufactured for continuous duty at full load.

All the pumps shall be capable of developing the required total head at rated capacity for continuous operation. The pumps shall operate satisfactorily at any point on the H-Q characteristic curve over a range of 50% to 130% capacity or capacity corresponding to 75% of the total head whichever is lower.

Capacity vs discharge pressure curve for each pump shall preferably be continuously drooping from the shut-off point to the rated operation point and be suitable for parallel operation. The pumps shall be designed to avoid cavitation at any of the operating points.

The required duty range for a pump shall be on stable portion of its head-capacity curve close to the best efficiency point. The head developed at the best efficiency point shall be close to the required differential pressure so that throttling is not required at pump discharge.

The equipment and auxiliaries shall be designed for quick and economical maintenance. The equipment shall be easily dismantlable without disturbing the suction and delivery pipe connections.

The equipment design shall incorporate provisions for reduction in noise level.

The rotating elements of the pumps shall be checked for critical speed in bending as well as torsion. The critical speeds shall be at least 30% away from the normal speeds for units with flexible shafts and at least 20% away from the maximum operating speed in case of stiff shafts.

All passages inside the pump casing and impellers, which may be inaccessible to machining, shall be ground to a smooth finish as far as practicable.

All pumps preferably shall be horizontally split type with maximum RPM of 1,500. However, very small pump of capacity less than 15 m³/h for air
washer application mono-block type pump may be provided.

Material of construction

Casing - C.I
Impeller - Bronze
Bearing Bracket - C.I
Shaft protection sleeve - Bronze
Wearing ring - Bronze
Shaft - C-45
Common base frame for pump & motor - M.S

The direction of rotation shall be clearly marked either by incorporating it on the casing or by an arrow on a separate metal plate securely fitted to the casing.

A stainless steel name plate of 2 mm thickness shall be provided and securely attached by stainless steel pins at an easily accessible point on the pump. The plate shall be stamped with the following minimum information:

a) DESIGN CAPACITY
b) TOTAL HEAD
c) SPEED
d) MOTOR RATING
e) MODEL NUMBER
f) MANUFACTURER’S SERIAL NUMBER
g) WEIGHT OF EQUIPMENT
h) TAG NUMBER

The total head-capacity curve shall preferably be continuously rising towards the shut-off. The shut-off head shall be at least 110% of the total head.

The required NPSH at duty point shall be at least 1.0 m lesser than the available NPSH.

The velocity of vibration shall be within 4.5 mm/sec.

The power rating of the pump motor shall be larger of the following

a) 110% of the power required at the duty point.

b) For parallel operation, motor rating should be sufficient enough for running of single pump also.

The common base frame for pump and motor shall be in one piece with suitable holes for grouting. Adequate space shall be provided between pump drain connections and base plate for installation of minimum 15mm drain piping. Pumps shall be supplied with suitable drain pans or drain rim type base plates with valved drain connections.

Coupling guard, made of expanded metal and bolted to the base plate shall be supplied for all pumps.

Pumps will be supplied with flexible coupling. Back-pull out type pump shall be provided with
spacer type coupling.

Standard hydrostatic test shall be conducted on the pump casing with water at 1.5 times the maximum discharge head or twice the rated discharge head whichever is higher. The hydrostatic tests on the casing shall be conducted for a minimum duration of 30 minutes.

Casing

The casing shall be of cast iron and shall be designed for a pressure not less than the shut-off pressure at the highest operating speed plus the maximum pressure that may be encountered at the pump inlet. In addition, CI casing shall have corrosion allowance of not lower than 3 mm.

Impellers

Impeller shall be of bronze. Impellers and balancing drums (if provided) shall be statically and dynamically balanced. Dynamic balancing shall be at the operating speed of the pump. For multi stage pumps, all the impellers shall be assembled together for balancing. Provision shall be made for adjusting the clearance between the impeller and the casing to compensate for wear.

The impeller shall be keyed or screwed on to the shaft in such a way that it does not come-out due to reverse rotation of the pump.

Shaft

The shaft shall be of EN-8 or C-40 or equivalent and shall be designed for critical speed. The ratio of critical speed to speed of shaft shall be not less than 1.3 for solid shafts.

The deflection in line shaft shall not exceed 1 mm per meter of length. All shafts above 150 mm diameter shall be ultrasonically tested. Shafts shall be checked for endurance and strength. Change of sections in shafts if considered shall be made with due allowance for stress concentration. Shafts shall be machined to close tolerance for mounting on impeller bearings, shaft seal, shaft sleeve, shaft coupling etc. The magnitude of shaft deflection at the face of the shaft seal shall not exceed 50 microns.

Coupling and coupling guard

Horizontal pump sets shall be provided with flexible couplings of pin and bush type and shall be constructed of metallic materials except for bush which shall be of rubber materials. Coupling shall be properly keyed in place and the cylindrical fit shall allow simple removal of the coupling in the field.

Removable coupling guards shall be supplied and mounted. Guards shall be sufficiently heavy and rigid to provide adequate personnel safety.

Shaft sealing

Shaft seals shall be provided to prevent leakage out of, or into, a pump over the range of specified operating conditions. The seals shall be suitable for variations in inlet conditions that may prevail during start-up and shut down. They shall be accessible for inspection and replacement without disturbing any part of the installation.
Bearing

Two bearing assemblies shall be provided, one within the frame to carry radial load only and the other to carry both radial and axial thrust. Bearings shall be of manufacturer standard design, antifriction type, oil / grease lubricated. Suitable thrust bearings shall be provided in the pump to take total thrust of the pump including hydraulic thrust. Thrust bearings shall be of oil lubricated type with suitable cooling arrangement. Motor thrust bearing shall be designed without water cooling arrangement. Suitable tapped holes shall be provided for refilling of oil in the bearing housing.

All the vertical pumps shall be provided with separate thrust bearings with proper lubrication and cooling facilities as required so that the thrust and other vertical loads due to the moving parts are not transferred to the prime mover.

Base plate

All horizontal pumps shall be supplied with sturdy base plates of manufacturer’s standard, common to pump and drive. Base plates and pump supports shall be constructed so rigidly and the unit so mounted as to minimize misalignment due to piping strain, internal differential thermal expansion, etc. Base plates shall be fabricated from MS channels.

Companion flanges, bolts, nuts & gaskets

Plate flanges having raised face shall be provided at suction and delivery side of pumps and they shall be of mild steel and conform to table 17 of IS: 6392-1971 (R.A.1988). Slip on raised face flanges to 150 Lbs. class conforming to ANSI B16.5 shall also be acceptable.

Black bolts and nuts conforming to IS 1362-1992 shall be provided for the companion flanges.

CAF gaskets of 1.5 mm thickness conforming to IS: 2712-1979 (R.A. 1994) shall be provided for the companion flanges.
03  DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER :-

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

1. Make and model no.
2. Type of pump
3. Capacity in m$^3$/hr.
4. Total head in m WC
5. Quantity
6. Material of Construction of
   • Shaft
   • Impeller
   • Casing
7. Pump speed (rpm)
8. Shaft power
9. Drive details
   • Motor make
   • Motor kW
   • Class of insulation
   • Frame size
10. Bearing type & make
11. Type of coupling
12. Vibration level
13. Noise level at 1 m distance
14. Duty
15. Weight of pump & motor separately
16. Characteristic curves for pumps
17. Type of liquid to be handled
10.0 **ES6 – VAPOUR ABSORPTION M/C (VAM)**

The VAM based chilled water plant shall include

- Vapour absorption machine(s) with accessories
- Hot well pumps (1w +1s)
- Cold well pumps (1w +1s)
- Condenser water pumps (1w+1s)
- Induced draft counter flow FRP cooling tower with RCC basin & PVC fills. Cooling tower basin shall be at higher elevation than the condenser water pump.
- Steam piping (from battery limit onwards) along with all necessary valves (shut off valve, flow control valve etc.), instruments & safety devices. IBR approval are in the scope of tenderer.
- Steam pressure & temperature control system.
- Steam condensate disposal arrangement. Steam condensate line shall be of SS
- Chilled water/ condenser water piping.
- Valves/ strainers etc in pipe lines
- Thermal insulation of chilled water pipes and steam pipelines.
- RCC hot well tank & cold well tank. Insulation of tanks. Tanks shall be located at the top most location of the entire chilled water piping network.
- MCC, starter panel, electrics, instrumentation etc.

VAM shall be completely factory assembled and wired in a single package complete with evaporator, absorber, two stage generator, condenser, heat exchangers, solution pump, refrigerant pump, vacuum pump for purging, starter panel (starting control), micro processor control panel (safety & operating controls), all necessary sensors/ instruments, internal cabling and piping work.

VAM shall be supplied with full operating charge of refrigerant (water) & lithium bromide solution (with non toxic inhibitor) and shall be factory tested under operating conditions.

Automatic control of chilled water outlet temperature by controlling steam flow rate.
VAM shall have connectivity for communication, data logging, history charts, mimics to PC at remote location.

M.O.C of all the heat exchangers tubes shall be of Cu (70%) -Ni (30%) & seamless.

Solution & refrigerant pump impeller shall be of SS & drive shall be hermetically sealed.

Insulation of VAM unit.

 Fouling factor for condenser & evaporator shall be considered 0.001 & 0.0005 hr-ft²°F/Btu respectively

Purchaser will make available steam at 8 Kg/cm² (g) pressure.

Vapour absorption m/c shall be chosen not only to meet the full load design, but also to perform efficiently at lower loads and at lower condenser water inlet temperature (particularly during winter season). If needed condenser water temperature control shall be provided. Tenderer shall furnish the inlet condenser water temperature range of their machine.

Evaporator heat exchanger design shall meet the chilled water inlet & outlet temperature required for process cooling.
11.0 ES7 - CENTRALISED HVAC SYSTEM VAPOUR COMPRESSION BASED

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of different type of Direct Expansion (DX) type / Chilled Water generator equipment with all accessories required to be installed for HVAC and process cooling purpose to achieve desired performance. Specific technical requirement of Direct Expansion (DX) type / Chilled water generator type equipment if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of different type of Direct Expansion (DX) / Chilled Water generator Type Equipment is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02 Description

1. **Base Frame:**

   Water chilling package base frame structure will hold the following :

   A. Reciprocating / centrifugal / screw refrigeration compressor
   B. Condenser
   C. DX water chiller
   D. Associated refrigerant piping, fittings and controls.

   Normally Water chilling package shall be of floor mounted two tier type.

   Direct Expansion (DX) type frame structure will hold the following :

   A. Reciprocating / centrifugal / screw refrigeration compressor
   B. Condenser
   C. Associated refrigerant piping, fittings and controls.

   Resistoflex neoprene pads shall be used as vibration isolator between common base frame and floor and spring cup type vibration dampers shall be used between compressor and common base frame.

2. **Refrigeration compressor**

   Refrigeration compressor shall be of multi cylinder reciprocating / centrifugal / screw type. The compressor shall be driven by TEFC motor through V-belt drive/flexible coupling direct drive. Compressor design shall conform the required safety measures as per IS-11461-1985 guide lines and testing of compressor shall confirm to IS-5111-1993.

   The chiller shall be supplied with full operating charge of refrigerant R-22/ R-134a & lubricating oil. Chiller performance shall be ARI certified as per ARI standard 550-92. Cooler (evaporator) shall be dry expansion type .

   Compressor housing cylinder head shall be of fine grained cast iron. Valve plates shall be of cast iron or stainless (ring plate type). The piston shall be made from light metal
alloys preferably Aluminum with one oil groove and two compressor rings. The connecting rod shall be of forged steel of Aluminum alloys with integral bearing surfaces on crank and piston pin ends. Crank shaft shall be of forged steel with drill for oil distribution. Crank shaft shall be statically and dynamically balanced to eliminate vibration. In case of shaft seal, the same shall be positive acting to prevent the leakage of refrigerant and infiltration of air during compressor operation and idle periods.

The main bearing shall be of self-alignment, horizontally split and lined with anti-friction bearing metal.

Compressor shall be lubricated by forced feed lubrication system comprising of reversible, positive displacement gear type oil pump, interconnecting pipes, filter cartridge, oil strainer, sight glass, oil drain valve. If required, oil coolers shall be provided. Oil safety switch shall be provided to stop the compressor in case of excessive or lower oil pressure.

The refrigerant compressor shall be equipped with built-in automatic unloaded starting arrangement.

Electrically operated crankcase heaters suitable for specified power supply system shall be provided. Heaters shall be automatically actuated when compressor is stopped.

The compressor shall have automatic capacity control in addition to manual capacity regulation. Capacity regulation shall permit the operation of the compressor at part load with reduced power consumption.

The following accessories and instrumentation shall be considered for the refrigerant compressor:

A. Large suction strainer, muffler.
B. Service stop valves for suction and discharge sides.
C. Pressure and temperature gauges for suction, discharge and lubricating oil.
D. Common base frame for compressor and motor including Coupling.
E. Flexible coupling/V-belt drive.
F. Coupling belt guard.
G. Crank case heater.
H. Oil chargers and oil check valves.
I. Electric motor, drive set.

The following controls and safety devices shall be provided for the compressor:

A. Oil safety switch.
B. High and Low pressure cut outs
C. Relief by pass valves.
D. Spring loaded, built-in safety valves for each cylinder.
E. Indicating lamps and alarms.
F. Timer to set time interval between starting and loading the compressor.

3. Condenser
The condenser shall be of horizontal, shell and tube type construction with water flowing inside the tubes and the refrigerant gas condensing outside the tubes. Alternatively as per job specification requirement air cooled type condenser may be provided. Condenser design shall confirm to IS-11327-1985 guidelines.

The condenser shall be equipped with integral finned type, solid drawn, seamless copper tubes.

Multi-pass construction condenser shall be provided. It shall be designed for proper number of passes to give optimum water velocity, efficient heat transfer and allowable pressure drop.

The condenser tubes shall be rolled into the grooves of tube sheets at either end to ensure a perfect water and air tight joint.

Adequate baffling arrangement shall be used in the condenser for improved heat transfer.

Condenser tubes shall be adequately supported to prevent sagging and vibration failure.

The joints of water boxes and tube sheets shall be water tight while those of tube sheets and shell are air tight to prevent leakage of refrigerant and infiltration of moisture into the system.

The condenser shall be equipped with following accessories/safety devices:

A. Purge valve
B. Charging valve
C. Relief valve/fusible plug
D. Hot gas inlet/liquid outlet connections or the shell with flanges.
E. Water inlet/ outlet connections with flanges.
F. Hand shut-off valve for water inlet and outlet to condenser and chiller.
G. Pressure and temperature gauges for water inlet and outlet/refrigerant gas inlet and outlet.
H. Vent valves etc.
I. Charging valve.

Chemically treated water shall be considered as make-up for condenser cooling system. Necessary water treatment/softening plant shall be considered by the successful tendered.

4. Chiller

The chiller will be of direct expansion, horizontal, shell and tube type construction with the refrigerant flowing inside the tubes and the water outside the tubes.

Chiller shall have MS fabricated shell, copper tubes with internal turbulators and MS tube sheet and MS fabricated or cast iron shell end boxes. The shell shall be designed for approximately 10 kg/cm2.

The copper tubes shall be rolled into grooves on tube sheets for a water and airtight joint. Joints between the tube/sheets and the shell should be watertight while those
between the shell and the boxes should be airtight. Adequate sealing gaskets should be used to prevent leakage of refrigerant and the infiltration of moisture and air into the system.

The chiller shell shall have flanged water inlet and outlet connections welded as an integral part of it.

The chiller assembly will be thermally insulated with polyurethane or equivalent material of adequate thickness and finished as described under ‘Insulation’.

Chiller shall be equipped with the following controls/accessories/safety devices:

A. Refrigerant liquid inlet and gas outlet connections with flanges and liquid line, shut-off valve,
B. Liquid distributor with proper circulating arrangement,
C. Thermostatic expansion valve,
D. Solenoid valve on liquid inlet line,
E. Cooling and anti-freeze thermostats,
F. Water inlet/outlet connections with flanges and shut-off valves, along with counter flanges.
G. Vent connections with valves,
H. Pressure and temperature gauges at the water inlet/outlet.
I. Relief valve, purge valve, drain valve, shut-off valve,
J. DP switch across the chiller.

5. Interconnecting refrigerant piping, fittings and valves

Refrigerant piping is required to interconnect the compressor, condenser and the chiller into a closed network.

Expansion valves shall be pilot operated type. Solenoid valve shall be provided for ‘Pump down’ operation of the unit.

Moisture indicators, filter/drier unit shall also be provided in the liquid line with isolating valves.

Strainers shall be of brass, complete with bronze screen and permanent magnet strainers shall be installed up-stream of refrigerant solenoid valves, as per requirements. Strainers shall be provided with isolating valves and valves bypass.

Heavy duty seamless steel pipes shall be used for the piping network; while seamless solid drawn copper tubes shall be used for the refrigerant liquid line.

The piping network shall incorporate loops in the circuit to efficiently separate oil and liquid refrigerant from the gas and suction vapour respectively.

All horizontal lines shall be pitched to 12 m for every 3 meters in the direction of refrigerant flow. All necessary loops and bends shall be provided to ensure proper return of oil to the Compressor. All the piping shall be adequately supported and isolated by means of suitable vibration isolators.

Suction line shall be thermally insulated with polyurethane or equivalent material of adequate thickness.
The following accessories/controls shall be provided for the refrigerant piping:

A. Liquid line strainer/drier,
B. Liquid to suction heat exchanger,
C. Hand shut-off valves,
D. Sight glass etc.

All the piping network shall be pressure tested, leak tested, dried, evacuated and charged with the refrigerant after erection.

6. Controls & Instruments

- **Pressure gauges**

Pressure gauge shall not be less than 150 mm diameter dial with appropriate working range and be complete with shut off gauge cocks etc., duly calibrated before installation. Pressure gauges shall be provided at the following location.

A. Supply and return of Chillers and Condensers.
B. Discharge of pumps.
C. Inlet and outlet of heat exchangers.
D. Supply and return chilled water line of A.H.U.

In refrigerant line suction side gauges shall be compound gauges of the range 0-75 mm (0.3") mercury vacuum and 4 kg/sq. cm positive pressure. Discharge side gauge 0-6 kg/sq cm pressure. Gauge shall be connected to pipe by 6 mm dia copper tubing through 6 mm dia shut off cocks.

- **Thermometers**

Thermometers shall be 150 mm dial type with capillary tube and protective sheets, duly calibrated before installation.
03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER:

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

1. **Refrigerant Compressor**

   a) Manufacturer
   b) Model No.
   c) Refrigerant
   d) Capacity at operating conditions
   e) Maximum speed/operating speed
   f) BHP at operating conditions
   g) BHP/TR at operating conditions
   h) BHP consumption
      
      100% load
      75% load
      50% load
   i) Types of controls offered and make
   j) Motor
      
      Make :
      Type :
      Rating (KW) and rpm :
   k) Starter : Make & Type
   l) Capacity control
   m) Lubrication
   n) Total weight
   o) Noise level at 1 meter distance in dB(A)
   p) Vibration level
   q) Vibration isolators details

2. **Condenser**

   a) Manufacturer
   b) Shell diameter and length (mm)
   c) Tube material
   d) Fouling factor
   e) No. of tubes
   f) Tube diameter (mm) and thickness
   g) Tube length (mm)
   h) Tube surface area inside (m²)
   i) Tube surface area outside (m²)
   j) No. of passes
   k) Water flow (M³/hr)
   l) Water velocity (m/sec)
   m) Water temperature entering (Deg.C)/leaving (Deg.C)
   n) Fin material and No. of fins/inch.
   o) Operating charge
   p) Pressure drop
   q) Refrigerant temp (Deg. C)
   r) Maximum cooling capacity (K.Cal/hr.)
3. Chiller

- **a)** Manufacturer
- **b)** Shell diameter and length (mm)
- **c)** Tube material
- **d)** Fouling factor
- **e)** No. of tubes
- **f)** Tube diameter (mm) and thickness
- **g)** Tube length (mm)
- **h)** Tube surface area inside \( (m^2) \)
- **i)** Tube surface area outside \( (m^2) \)
- **k)** Water flow \( (M^3/hr) \)
- **l)** Water velocity \( (m/sec) \)
- **m)** Water temperature entering (Deg.C)/leaving (Deg.C)
- **n)** Fin material and No. of fins/\text{inch.}
- **o)** Pressure drop
- **q)** Refrigerant temperature inlet /outlet \( (\text{Deg. C}) \)
- **r)** Maximum cooling capacity \( (K.Cal/hr.) \)
- **s)** Operating weight (kg)
12.0  ES8 - CHAIN PULLEY BLOCK

01  General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of Chain Pulley Block with all accessories complete in all respect. Specific technical requirement of Chain Pulley Block if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of the Chain Pulley Block is given below under clause No. 02. The equipment-wise list of data to be furnished by the tenderer along with the offer is shown below under clause No. 03.

02  Description

Chain pulley block shall be considered conforming to IS:3832 – 1986.

Indian Standard

Hand-operated chain pulley blocks are used extensively for material handling during construction, erection and maintenance of industrial plants.

The minimum requirements of load chains shall be graded to Grade 40. Further a design test to prove the design of the block to a factor of safety of 4 has been included.

This standard lays down the general requirements and testing of the hand-operated chain pulley blocks, worm or spur gear type.

Hand-Operated Chain Pulley Blocks - A block riveted with a load chain and operated by a hand chain so as to give a mechanical advantage.

DESIGN - The blocks shall be so designed that all components shall withstand without failure, an application to the block of a load equal to at least four times the working load limit.

RATING - The hand-operated chain pulley blocks shall be rated according to the working load limit which in case of a block with four or fewer falls shall be determined from the safe working load of the load chain. Where the falls exceed four, or angles are introduced into the chain run, a chain stronger than that for the corresponding four-fold block is required to provide for the additional load caused by friction.

Each chain pulley block shall be subjected by the manufacturer to a proof load of 1.5 times the working load limit through a length of lift which will ensure that every part of the block will sustain the load test.
03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

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

1. Make & Model
2. Capacity handling in ton
3. Quantity
4. Class of duty as per IS:3832-1988
5. Head room, mm
6. Lift room, mm
7. Minimum radius of curvature of the track beam with which this hoist can be negotiate
8. Weight
9. Specification of each chain
10. Tools & tackles included in the offer
11. Commissioning spares & 2 years operating spares included in offer.
12. Effort
13. Velocity ratio
01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of Cooling Tower with all accessories to make operation of Cooling Tower complete in all respect. Specific technical requirement of Cooling Tower if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of the Cooling Tower is given below under clause No. 02. The equipment-wise list of data to be furnished by the tenderer along with the offer is shown below under clause No. 03.

Job specification of the project shall be referred for any specific requirement.

02 Description

Cooling tower shall be power driven or natural draft type shall be selected as per job specification requirement.

In General FRP type cooling tower shall be provided for the cooling of condenser recirculating water for HVAC application.

The capacity of the cooling tower shall be adequate to take care of the entire cooling water required for the air-conditioning plant. Only make up water will be made available from the plant network.

The cooling tower shall be mounted on masonry pillars on the floor.

Normally natural draft cooling tower shall have RCC basin construction. Alternatively the party may offer for wooden basin as per job specification requirement. Cooling tower capacity shall be adequate to cool water basin temperature up to maximum 32°C as per prevailing ambient condition.

Cooling Tower

Type : Induced draft counter flow
Casing/ Basin : RCC ( for chilled water plant), FRP (for air conditioning systems)
Frame Work : MS hot dip galvanized (for air conditioning systems)
Fills : PVC
Nozzles : Brass
Bolts, nuts, miscellaneous hardware : MS electro galvanized
Fan hub & blades : Cast Aluminium
Fan type : Axial flow, direct drive
Fan speed : 720 rpm
Degree of protection of motor : IP 55 (temperature rise limited to class B)
Ladder : Galvanized steel ladder with safety cage & hand railing up to the top of tower. Inclined to 30º to the vertical
Eliminators : No. of deflector to be arranged to reduce drift loss < 0.2% of water circulation.
(i) Level switch at cooling tower basin (to be interlocked with pump)
(ii) Make up connection with float valve (float made of copper), back up ball valve
(iii) Quick fill connection with ball valve
(iv) Overflow connection
(v) Drain connection with ball valve
(vi) GI wire mesh 18 gauge strainer
(vii) Equalizing line of cooling towers with isolation valves
(viii) Cooling tower basin (for chilled water plant) shall have minimum 5 minute water holding capacity (of circulation water volume)
03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The following data shall be furnished by the tenderer along with the offer for cooling tower.

1. Make & Model
2. Type
3. Quantity
4. Overall size of cooling tower
5. Capacity of cooling in TR.
6. Water flow m³/h
7. Air flow
8. Design water inlet temperature, outlet temperature
9. Material of construction and its thickness
10. Speed in rpm.
11. Drive details.
12. Shaft Power consumption.
13. Wheel diameter.
15. Size of fan
16. Static & Dynamic weight of fan & motor assembly
17. Bare weight and operating weight of cooling tower
18. Noise level at 1m distance in dB(A)
19. Fixing details.
20. Vibration level.
21. Water spray nozzle type
14.0 **ES10 - CYCLONES, MULTI-CLONE & PRE-COLLECTOR**

**01 General**

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of Cyclone / Multi-clone/Pre-collector System with all accessories required to be installed for dust extraction / process application to achieve desired performance in all respect. Specific technical requirement of Cyclone /Multi-clone/Pre-collector System if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification. Brief description of Cyclone /Multi-clone/Pre-collector is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

**02. Description**

**02.1 Single cyclone/group of cyclones**

This consists of a vertical cylindrical body, in which dust-laden gas is introduced at the top through horizontal tangential inlet. The cylinder has a truncated cone as the lower section. As the gas moves down the cyclone body, it forms a peripheral vortex. This gives rise to centrifugal force, which throws the dust particles in the gas stream towards the walls which then separate from the gas stream and fall down and are taken out through a dust pipe. As the gas reaches the conical portion, the gas stream reverses direction and moves upwards towards the exhaust pipe forming an inner vortex. Cyclones shall be constructed of suitably stiffened mild steel casing of not less than 6 mm thickness. For variable flow application compartmentalized cyclone chamber shall be constructed to maintain required minimum velocity to achieve desired performance.

**02.2 Multi-clone**

This shall consist of a number of small diameter cyclones operating in parallel. Multi-cell cyclones shall be enclosed in suitably stiffened mild steel casing of not less than 6 mm thickness. The cyclone elements shall in general have diameters of 150 mm and below and shall have smooth finished surfaces.

Each unit shall include, but not be limited to the following: gas inlet chamber, cyclone elements with casing, clean gas exhaust chamber, bottom hopper for dust collection, rotary valve for each hopper, a differential pressure gauge to measure pressure drop across the unit and leak proof access openings. For variable flow application compartmentalized cyclone chamber shall be constructed to maintain required minimum velocity to achieve desired performance.

**02.3 Pre-Collector**

The collector shall be used as a preliminary dust catcher and a common header for different incoming ducts from various suction hoods. The collector shall comprise cylindrical casing with service doors of quickly clamped type, incoming and exhaust manifold connected to collector, rotary air lock / double flap valve at the bottom. The dust accumulated at the bottom of collector shall be disposed off through rotary air lock / double flap valve to the conveyor. The velocity of air inside the collector shall be around 4-5 m/s. The Tenderer shall compute the diameter of the collectors to achieve this velocity. The length of the collector shall depend on the convenience of connecting various ducts to it. Duct connections should not be bunched in a particular area and shall be evenly distributed on the cylindrical surface.
of the collector. The mode of connecting incoming ducts with collector body shall be of
flanged type. The air shall enter the collector tangentially and not radially. The exhaust duct
shall be fitted to the exhaust manifold by flanged connection. The body and support of the
collector shall be designed to withstand its self weight along with the weight of water and
dust considering worst conditions.

03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The tenderer along with the offer shall furnish the following data.

a) Pre-collector

1. Make & Model.
2. Capacity in m$^3$/h.
3. Pressure drop in mmWC.
4. Overall size of pre-collector
5. Velocity through collector body in m/sec.
6. Material of construction
7. Cleaning efficiency Vs particle size
8. Methods of dust disposal.
10. Total weight of pre-collector

b) Cyclone

1. Make & Model.
2. Capacity in m$^3$/h.
3. Pressure drop in mmWC.
4. Overall size of cyclone
5. Velocity through cyclone body in m/sec.
6. Material of construction
7. Cleaning efficiency Vs particle size
8. Methods of dust disposal.
10. Total weight of cyclone

c) Multi-clone

1. Make & Model.
2. Capacity in m$^3$/h.
3. Pressure drop in mmWC.
4. Overall size of multi-clone
5. Smaller cyclone diameter of multi-clone
6. Velocity through multi-clone body in m/sec.
7. Material of construction
8. Cleaning efficiency Vs particle size
10. Supporting frame details.
11. Total weight of multi-clone
15.0  ES11 - DAMPERS FOR AIR FLOW CONTROL

01  General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of different type of air dampers required to be installed in the Air Flow Path with all accessories for HVAC system. Specific technical requirement of air dampers if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of dry air dampers is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02.  Descriptions of the dampers

02.01  Wall mounted dampers

a)  Self acting damper (Gravity damper)

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

b)  Fusible link fire damper

Fusible link fire dampers are provided to stop the flow of air through the exhaust opening when fire breaks out in the premises. This damper shall be provided at the inside face of wall opening to be provided for outlet/exhaust of air from the premises. This damper shall essentially consist of multi-leaf blades. MS frame, fusible link with spring/gravity arrangement of auto closing of the damper. The fusible link shall be made of low melting alloy which can fuse at a temperature of about 70/80°C. The damper shall be normally open position; it shall close on melting of the fusible link caused by temperature rise due to fire etc. in the premises.

02.02  Duct line dampers

a)  Hand operated damper (Geared hand wheel)

The hand operated damper shall be multileaf opposite acting aerofoil blade type damper with external operating links provided at the outlet of the fan for controlling air flow. The damper shall be made of GI sheet with MS frame unless otherwise specified in the TS. The fully close/open/partial closing position shall be marked on the damper casing.

b)  Electrically operated/pneumatic damper

The electrically operated damper shall be provided as a regulating device for control of air flow through duct as per TS requirement. Provisions shall be kept for interlocking the damper with fire protection system. The fully closed/open/partial closing position shall be marked on the damper casing.
c) **Solenoid operated fire proof damper**

This damper shall be provided in supply air duct. It shall be operated by solenoid which is to be interlocked with the fire detection system of the served premises. In case of fire in the premises the fire detection system shall activate the solenoid and the solenoid in turn shall close the damper to stop air flow in the duct line. The fully close/open position of the damper shall be marked on damper casing.

### 03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

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

#### 03.01 Wall Mounted Dampers

a) **General data applicable for all types of dampers**

1. Size
2. Quantity offered
3. Material of construction and its thickness  
   i) Frame
   ii) Blade
   iii) Flange
4. Provision of horizontal & vertical direction control
5. Weight
6. Velocity of air

b) **Self acting damper**

1. Operate on differential pressure requirement mm WG –

c) **Fusible link fire damper**

1. Material of fuse link
2. Melting temperature of the fuse link

#### 03.02 Duct line Dampers

a) **Hand operated damper (Geared hand wheel)**

1. Operating device

b) **Electrically operated damper**

1. Type of actuator
2. Motor kW /Pole (in case of electrically operated damper)
3. Pneumatic piston (for pneumatic operated damper): make, type and weight
4. Compressed air requirement with pressure for pneumatic operated damper

b) **Solenoid operated fire proof damper**

1. Type of actuator
2. Supply voltage and solenoid power supply rating
16.0 ES12 - DUCTING NETWORK OF DUST EXTRACTION SYSTEM

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of Ducting Network with all accessories required to be installed for Dedusting System application to achieve desired performance in all respect. Specific technical requirement of Ducting Network of Dust Extraction System if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Ducting Network of Dedusting System is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02. DUCTING NETWORK

Ducting Network shall comprise of suction hood, ducting, duct support, measuring hatch, cleaning hatch and duct line dampers as required.

Details of collecting enclosure and suction hoods

The suction hoods and enclosures shall be constructed of 5 mm MS plate unless otherwise specified in the job specification with necessary external stiffeners, flanges, counter flanges, fasteners, gaskets and other accessories for fixing with technological equipment and duct line.

Dust collection hoods and enclosures shall be fitted with conveniently placed hinged access doors (top hinged type) to enable internal access to the equipment for maintenance as required. The air velocity at hood inlet shall be 1.5m/Sec (max).

Duct work details shall have following minimum features:

1) Construction

The duct sizing shall be so selected to maintain proper conveying velocity throughout the system. Man holes/hand holes and dust outlets shall be provided at intervals to facilitate cleaning of dusts and for disposal of dust. The successful tenderer shall design the dedusting system ductwork connecting the dust collection hoods, to the dust collector, fans and stack. The ducting shall be fabricated from M.S.(IS : 2062- 1999 ) having thickness as follows unless otherwise specified in the job specification:
### Duct diameter | Straight line duct thickness | Bend Thickness
---|---|---
Upto 500 mm | 3.15 mm | 4 mm
Upto φ 900mm | 4 mm | 6 mm
φ 900mm to φ 1500mm | 6 mm | 8 mm
φ1500mm to φ 2000 mm | 8 mm | 10 mm
above φ 2000mm | 10 mm | 10 mm

At all duct bends (carrying abrasive dust such as sinter dust etc.) above 900 mm diameter shall have abrasion resistant liners with caster wood / rock basalt/FRP in line with job specification requirement.

For special application corrosion / abrasion resistant duct liner material of construction of FRP / Linear material may be required to be installed in line with job specification requirement.

**2) Conveying velocity**
A conveying velocity of 18-25 m/Sec shall be maintained at all points in the ductwork between dust collection hood and dust collection plant to ensure flow of air without settling of dust.

**3) Provision for Slide Gates/ Dampers**
All extraction points shall have slide gates (single leaf inclined plate type) /dampers provisions for flow balancing during commissioning if required. These gates/dampers shall be bolted by the successful tenderer in position after commissioning to prevent inadvertent operation and consequent un-balancing of flow of the dedusting system.

**4) Provision of Flow Testing Points**
All extraction branch ducts shall have two 50mm diameter capped sockets installed at 90° to one another at least 6D away from flow disturbance (bends, hood inlets) for insertion of pitot tubes for flow measurement and system balancing during commissioning. Test points are to be located in a readily accessible position in the duct. However in any suction hood if flow appears to be on the lower then necessary flow measurement and correcting device shall be made by the successful tenderer to suit site.

**5) Straight Duct Runs**
Interconnecting duct work shall be circular in cross section. The duct work shall be fabricated from mild steel plate, IS:2062-1999 or be seam welded spiral wound duct work as per job specification requirement.

**6) Branches**
Branch connections should be oriented to the top or side of the main with no two branches entering at opposite sides.

**7) Joints**
Matching flanges are to be bolted together with asbestos rope gasket or rubber gaskets. All bolts and gaskets for jointing shall be included in the successful tenderer scope of work. All duct joints are to be air tight to minimise air leakage.

8) **Duct Cleanout Doors**

Clean-out doors will be provided on horizontal runs, before elbows and junctions. The spacing between cleanout doors should not exceed 6 meters. Clean out doors will be constructed to have a length of 600 mm or the duct diameter which ever is less for ducts upto 1 meter diameter. Larger diameter ducts will have clean out doors sized 600 mm high by 600 mm wide.

9) **Duct system hangers and support**

The ductwork support spacing and hangers will be designed for the weight of settled dust plus a 25% design margin. Following dust load will be considered for designing duct and duct support and duct stiffeners.

<table>
<thead>
<tr>
<th>Duct dia</th>
<th>% Cross section of duct filled up with dust</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 500 mm</td>
<td>35%</td>
</tr>
<tr>
<td>500 mm to 1400 mm</td>
<td>30%</td>
</tr>
<tr>
<td>1400 mm and more</td>
<td>25%</td>
</tr>
</tbody>
</table>

Bulk density of dust will be considered 1.7 t/m$^3$ unless otherwise specified in job specification.

All inside building duct and duct along main structural building will be supported from plant building structure. Duct supporting member's length height section will be decided during detail engineering. To suit site condition supporting members may have to be modified by the successful tenderer without any commercial implication to the purchaser. All outside ducting network shall have independent duct supporting trestles.

10) **Ductwork Layout**

Ductwork will not interfere with fixed or mobile crane access to the plant. Horizontal run of the ducting will be avoided to prevent settling of dust.

Minimum horizontal clearance from road center line is 5 meters. It is the successful tenderers responsibility to effect the dedusting system ductwork arrangement in accordance with the design requirements set down in the specification and to the satisfaction of the purchaser/consultant.

11) **Ductwork integrity**

The successful tenderer’s ductwork design must ensure that the ductwork will not collapse at any point, should it be subject to the maximum suction capacity of the fan system. The design will accommodate any variation in ambient temperature.

12) It is the responsibility of the Successful tenderer to size all ductwork in detail as per duct balancing calculation. Duct balancing calculation will be furnished by the successful tenderer for approval of the purchaser. It is the Successful tenderer’s responsibility to
establish routes both inside and outside building. This is to be done in conjunction with and to satisfy the Purchaser.

13) The duct work will be pressure balance type. However, during testing and commissioning if any throttle piece is required for adjustment of flow in any duct branch same will be carried out by the successful tenderer without any commercial implication.

14) Flexible connection at inlet & outlet of fan and in the ducting network will be provided by the successful tenderer as required.
03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

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

A. Ducting

1. M$^2$ of duct work
2. Weight of duct work
3. Weight of supports and flanges
4. Material and thickness of duct work

B. Suction Hood

1. Material of construction
2. Measuring hatch provided or not
3. Capturing velocity
4. Hoods sizes

C. Duct line Damper – Manual / Elec. Operated

1. Make & Model & Type
2. Size of amp.
3. Material of construction and its thickness
4. Total weight
5. Fixing arrangement
6. Any other information
17.0 ES13 - DUCTING NETWORK FOR HVAC SYSTEM

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of GI/MS Ducting Network with all accessories required to be installed for HVAC application to achieve desired performance in all respect. Specific technical requirement of Ducting Network if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Ducting Network is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02. Description of ducting network

The ducting network comprises of ducting work, duct line dampers, down comer & supply air diffuser with volume control damper (for HVAC system only), supply air grill/ adjustable louver grill duct supporting arrangement, flexible connections etc.


These items are briefly described below:-

a) Ducting work

Ducting work consists of main duct, branch ducts, bends, reducers, joints, access doors etc. Duct work shall be complete with flanges, gaskets, stiffeners, fasteners (nuts, bolts & washers), hangers, etc. as required. Minor modification of ducting network may be required to suit site condition. GI Ducts shall be fabricated at site to match with site condition. Alternatively ventilation duct work may be fabricated with MS sheet in line with job specification requirement.

All ducting work shall be properly reinforced to prevent sagging, buckling or vibration.

GI Ducting shall be provided with joints at 2.5-3m interval conforming to IS: 655-1963 (RA 1999) as and where required. In case of flanged joints, the flanges shall be of angle iron type riveted with GI sheet on duct perimeter. Flange joints should be made air tight with use of felt gaskets.

Duct supports shall be provided to keep the ducting in position in aligned condition.

Measuring hatch for measurement of flow / pressure shall be provided in ducting network at convenient locations.

For proper distribution of air in the premises supply air grills (adjustable louver grills) with volume control dampers shall be provided in the ducting work for ventilation system and supply air diffusers with volume control damper shall be provided in the ducting work for air conditioning system.
Sizing of the duct shall be done for pressure balancing as well as to maintain the air velocities in the ducting work as given below:

<table>
<thead>
<tr>
<th>Description</th>
<th>Air Velocity for Ventilation System</th>
<th>Air velocity for Air conditioning system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main duct</td>
<td>8 – 10 m/sec.</td>
<td>6 – 7 m/sec.</td>
</tr>
<tr>
<td>Branch ducts</td>
<td>6 – 8 m/sec.</td>
<td>4 – 5 m/sec.</td>
</tr>
<tr>
<td>Supply air grills</td>
<td>4 – 6 m/sec.</td>
<td>-</td>
</tr>
<tr>
<td>Branch risers</td>
<td>-</td>
<td>4 – 5 m/sec.</td>
</tr>
<tr>
<td>Supply air diffuser</td>
<td>-</td>
<td>3 – 4 m/sec.</td>
</tr>
</tbody>
</table>

The following accessories may be fitted in the duct line depending upon the job specification requirement:

i) High efficiency filter
ii) Strip heater for dehumidification purpose
iii) Pan humidifier for humidification purpose

Joints :

In line with IS 655-1963 guide lines the type of transverse joints shall be follows unless otherwise specified in job specification:

Sealing:

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

Bends :

The interior of all ducts shall be smooth for free flow of air. The radius to bend shall be not less than 1.5 D. Turning guide vane shall be provided in all large duct bends and bends with radius less than 1.5 D for proper air flow.

Access door :

All main ductwork shall be accessible throughout using tight fitted hinged access doors, provided with sponge rubber gaskets. Angle joints shall be provided with felt or rubber gaskets for leak-tightness of the joints.

Access doors/panels are to be provided at following places:

- Near each fire damper
- Near each Reheat coil
- Near high efficiency filter/absolute filter

Any other place if envisaged by the owner about its essentiality during drawing approval or construction period.

In case access doors are to be installed in the insulated ducts, the access door panel should be insulated too with overlapping, such that it can be operated without damaging the duct insulation and there should be no condensation either on the access doors or on the duct when the plant is in running condition.
b) **Duct line dampers**:

Refer equipment specification no. ES-10.

c) **Adjustable louvers grill (Supply air grill) with volume control damper for ventilation system**

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 grill 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 louver grill shall be provided with volume control damper as well as double deflection flap/grill for direction control.

d) **Supply air diffuser with volume control damper for AC System only**

Thickness of Grills, Diffuser, Damper shall be as follows:

(a) Frame 16 gauge  
(b) Louvers 18 gauge

Supply air diffusers shall be circular/rectangular in shape as per detailed engineering requirement. The throat of a diffuser shall be connected with collar piece provided at the duct bottom for holding the diffuser as well as for supply of air. Each diffuser shall be provided with volume control damper. Each diffuser shall comprise of fixed plate, damper blade, damper blade operating knob, spindle, connecting rod etc. The diffuser should flush with the false ceiling. False ceiling shall not bear the load of any diffuser. The load of diffuser shall be borne by the duct and collar. Each diffuser shall be painted with appropriate colour to match with the colour of the false ceiling. Diffuser shall be placed considering light fittings position and false ceiling runner position. Diffusers/grills shall be of extruded aluminum powder coated/Anodized aluminum.

e) **Return air grill**

In general the return air opening shall be provided above false ceiling in the wall between served premises (control room) and A.C. plant room. The return air grill of suitable size shall be provided at the A.C. plant room side face of the said opening for smooth flow of return air. The air supplied in the served premises (control room) shall come/return above false ceiling through the return air slit of 50~100 mm all around false ceiling along the walls of the served premises. From there it shall pass into the A.C. plant room through the return air passage. The return grill shall comprise of horizontal fixed louvers made of 2 mm thick MS sheet, 50x6 thick MS
flat placed vertically at middle of the louvers, 50x50x6 size angle frame all around. Spacing of the fixed louvers in the grill shall be 25 mm.

f) **Insulation**

Sheet metal duct shall be acoustically and thermally insulated as per requirement. For details of insulation refer respective equipment specification.

g) **Flexible connections**

Flexible material shall be used for fabrication of flexible connections of at least 100 mm length shall be provided at each connection between duct work and fan units and any other places as asked in the job specification. Flexible connection material shall be selected considering temperature, pressure application of the job specification requirement.

h) **Hangers & supports for ducting**

All duct work shall be provided with adequate supports as required to ensure rigid support and to prevent vibration.

The fixed and supports interval shall not exceed 3 meters. Hanger rods having U-bend at one end and threading at other end shall be hanged from angle clit to be anchor fastened from. Hanger rod shall be attached to the ceiling by anchor/ expansion bolts. Duct angle supports from brick wall/RCC wall/ structural wall shall be grouted / welded to suite site.
03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The following data shall be furnished by the tenderer along with the offers.

a) Ducting

1. m² of duct work
2. Weight of duct work
3. Weight of support and flanges
4. Material and thickness of duct work
5. Duct support type and material
6. Velocity of air.

b) Supply Air Grills (Adjustable louver grills) /Diffuser with volume control facility

1. Size
2. Quantity offered
3. Material of construction & thickness
4. Provision of horizontal & vertical direction control
5. Weight
6. Velocity of air
7. Methods of volume control

e) Return air grills/intake air louver

1. Size
2. Quantity offered
3. Material of construction
4. Weight
5. Velocity of air
18.0 **ES14 - ELECTROSTATIC PRECIPITATOR**

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of Electrostatic Precipitator (ESP) System with all accessories required to be installed dust extraction / process application to achieve desired performance in all respect. Specific technical requirement of Electrostatic Precipitator (ESP) System if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Electrostatic Precipitator (ESP) System is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02 Description

1. **Electro Static Precipitator and Accessories will include:**
   - Housing assembly of fabricated plate work.
   - Gas distributor plate at inlet and outlet of ESP.
   - Dust hopper assembly of fabricated plate work.
   - Discharge electrodes.
   - Dust collecting electrodes.
   - Rapping units for both discharge, collecting electrodes and gas distributors.
   - ESP supporting structure complete with service platforms and walkways, stairs, hoisting facilities etc.
   - In general Minimum no. of 4 electric field shall be considered unless defined in the TS to achieve required stack emission standard
   - Two nos. rapping system (for collecting electrodes) at the 3\textsuperscript{rd} & 4\textsuperscript{th} field to control puffing dust .
   - Specific collection area shall be considered based on party experience on past project. However required specific collection area shall not be less than minimum as defined in the TS.

2. **Electrics**
   - High voltage power supply package.
   - Power supply to all drives with interlocks and controls.
   - TR controller with feedback control optimization of current voltage from on line continuous stack monitoring instruments.
   - For details refer job specification requirement.
   - Temperature and pressure transmitter, CO gas analyser as required.

**DESCRIPTION OF ESP SYSTEM**

ESP system will comprise of multiple fields, unit/multiple cells Electrostatic Precipitator (ESP) and its accessories such as Dust disposal system, Electrics and control, Instrumentation, interlocks, Supports etc.
Design requirement

1. The Electrostatic Precipitator (ESP) will be in general dry, horizontal flow type. It should be a completely self-supporting unit, ready to be assembled on the foundation.

2. Configuration

The Electrostatic Precipitator will feature one gas pass design. with Compensator at inlet & outlet of ESP.

3. Electrostatic Precipitator casing

a) The precipitator steel casing will be gas tight and of welded construction throughout. Casing plate thickness will be 6 mm minimum unless otherwise specified in job specification.

b) The precipitator must cope with the fan running at full output and the fan inlet damper shut without suffering structural or mechanical damage. For gas cleaning system, working pressure will be maintained as per system requirement. The normal working pressure of suction and temperature will be considered as specified in job specification.

c) The precipitator will have access openings ladders, will stairs, platform etc. necessary for inspection, cleaning and maintenance. All equipment and the openings will be made accessible to the maintenance personnel by installation of access ways, ladders, platforms etc.

d) Sealing of glands, inspection doors, etc. must be such that air is prevented from leaking into the electrostatic precipitator to prevent in filtration of ambient air. The precipitator will be of weatherproof construction.

4. Electrodes

a) The discharge electrodes will be of rigid ribbon type so that they can withstand efficient rapping and temperature changes.

b) Collecting electrodes will have a spacing of approximate 400 mm. The collecting plates should be 1.5 mm thick CR sheets to ensure an adequate service life.

c) Discharge electrodes and collecting plates will be automatically and sequentially rapped with heavy duty tumbling hammer type mechanical rappers.

5. Rapping

The electrode rapping system will be capable of maintaining clean electrodes. The supplied rapping mechanism will feature a microprocessor based adjustable rapping frequency for each field.

6. Insulator housing

Special attention will be given to the support rapping shaft insulators. These will be electrically heated to avoid condensation and will have efficient seals to avoid dust deposits.
7. Safety

The Electrostatic Precipitator will be provided with a key interlocking system for preventing access to high voltage internals of the precipitator until the associated high voltage system is de-energised and grounded. All the access opening will be provided with earthing rods. The earthing strips will be of GI and it will be firmly bolted to the precipitator casing.

8. Hoppers

Each field of the Electrostatic Precipitator will be fitted with a dust hopper. The hopper will be constructed of 8 mm plate unless otherwise specified in TS. The hoppers will have a pyramidal / conical configuration with 65° valley angle minimum.

Inspection doors, poke holes and electric heaters will be provided in the hoppers. Motorised double cone valves will be provided at the hopper discharge. High and intermediate level switches will be installed in each ESP hopper. With the help of intermediate level switch dust in hopper can be discharged into the chain conveyor by double cone valve. High level switch in ESP hopper will be provided for safety interlocks. Stainless steel liner of 1.6 mm thick up to a height of 1.2 m from the bottom flange of ESP hoppers and storage hopper will be provided for smooth flow of dust.

Separate dust-dumping outlets with flange provision, necessary chutes, gates etc. will be provided by Successful Tenderer with each ESP hopper and dust storage hopper for dumping of dust in case of increase in alkali content to prevent recycling of dust under emergency situations as per requirement. Therefore, Truck / dumper entry provision below each ESP hopper will be provided by Successful Tenderer for dust disposal.

9. Insulation

ESP walls, roof panels, and hoppers will be provided with thermal insulation of resin bonded mineral wool of density 100 kg/m3 as per IS 8183-1993 having 50mm thickness for hot gas application. The thermal insulation will be covered with 0.8 mm CGI sheet cladding.

10. Platforms and access ladders

The minimum platform width will always be 1.00 meters. The platforms will be located at the top of hoppers level and at the top of the gas cleaning equipment. Safe guard rails will be provided around all the platforms. Angular rather than round rails members will be used, if possible. Safe and easy access to the platforms will be provided by providing stairways to chain conveyor platform level, ESP chamber access door level, ESP top and transformer house etc. Maintenance platforms all over ESP area, at dust disposal conveyor level will be provided. Access door to ESP chamber will be provided from both side. Access doors to distributor grid will also be provided. Maintenance platforms at access door level all around ESP will be provided. Ladder approach with platform will be provided for hopper level switches, access doors, hopper heater and for any other equipment or access above man height.
Brief specification of material of construction is mentioned below:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Item</th>
<th>Material</th>
<th>Thickness (minimum)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Collecting Electrodes</td>
<td>IS-513 CR sheet</td>
<td>1.5 mm</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Discharge Electrodes</td>
<td>IS-513 spiral SS coil / rigid member</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>ESP casing</td>
<td>IS-2062-1999 Gr. A</td>
<td>6.0 mm thick</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>G.D. screen</td>
<td>IS-2062-1999 Gr. A</td>
<td>3.15 mm</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Hopper wall</td>
<td>IS-2062-1999 Gr. A</td>
<td>8.0 mm thick</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Pert house roof(insulator chamber)</td>
<td>IS-2062-1999 Gr. A</td>
<td>5.0 mm thick</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Side wall of insulator chamber</td>
<td>IS-2062-1999 Gr. A</td>
<td>3.15 thick</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>ESP inlet and outlet connection piece</td>
<td>IS-2062-1999 Gr. A</td>
<td>8.0 mm</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Access grating, stair trades</td>
<td>IS-2062-1999</td>
<td>45 depth – 6 mm thick, 40 centre to centre</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Insulation or ESP casing (for hot gas application)</td>
<td>Resin bonded mineral wool IS-8183-1993 density 100 kg/m³</td>
<td>50 mm thick with 0.8 mm CGI sheet cladding</td>
<td>Density of wool 100 kg/m³</td>
</tr>
<tr>
<td>13.</td>
<td>Insulation of hopper (for hot gas application)</td>
<td>Resin bonded mineral wool IS-8183-1993 density</td>
<td>50 mm thick with 0.8 mm CGI sheet cladding</td>
<td>Density of wool 100 kg/m³</td>
</tr>
</tbody>
</table>

Keeping in view the properties of the dust, the Successful Tenderer will make selection of material and thickness of plates and supporting structure. However, minimum material of construction specification shall be as mentioned above.

11 Air tightness of ESP housing

The construction of the ESP housing and design of dust disposal gates, insulator boxes and discharge electrodes will be such that air infiltration inside ESP housing is negligible to prevent corrosion problem.

**DESIGN CRITERIA**

1. Following technical input parameters will be considered as a general guide line only for designing the ESP cleaning system since the actual gas & dust composition and condition of gases changes based on operation / process condition of technological plant. Based on the job specification data as well as the past experience of successful tenderer and their collaborator on design of ESP for technological process, successful tenderer will demonstrate and establish performance guarantee parameters under varying process parameters.

   i) Type : cells, fields, dry/wet, horizontal/vertical
   ii) Gas handled : Dusty gas from process application
   iii) Design flow : m³/hr (avg.). at operating temp.
iv) Temperature : -- °C Normal -- °C maximum
v) Bulk density of dust : - t/m3.
vi) Dust content at ESP inlet : - gm /Nm3.
 vii) Dust content at ESP outlet : - mg /Nm3.
viii) Gas velocity through ESP : - m/sec
ix) ESP duty condition : 24 hrs continuous operation
x) Chemical composition of air(% vol.)
  Oxygen -
  Carbon dioxide -
  Carbon monoxide -
  Nitrogen -
  Sulphur dioxide-
  Moisture-
  Other constituents-

xi) Chemical composition of dust (% weight)
  CaO -
  SiO₂ -
  Fe₂O₃ -
  Fe –
  FeO –
  Al₂O₃ -
  MgO –
  MnO -
  P -
  S -
  C -
  Na₂O & K₂O -
  Other constituents-

xii) Particle size of dust (% distribution):
< 5micron :
5-10 micron :
10-20 micron :
20-30 micron :
30-40 micron :
> 40 micron :

xiii) Expected cleaning efficiency under normal design condition:
(moisture content -v/v, Temperature : Deg C ,
Inlet dust content - gm/Nm3, Gas flow volume - m3/hr)

xiv) Basicity Ratio –

xv) Migration velocity – cm/sec

xv) Casing design condition - mmWC suction / ---°C

xvi) Permissible noise level - 85 dB (A)

2. Guaranteed Emission value

The efficiency of the ESP will be such that the guaranteed emission of dust from stack will not be more than 50 mg/Nm³ or as per job specification requirement.

Correction curves for calculating revised efficiency will be applicable for change in following input parameters:
a) Temperature : Design temperature will be considered as defined in the TS.

b) Moisture content : Correction factor will be not be applicable

c) Dust load : Correction factor will be applicable provided dust emission not exceeding 50 mg/ Nm3.

d) Gas flow : Positive factor or negative correction factor will be applicable for decrease or increase in gas flow respectively.

e) Dust composition : No correction factor will be applicable for gas composition and change in said parameters. Successful tenderer will select the ESP which will be suitable for dust generated by the specific process.

3. The Successful Tenderer will adopt the following criteria while designing dust disposal system.

i) Easy maintenance of dust disposal equipment.

ii) Minimisation of outside infiltration to the ESP casing.

iii) Moisture regulation facilities to control dry dust disposal nuisance as well as too much wet dust handling problem.

4. The equipment will be suitable to operate satisfactorily under such variations of load, pressure and climatic conditions as may occur during working.

5. Working parts of all equipment will be suitably located for convenient operation and will allow access to facilitate easy replacement, connecting up, inspection, lubrication, maintenance and repair, without dismantling other equipment/ components/ structures.

6. The Successful Tenderer will do physical model testing for gas flow distribution study inside ESP at a minimum scale of 1:15 for this project at manufacturer's works for designing and selection of GD screen. Necessary inside model elements of ESP like GD screen, discharge electrodes, collecting electrodes etc. will be fitted with the model as per scale. Purchaser and purchaser's representative will witness the above testing at manufacturer's works. The date of witnessing of the test will be informed by the Successful Tenderer during design engineering.

7. Design calculation of ESP main supports, weather enclosure, structures, platform will be based on IS-875-1987 Part-I, II & III and IS-800-1984. Service load of 4KN/sqm and 2 KN/sqm will be considered for maintenance platform and walk ways respectively.

8. Compensator between rotary feeder and the chain conveyors, between two conveyors and between dust moistener and rotary feeder will be provided to facilitate maintenance. Slide gates will be provided before all the double cone dust valves/rotary feeder. For calculation and design of structural members, accidental fill up of dust up to top of ESP hoppers in worst case will be considered by Contractor.

9. To ensure safe and reliable operation of ESP, the Successful Tenderer will provide the following minimum safety measures.
i) Prevention of condensation inside ESP chamber.
ii) Prevention of rapping system from damage.
iii) Prevention of insulator creeping and damage.
iv) Prevention of air leakage and corrosion.
v) Provision of heat expansion accommodation.
vi) Prevention of personal inquiry.
vvii) Lighting resistance and grounding
viii) Explosion protection arrangement.
### 03. DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER:

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Item Description</th>
<th>Technical Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td><strong>ESP design data</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Model No.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Treatment velocity</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Treatment time sec/Treatment length m</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Aspect ratio</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Press, drop mm WC</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Migration velocity cm/sec</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Guaranteed outlet emission at design conditions</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>WI of ESP with dust, ton</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Overall size, Approx. WxLxH m</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Cross sectional Area m2</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Collaborator</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Casing Design condition</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>TR set rating</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>SCA m2/m3/sec.</td>
<td></td>
</tr>
<tr>
<td>B.</td>
<td><strong>Collecting Electrode</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Material</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Height m</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Spacing mm</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Area m2</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Rapper type</td>
<td></td>
</tr>
<tr>
<td>C.</td>
<td><strong>Bdischarge Electrode</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Material</td>
<td></td>
</tr>
<tr>
<td>D.</td>
<td><strong>ESP – Proper</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Gas distributor</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Insulator heating</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Bearing</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>ESP, inlet and outlet cones</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Whether enclosure sheeting and fixing hardware for TR set</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Monorail with electrical operated trolley and hoist for lifting TR sets</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Insulation of casing and hopper</td>
<td></td>
</tr>
<tr>
<td>E.</td>
<td><strong>ESP Hopper</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Quantity</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Hopper volume each</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Valley Angle in deg.</td>
<td></td>
</tr>
<tr>
<td>F.</td>
<td><strong>TR Rating and Drive Rating in KW</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>TR sets for different fields with quantity</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Rappers :</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gas distributor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C. Electrode</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D. Electrode</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hopper heater</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RAL Valve</td>
<td></td>
</tr>
<tr>
<td>G.</td>
<td><strong>Safety Interlock System</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Mechanical Key interlock safety system for each access door</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Lightning arestor and grounding</td>
<td></td>
</tr>
</tbody>
</table>
19.0  ES15 - FILTER DRY TYPE

01  General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of different type of dry air filters required to be installed in the Air Flow Path with all accessories for HVAC system to achieve desired efficiency of cleaning. Specific technical requirement of air filter if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of dry air filter is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02  Description of the dry air filters

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 mm WC when dirty. Efficiency of the normal air filter shall not be less than 90% down to 10 microns unless otherwise specified in the TS. Cleaning efficiency of the high efficiency air filter shall not be less than 99% down to 5 microns unless otherwise specified in the TS. Absolute filter as required shall be considered in line with job specification requirement. The whole filter and frame assembly shall be mounted at the wall / at the inlet of tube axial flow fan/ metallic box as required Panel type air Filters testing shall conform to IS-7613 –1975 ( Reaffirmed – 1996)
03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The tenderer along with the offer shall furnish the following data.

a) Dry Panel type filter
   1. Make & Model.
   2. Capacity in m$^3$/h.
   3. Pressure drop in mmWC.
      i) When clean
      ii) When dirty
   4. Effective cross sectional free and face area in m$^2$
   5. Velocity through filter free and face area in m/sec.
   7. Cleaning efficiency Vs particle size
   8. Methods of surface regeneration.
  10. Overall dimensions & no. of filters.
  11. Fixing frame details.
  12. Total weight. free and face area
20.0 ES16 – FILTER VISCOUS OIL TYPE : VOID

01 t
21.0 **ES17 – THERMAL & ACOUSTIC INSULATION FOR HAVAC (INSULATION FOR COLD APPLICATION)**

**01 General**

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of Insulation with all accessories for HVAC application. Specific technical requirement of Insulation if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of the Insulation is given below under clause No. 02. The equipment-wise list of data to be furnished by the tenderer along with the offer is shown below under clause No. 03.

**02. Description of Insulation requirement:**

The insulation of water piping, air-handling units, ducting, chillers etc. shall be carried out as per following specifications (a) to maintain proper temperature of fluid/vapour in the conduits (b) to prevent surface condensation on cold surfaces.

1. **Insulation Materials:**

The materials to be used for insulation shall be as follows, unless some other material is specifically mentioned elsewhere.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Surface Material</th>
<th>Insulation material</th>
<th>Insulation</th>
<th>Thickness (mm)</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Refrigerant piping</td>
<td>Closed cell foamed plastic</td>
<td>--</td>
<td>30</td>
<td>Al cladding</td>
</tr>
<tr>
<td>2.</td>
<td>AHU drain pipe</td>
<td>Closed cell foamed plastic</td>
<td>Pipe section</td>
<td>30</td>
<td>Al cladding</td>
</tr>
<tr>
<td>3.</td>
<td>AHU casing and condensate pan</td>
<td>PUF</td>
<td>Slabs</td>
<td>25</td>
<td>--</td>
</tr>
<tr>
<td>4.</td>
<td>Chilled water piping (100 NB &amp; less)</td>
<td>PUF</td>
<td>Pipe section</td>
<td>30</td>
<td>Al cladding</td>
</tr>
<tr>
<td>5.</td>
<td>Chilled water pipe insulation (125 NB &amp; above)</td>
<td>PUF</td>
<td>Pipe section</td>
<td>50</td>
<td>Al cladding</td>
</tr>
<tr>
<td>6.</td>
<td>Cooler</td>
<td>Closed cell foamed plastic</td>
<td>--</td>
<td>50</td>
<td>Al cladding</td>
</tr>
<tr>
<td>7.</td>
<td>Chilled water pumps, valves, flanges etc.</td>
<td>Resin bonded glass wool</td>
<td>--</td>
<td>--</td>
<td>Al cladding, Sand cement plaster</td>
</tr>
<tr>
<td>8.</td>
<td>Expansion tank</td>
<td>PUF</td>
<td>Slab</td>
<td>50</td>
<td>--</td>
</tr>
</tbody>
</table>
3.0 **Ducting**:  

The air handling ducts shall be insulated with resin bonded glass/mineral wool with density not below 24/48 Kg/M3 with polythene back bessian on outer side. Duct insulation thickness shall be as follows:

- AC Duct in conditioned space - 25 mm thickness
- AC Duct in unconditioned space - 50 mm thickness
- AC Duct with treated fresh air - 50 mm thickness

5.1 **Application Procedure**:  

Clean the surface with wire brush to make it free from rust etc. Apply two coats of hot bitumen 85/25 to the surface at a ratio of 1.0 Kg/M2 for first coat & in patches for second coat wrap the duct with insulation blankets of the specified thickness. Apply PBH layer on the outside and reinforce it by tying GI wire of 0.5 mm at interval of 450 mm.

Duct in outdoor areas exposed to weather shall be covered with 24 SWG Aluminum sheet bent true to shape and secured with self-tapping screws and over lapped joints sealed with Loidseal – 94.

4.0 **Acoustic Lining**:  

The first 4.5 meter length of duct starting from each fan outlet shall be provided with insulation for acoustic purposes. The insulation material already specified in clause 2.2.2. Then it shall be covered with 0.56 mm perforated Aluminium sheets.

4.1 **Application Procedure**:  

The duct surface shall first be cleaned from inside. The insulation boards shall be wrapped in Glass Cloth of 7 mil thick. With ends stitched. The boards shall be fixed inside the duct. The insulation shall then be covered with 0.56 (24 SWG) perforated Aluminum sheets.

The sheet and the insulation, shall be secured to the duct by means of cadmium plated bolts, nuts and washers and the ends should be completely sealed off so that no insulation material is exposed.

5.0 **Walls and Ceiling – Acoustic Treatments of equipment rooms**:  

Insulation material shall be resin bonded glass wool/mineral wool of density 32/48 Kg/M3 of 50 mm thickness.

5.1 **Application Procedure**:  

Fix 40 mm x 50 mm Deodar/Kail wood battens at 500 mm intervals longitudinally. Then fix cross battens at 1.0 meter C – C using suitable gutties and brass/SS Screws.
Fill each rectangle with 50 mm resin bonded glass/mineral wool wrapped in glass cloth. Then tie with 24 SWG GI wires at 300 mm intervals. Then cover with 24 SWG (0.56 mm) perforated Aluminum sheet having 3 mm perforations at 6 mm C – C. Overlap all the joints and provide beady of 25 mm by 1.5 mm MS flat.

**Extent of Acoustic Treatment:***

Walls : Two of the walls enclosing the room starting from 1 ft. above the floor up to the ceiling.

Ceiling : The entire ceiling covering the room.

6.0 **Measurement:**

The measurement of insulation of vessels, piping and ducts shall be made over the insulated surface area as per IS : 7240 – 1981.

**03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER FOR INSULATION OF HVAC APPLICATION**

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

22. Make & Type
23. Quantity
24. Density in kg/m3
25. Thermal conductivity
26. Sound absorption co-efficient
27. Material of construction and its thickness
29. Vapour barrier material
30. Firel resistance property
31. Cladding material
22.0 **ES18 - INSULATION FOR HOT APPLICATION**

01 **General**

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of Insulation with all accessories for hot surface application. Specific technical requirement of Insulation if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of the Insulation is given below under clause No. 02. The equipment-wise list of data to be furnished by the tenderer along with the offer is shown below under clause No. 03.

02. **Description of Insulation requirement:**

02.1 **General Requirements:**

Thermal insulation shall be provided for all vessels, equipment, pipe fittings, heat exchangers etc. containing fluid or vapour for which it is necessary to (a) Conserve heat (b) Maintain temperature for process control (c) provide for personnel protection.

Thermal insulation system shall be selected so as not to result in a residual heat loss exceeding 150 Watts/M2 under plant operating conditions measured over insulated surfaces. For design, the following data are specified:

Ambient air temperature : 45°C (Max.)
Wind velocity : 1 m/sec.
Surface temperature : Not to exceed 15°C above ambient

Design should include de-rating factors of direct conduction paths e.g. spacer rings and stitching wires normally associated with blanket type insulation material.

02.2 **Reference Standards:**

IS : 8183 - Specification for Bonded Mineral Wool, Group – III & IV
IS : 9842 - Specification for pre-formed Fibrous Pipe Insulation, Group– III
IS : 737 - Wrought Aluminum and Aluminum Alloys, sheets & strips
IS : 7413 - Code of practice for the application & Finishing of thermal insulation materials at temperatures between 40°C and 700°C (latest revision)

02.3 **Application procedure : Piping:**

- For surface preparation wire brush shall be used to remove rust, dust or oil etc. thoroughly.

- Fix the pre-formed pipe-section insulation of required thickness against each diameter of pipe as per the Thickness requirement for Temperature glass and pipe diameter. Construction (upto 75mm thick – 1 layer thereafter 2 or 3 multi layer) joints should be staggered so that complete breaks are minimum on single layer insulation and no through joints occur in multi layout work. The insulation must be held in position by strapping with 20mm x 24 SWG Aluminium Straps.

- When lightly bonded rock wool mattress are used, they shall be wrapped around the pipes without any under layer. On top of each layer, the wire netting already on top of mattresses should be tightly butted against each other so that the fibers interlock both along the longitudinal
and circumferential joints. The pipe joints shall be stitched with 22 SWG soft GI lacing wire for pipes upto 400mm O.D. For pipes over 400mm O.D., the mattresses should be further secured by strapping with 20 mm x 24 SWG Al. straps at 500mm intervals.

- All uninsulated flanges, pipeline insulation shall be stopped off at a suitable distance from the flange for facilitating withdrawal of bolts without disturbing insulation.

- In regard to supporting of insulation to vertical pipelines it is essential that all the pipe insulation (above 200 NB pipe) should be supported at minimum of 3.0 meters distance by applying insulation support spider clamps. These clamps are fitted around the pipeline bare surface with projecting legs whose length should not be more than 70% of insulation thickness.

**Flanges and Valves**

Removable covers shall be provided over all flanges and valves whenever they are insulated with preformed materials. These covers over valves and flanges shall have provision for quick – release clips.

**Sheet Metal Cladding**

All pipes shall be covered with Aluminum sheet (Aluminum sheet of 24 SWG/0.56mm upto 325mm O.D. inclusive of insulation thickness and Aluminum sheet of 22 SWG/0.71mm beyond 325mm O.D.) conforming to IS:737, to the outside of the insulation with minimum 25mm circumferential and longitudinal over laps. The over lapping should be grooved so as to prevent ingress of water into the insulation. In horizontal piping, joints shall be arranged at an angle of 30 to 40° from the horizontal so as to shed rain water.

When lightly bonded rock wool mattresses have been used as the insulation material, spacer rings shall be required screwing the Aluminum sheet. The sheet metal shall be secured to themselves by self-tapping screws at a pitch not exceeding 150mm.

After securing the Aluminum sheet, the overlapped joints of the sheet metal shall be sealed with metal sealant to make joints perfectly waterproof.

**02.4 Application Procedure – Vessels & Equipment:**

- The surface to be insulated shall be thoroughly cleaned by wire brushing to remove dirt, loose scales, dust etc.

- Where welding is permissible, weld 10 SWG GI spokes at 300 – 400mm diamond pitch.

- ‘L’ shaped lugs to be fixed to the spacer rings made of 25mm x 3mm MS flats at 450mm C – C with 25mm x 25mm x 3mm asbestos mill board washers and 4mm MS rivets.

- The spacer rings shall be fixed around the tank at 900mm C – C by welding ‘L’ shaped lugs to tank body.

- Impale Rock wool lightly bonded machine stitched mattresses with one side wire netting of required density (upto 400° – 100 Kgh/M3, above 400° – 120 Kg/M3) and thickness with the ends of mattresses butted closely together with lacing wire of 22 SWG. In addition, mattresses shall be secured with tightly tensioned circumferential Aluminium bands at approx. 450mm pitch.
· The ends of GI spokes to be bent on the insulation.

· The Aluminium metal cladding (22 SWG/0.71mm) is to be fixed on the spacer rings with self-tapping screws at 150mm C – C.

· All over lapped joints of Aluminum sheet metal shall be sealed with loidseal-94 to make joints waterproof.

02.5 Expansion Joints:

Expansion joints shall be provided in the insulation to allow for movement and expansion of the pipe or vessel without producing random craAt the expansion joints, there shall be complete cut and the cutout portion shall be 25mm wide and dry filled with loose insulation material the density of which shall be equal to that of the basic insulation. The expansion joints wherever necessary shall be installed by overlapping the cladding material.

Pipe temp. °C | Spacing of Expn. Joints in meters
---|---
Upto 200°C | No Expn. Joint.
201 to 300°C | 3.5
301 to 400°C | 3.0
Above 400°C | 2.0

02.6 Design Criteria

Ambient air temperature : 35°C or 45°C
Design surface temperature : Not to exceed 15°C above ambient air temperature
Wind velocity : 1 meter/second
Cladding over insulation : Aluminium (Emissivity : 0.2)
Insulation material : Rock wool density 144 Kg/M3 upto 350 mm NB,

Rock wool mattresses above 350mm NB pipes density 100 Kg/M3 upto 400°C and 150 Kg./M3 above 400°C

General Guidelines for insulation thickness

<table>
<thead>
<tr>
<th>Temperature Range</th>
<th>100°C</th>
<th>200°C</th>
<th>300°C</th>
<th>400°C</th>
<th>500°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe NB</td>
<td>-</td>
<td>Thickness of Insulation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>25</td>
<td>40</td>
<td>70</td>
<td>100</td>
<td>140</td>
</tr>
<tr>
<td>200</td>
<td>25</td>
<td>45</td>
<td>80</td>
<td>115</td>
<td>160</td>
</tr>
<tr>
<td>300</td>
<td>25</td>
<td>45</td>
<td>85</td>
<td>125</td>
<td>170</td>
</tr>
<tr>
<td>400</td>
<td>25</td>
<td>55</td>
<td>95</td>
<td>145</td>
<td>190</td>
</tr>
<tr>
<td>500</td>
<td>25</td>
<td>55</td>
<td>95</td>
<td>150</td>
<td>195</td>
</tr>
<tr>
<td>600</td>
<td>25</td>
<td>55</td>
<td>100</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>Flat</td>
<td>25</td>
<td>60</td>
<td>115</td>
<td>140</td>
<td>255</td>
</tr>
</tbody>
</table>

Note: For piping upto 325 mm OD (including insulation thickness) aluminum sheet thickness – 24 SWG (0.56mm) and beyond 325 mm OD (including insulation thickness) aluminum sheet thickness – 22 SWG (0.71mm).
03. **DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER FOR INSULATION OF HOT SURFACE APPLICATION**

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

32. Make & Type  
33. Quantity  
34. Density in kg/m³  
35. Thermal conductivity  
36. Material of construction and its thickness  
38. Vapour barrier material  
39. Fire resistance property  
40. Cladding material
23.0 ES19- PACKAGE AIR CONDITIONER

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of Package Air Conditioner with all accessories to make operation of Package Air Conditioner complete in all respect. Specific technical requirement of Package Air Conditioner if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of the Package Air Conditioner is given below under clause No. 02. The equipment-wise list of data to be furnished by the tenderer along with the offer is shown below under clause No. 03.

02 Description

The water/air cooled packaged air-conditioner will be designed for continuous duty.

The equipment shall be designed, manufactured and tested as per IS:8148- 1976 (RA 1995).

The packaged unit shall comprise compressor, cooling coil, refrigerant circuit, fan, air filters, electric drives and controls, instruments and other necessary standard accessories assembled in packaged form in a steel cabinet.

All electrical connections shall be built in, Purchaser will provide the power supply load.

Each package air-conditioner will essentially comprise of compressor, cooling coil, refrigerant circuit, condenser, blowers, air filter, electric drives, instruments and controls and other standard accessories assembled in steel cabinet.

The compressor will be semi-hermetically/ hermetically sealed, mounted on anti-vibration pads & dynamically balanced.

The condenser will be water cooled, shell and tube type with effective surface area for heat transfer taking into consideration the scale factor for water side and optimum number of passes to achieve desired duty conditions water cooled package AC unit. Provision will be made in the steel cabinet for tube side cleaning during maintenance. The condenser will also serve as refrigerant receiver of refrigerant circuit with fusible relief plug. Alternatively as per job specification requirement condenser may be air cooled with fins and tube type with effective heat transfer area taking into consideration high ambient temperature of site selected. A refrigerant receiver shall be provided in the refrigerant circuit. Air cooled condenser along with the fan shall be installed in the free area for movement of outside air through condenser tube for effective cooling of refrigerant.

Cooling coil will be direct expansion type with integrally finned copper tubes and fitted with equalising distributors to ensure equal amount of refrigerant in each circuit. Condensate drip pan will be provided below the cooling coil for collecting the condensate.

The refrigerant circuit will be completely piped at factory and charged with required amount of refrigerant. The circuit will comprise of thermostatic expansion valve, distributor, liquid strainer, liquid line shut off valve, dehydrator etc. The circuit will be protected with safety devices such as high and low pressure cutouts, fusible plug, water flow/differential pressure switch, oil safety switch, time delay relay etc. to protect the unit from damage due to sudden and serious
fluctuations in operating conditions. The refrigerant will be R22 / ANY OTHER OZONE FRIENDLY REFRIGERANT.

For control of temperature and dehumidification of the conditioned premises, thermostat and humidistat will be provided in the package A.C. plant room as per job specification requirement.

The centrifugal blower will be designed for distribution of the conditioned air through the network of duct and supply air diffusers. The impeller will be of forward curved, dynamically balanced for low noise and vibration free operation. The fan will be coupled with motor by V-belt and mounted on anti vibration mounting.

**Control & Instruments:**

The necessary control and instruments include thermostatic expansion valve, sight glass, strainer, cooling thermostat, heating thermostat, humidistat, strip heater, shut off purge valve and drain valve, dial type pressure and temperature gauges etc. Cooling thermostat and humidistat will be provided in the return air circuit (in A.C. plant room) as per job specification requirement.

The dial type 150mm dia pressure gauge will be provided with isolating cocks/valves. Flow switch will be installed in condenser water inlet line to stop the compressor while water supply stops. High efficiency filter & strip heater will be installed in the supply air duct at the discharge end of packaged unit and the strip heater will be interlocked with the blower of the packaged unit to prevent independent control/switching of heaters as per job specification requirement.

The blower and the evaporative coil sections of the packaged unit will be thermally insulated to minimise thermal leakage. The unit will be supplied with rubber pad for installation on PCC pedestals.

Circulating condenser water cooling pipeline will be provided with strainer and by pass line.

Minimum efficiency of pre filter unit in package AC will be 90% down to 10 micron.
DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The following data shall be furnished by the tenderer along with the offer for Package Air Conditioner Unit.

41. Make & Model
42. Quantity
43. Capacity in TR
44. Overall dimension of Package AC Unit
45. Air flow capacity of blower m3/h
46. Total Pressure, mm WC
47. Fan Motor kW
48. Fan RPM
49. Compressor type, model
50. Compressor motor kW
51. Refrigerant type
52. Condenser type
53. Condenser material of construction
54. Overall size of condenser
55. Material of construction and its thickness of casing
56. Insulating material of casing
57. Total Power consumption.
58. Noise level at 1m distance in dB(A)
59. Vibration isolation pad
60. Performance curve.
61. Fixing details.
62. Refrigerant drier and strainer
24.0 **ES20 - PROPELLER FAN**

**01 General**

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of Propeller Fan with all accessories to make operation of Propeller Fan complete in all respect. Specific technical requirement of Propeller Fan if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of the Propeller Fan is given below under clause No. 02. The equipment-wise list of data to be furnished by the tenderer along with the offer is shown below under clause No. 03.

**02 Description of Equipment**

Propeller type axial flow fan

This type of fan is used for general air exchange of the premises. The fan shall be heavy duty and wall mounted type propeller fan design shall conform to IS:2312 – 1967 (Reaffirmed 1994). Fan impeller blade shall be of aerofoil section and mounted directly at the motor shaft. The RPM of the fan preferably shall be restricted to 900 RPM. Noise level should not exceed 85 dB(A) at 1 m distance. Air entry shall be from motor side. Louver shutter/non-return damper shall be provided at the outlet side of fan to prevent back draft. The fan shall be provided with fixing frame, supporting lugs and other standard accessories.

**03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER**

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

14. Make & Model
15. Capacity in m³/hr
16. Quantity
17. Material of construction
18. Total pressure in kgf/m²
19. Characteristic curve
20. Speed in rpm
21. Size of fan
22. RPM
23. Drive details (kW & power supply)
24. Efficiency
25. Fixing details
26. Weight of fan & motor
27. Performance curve
28. Details of non-return damper/louver shutter
29. Fixing frame
25.0  SCRUBBER (ES21 for DE System Application)

01.  General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of Centrifugal / Venturi Scrubber System with all accessories required to be installed for dust extraction / process application to achieve desired performance in all respect. Specific technical requirement of Centrifugal / Venturi Scrubber System if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Centrifugal / Venturi Scrubber is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02.  Description

02.1  Centrifugal scrubber

Centrifugal scrubber is essentially a vertical steel cylinder with conical bottom. Casing and bottom are made of heavy gauge sheet steel. The top of the casing is connected to exhaust fan and conical portion of the casing is provided with a hydraulic seal. The rectangular inlet of the scrubber is welded to the casing tangentially with respect to its inside surface and with a slant of 10°C toward casing. Dust deposited on the walls of the inlet duct is washed by water sprayers.

The inside surface of the casing is continuously sprayed by sprayers. The water jet emerges from sprayers in the same direction as the swirling air, and at the same time, tangentially to the inside surface of the casing and thus washes it without producing any droplets. The operation of nozzles is checked through inspection holes located just above them.

Dust laden air enters the bottom cylindrical part of the scrubber casing through inlet duct at an approximate velocity of 20 m/sec. As it enters the scrubber, a portion of the stream is directed upwards along a helical line, following closely the inside surface of the casing and thus washes it without producing any droplets. The remaining stream revolves and descends, rebounds from the scrubber bottom and rises along a helical line but closer to cyclone axis. Both streams merge at the outlet.

A centrifugal force arising on rotation of the air stream ejects dust particles towards the sprayed surface of the scrubber. The majority of the particles reaches the film of water and are captured by it.

Water containing captured dust particles trickles down the casing wall and is removed via the hydraulic seal. The protective baffle provided above the sprayers is intended to minimize entertainment of droplets. The mean air velocity for the full cross section of the cylindrical portion of the scrubber is taken to be 5.5 m/sec.

The efficiency of the scrubber should be sufficiently high so that the dust concentration in the exhaust ducting shall not exceed 50 mg/Nm3.
02.2 Venturi scrubber

The venturi scrubber consists of high speed atomizer and centrifugal separator. High speed atomizer consists of converging cone, throat and diverging cone. Air stream is accelerated in converging cone and the velocity of the stream rises. Water is introduced at the throat, where it is atomised due to high pressure.

Dust laden air and water enter the throat, where they are mixed at high energy and extreme turbulence. The throat with its length provides an extended period of thorough mixing. The scrubbed air and entrained droplets (with contaminants entrapped) then enters the diverging cone where further collisions and agglomeration takes place creating larger droplets. The air stream then proceeds to centrifugal separator where liquid droplets due to their coarse size are easily removed from the air stream. The working of the centrifugal separator is similar to that of centrifugal scrubber except that the water sprayers are not required.

The efficiency of the venturi scrubber shall be sufficiently high so that the dust concentration in the chimney does not exceed 50 mg/Nm$^3$ or as per job specification requirement.

03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The tenderer along with the offer shall furnish the following data.

d) Centrifugal Scrubber

11. Make & Model.
12. Capacity in m$^3$/h.
13. Pressure drop in mmWC.
14. Overall size of centrifugal scrubber
15. Air velocity through scrubber body in m/sec.
16. Water quantity and pressure required for scrubbing
17. Spray nozzle quantity, diameter and material of construction
18. Material of construction of scrubber body
19. Cleaning efficiency Vs particle size
20. Water sealing arrangement at bottom of scrubber
22. Supporting frame details.
23. Total weight of pre-collector

e) Venturi Scrubber

1. Make & Model & capacity in m$^3$/h.
2. Pressure drop in mmWC.
3. Overall size of venturi scrubber and centrifugal collector
4. Air velocity at inlet, throat & outlet of scrubber in m/sec.
5. Water quantity and pressure required for scrubbing at throat & slurry disposal at centrifugal collector
6. Spray nozzle quantity, diameter and material of construction
7. Material of construction of scrubber body
8. Material construction of throat
9. Cleaning efficiency Vs particle size
10. Water sealing arrangement at bottom of centrifugal collector
11. Methods of slurry disposal.
12. Supporting frame details.
13. Total weight of pre-collector
26.0  ES22 - STACK

01  General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of Stack with all accessories required to be installed for exhaust of air to achieve desired performance in all respect. Specific technical requirement of Stack if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Stack is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02  STACK

1.  Construction

Self-supported stack made of M.S. Plates (IS:2062-1999) shall be provided to discharge the cleaned air from each of the system to atmosphere.

The height of the stack shall be as per CPCB norms i.e. 2-3m above the nearest highest building or minimum 30m. Stack shall be fabricated as per IS – 6533-1989 (RA 1995) Part – I & Part – II or as specified in TS.

2.  Lightning Protection

Protection against lightning shall be made in accordance with IS:2309-1989 (RA 1995).

Lightning Protection shall be provided by creating a path of minimum electrical impedance from the stack top to an earthing strip on the ground. At about 1500 mm from the stack top, a circumferential conductor (coronal band) shall be provided which is lead-covered, stranded and of tinned copper. This is connected to air-terminal rods (which shall project about 750 mm above the top of the earthing strip. During construction temporary lightning protection shall be provided and this should be in the form of a single conductor connected to a temporary air-terminal at the top of the earthing system on the ground.

Vertical reinforcing bars near the stack base shall be electrically connected to a down conductor. Similarly all steel parts and footing reinforcement should be connected to a down conductor. At the top of the stack the lightning conductors shall be adequately protected from chemical corrosion by applying a lead coating or by other suitable means.

3.  Aviation Warning Lights

Aviation warning lights shall be provided even during construction once the stack reaches a height of about 45m above ground. Both temporary as well as permanent provisions shall be of
neon type. These lights shall have sufficient intensity (about 100 lux) so that they are conspicuous considering the background illumination level against which they are viewed.

Day marking shall be provided by painting the stack in contrast colour bands for at least the top one-third of its height. Such bands shall range from 0.75 to 3 m in width with the outer bands in darker colour. The paint used for the bands shall be acid-resistant and shall safely withstand the temperature expected at the top of the stack.

4. **Staircase**

The stack shall be provided with staircase, landing / resting platform at every 10 m, handrails, painter's trolley, structures etc. Ring platform around stack shall be provided at location of aviation lamps.

5. **Clean-out and Access Door**

A suitable access door shall be provided at the bottom of the stack.

6. **Sampling Ports**

The sampling ports shall be provided as per Emission Regulation Part-III or its latest amendments.

7. **Work Platform**

a) **Construction**

Size and extent of platform: If two ports are required at 90 degrees the work platform should serve that half of the stack circumference between the ports and extend at least 1.2 meters beyond each port. If four ports are required at 90 degrees, the work platform should serve the entire circumference of the stack. The minimum platform width shall always be 1.2 meters regardless of diameter of stack and number of sampling ports.

b) **Platform Access**

Safe and easy access to the platform shall be provided via stairway or other suitable means.

Guardrails and Stairwells: A safe guard rail should be provided on the platform. Angular rather than round rails members should be used, if possible. No stairwell or any other opening shall be located within 1 meter of any port.

c) **Platform loading**

The work platform should be able to support at least three men (average 80 kg each) and 91 kg of test equipment (stack monitoring kit etc.). If the stack exists through a
building roof, the roof may suffice as the work platform, provided the minimum test site conditions are still met.

d) **Clearance Zone**
A three dimensional, obstruction free clearance zone should be provided around each port. The zone should extend 0.6 m above, below, to either side of the port. The zone should extend outward from the exterior wall of the stack to a distance of at least 3 meters.

**03. DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER:**

The tenderer along with the offer shall furnish the following data:

Stack / exhaust dust

a) Diameter in mm
b) Material & thickness
c) Height in m
d) Level of sampling port holes
e) Level of platforms
f) Support & structure with stairs
g) Weather Cowl / telescopic duct connection
27.0 **ES23 - TUBE AXIAL FLOW FAN**

01 **General**

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of Tube Axial Flow Fan with all accessories to make operation of Tube Axial Flow Fan complete in all respects. Specific technical requirement of Axial Flow Fan if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of the Tube Axial Flow Fan is given below under clause No. 02. The equipment-wise list of data to be furnished by the tenderer along with the offer is shown below under clause No. 03.

Job specification of the project shall be referred.

02 **Description of Equipment**

These fans shall be of heavy duty type and of four kinds, as per service requirement, as follows: a) Roof exhauster, b) Roof mounted supply air fan, c) Wall exhauster, d) wall mounted supply air fan.

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

The roof exhauster / roof mounted supply air fan shall have multi-bladed impeller with short duct casing while the wall exhauster/ wall mounted supply air fan shall have cone inlet suitable for 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.

The first critical speed of the rotating assembly shall be at least 25% above the operating speed. The speed of the fan shall preferably 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 casings for wall mounted/roof mounted fans and their components shall be suitable for outdoor installation. The casing shall be minimum 2 mm thick. The casings 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 also motor terminals are easily accessible through the cover.

**Hood and Cowl**

a) Roof exhauster/supply air fans shall be provided with hood for protection against
rain and other contingencies. It must ensure no dripping of rain water under any circumstances and will have low pressure drop of air. The hoods shall be provided with a heavy gauge expanded metal bird screen.

b) Rain protection cowls shall be designed to suit wall exhausters for protecting fans from rain. The cowls shall be provided with bird screen of heavy gauge expanded metal netting. The rain protection hood & cowl shall be fabricated from minimum 14G thick MS sheet (Hot dip galvanised).

**Coned Inlet**

Wall exhausters shall be provided with coned inlet made of MS 2 mm thick or 16G, GI sheet.

**Inlet Screen**

Inlet screen shall be manufactured with minimum 14 SWG galvanised wire knitted in 25 mm square mesh. Suitable flanges to protect the edges of the screen shall be provided.

**Fans for Special Application**

These fans & motor when used in explosive / inflammable fume extraction system shall be of spark proof construction. Fan impeller and inside surface of the casing shall be epoxy painted. In case of exposure to acid fumes, the fan along with drive motor, accessories & supports etc. shall have acid proof painting.

**Fan Drive**

All direct drive axial flow fan impellers shall be directly mounted on extended motor shafts special constructional features shall be applicable as for fan. Alternatively as per job specification requirement bifurcated type V-belt drive may be considered.

**Materials of Construction**

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

a) Impeller : Cast Aluminium Alloy  
b) Shaft : EN-8 as per BS-900 or its equivalent  
c) Fan Scroll : Heavy gauge M.S.  
d) Fan Supports, Frames : M.S. of adequate thickness and Structures  
e) Coned inlet for wall Exhausters/supply fans : M.S. 2mm thick  
f) Dampers : M.S. of heavy gauge  
g) Connection pieces : Galvanised/M.S. unless otherwise specified  
h) Bolts and Nuts : Galvanised/M.S. unless otherwise specified  
i) Rain protection cowls, hoods and casing for wall & roof exhausters : GI/MS sheet

**03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER**

The following data shall be furnished by the tenderer along with the offer.
63. Make & Model
64. Quantity
65. Capacity in m\(^3\)/h.
66. Total Pressure, mm WC
67. Material of construction and its thickness
68. Speed in rpm.
69. Drive details like make, kW rating, type, insulation & protection class etc.
70. Shaft Power consumption.
71. Wheel diameter.
72. Efficiency.
73. Size of fan
74. Static & Dynamic weight of fan & motor assembly
75. Critical speed of fan
76. Noise level at 1m distance in dB(A)
77. Performance curve.
78. Air flow direction.
79. Fixing details.
80. Vibration level.
28.0 ES24 – WATER LINE VALVES

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of Valves with all accessories required to be installed for exhaust of air to achieve desired performance in all respect. Specific technical requirement of Valves if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Valves is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02. Valves

Gate valves will be provided at pump outlets & inlets & at tank outlets.

Non return valves shall be provided at pump outlets

Pressure relief valves shall be provided at pump outlet to divert water back to the tank in case downstream usage of water is reduced.

Butterfly valves shall be provided in branch headers to operate a particular group of sprinklers

Globe valves shall be provided on sprinkler headers to control the flow through each sprinkler.

All valves shall conform to the relevant IS code.

Valves

Butterfly Valves shall be provided in water line of size 65 NB and above and ball valve be provided for pipe size below 65 NB

Butterfly valve

Type : Wafer design, flange less
Body : SG iron with nitrile rubber/ EPDM lining
Disc : SG Iron with teflon (PTFE) coating
Stem : High tensile stainless steel

The valves shall be provided with integrally moulded & bonded body liner to provide perfect seating and complete isolation of body material from fluid. The body liner shall provide the seating to valve disc, primary seal to the stem & gasket joint with mating pipe flanges. Valves shall be provided with self locking lever operation from open to fully closed position with intermediate positions marked on the indicator plate mounted on the top flange. The valves shall conform to BS : 5155 / IS : 13095. Extended valve
shaft shall be provided so that the lever can be operated without any obstruction on the insulated pipes. Gear operated valves shall be provided for sizes more than 250 NB.

Ball Valve

Body : Cast steel
Body liner : Nitrile rubber/ EPDM
Ball : ASTM A351 Gr CF8
3 piece design
Socket welded type

Ball valves shall be with 200 mm length welded joint pipes from manufacturer works.

Check valve

Type : Dual plate check valve with two springs hinged on a central hinge rod
Body : SG iron
Body liner : Nitrile rubber/ EPDM
Disc : ASTM A351 Gr CF8
Wafer design

03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

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

81. Make & Model  -
82. Type  -
83. Quantity  -
84. Size  -
85. Pressure rating  -
86. Material of construction  -
87. Operating system  -
88. Drive details.  -
89. Gland packing  -
90. End connections  -
91. Service  -
92. Test pressure  -
29.0 ES25 - WINDOW TYPE AIR CONDITIONER/SPLIT TYPE AIR CONDITIONER

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of Window Type Air Conditioner / Split Type Air Conditioner with all accessories to make operation of Window Type Air Conditioner / Split Type Air Conditioner complete in all respect. Specific technical requirement of Window Type Air Conditioner / Split Type Air Conditioner if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of the Tube Axial Flow Fan is given below under clause No. 02. The equipment-wise list of data to be furnished by the tenderer along with the offer is shown below under clause No. 03.

Job specification of the project shall be referred for any specific requirement.

02. Description

1. Window Type Air Conditioners

Window air conditioners shall comprises of hermetically sealed compressors, air cooled condenser, refrigerant piping, blower, instruments and controls, supply air grill with direction deflector etc. enclosed in a insulated steel cabinet. 3 meter long power cable along with plug and socket unit shall be provided for each air conditioner. Necessary installation fittings like condensate drain pan and fixing attachment shall be provided by the successful tenderer. Any additional services required shall be included in line with job specification requirement. Window air conditioner unit shall conform to IS:1391-1992 Part I.

2. Split Type Air Conditioner

Split air conditioning unit mainly comprises of two section, Indoor and Outdoor section. Indoor section comprises of cooling coil, fan, supply air grill, filter. Outdoor section comprises of air cooled condenser, blower, hermetically sealed compressor. Sealed refrigerant piping inter connect indoor and outdoor section. Outdoor unit shall be installed in open space for easy heat dissipation from condenser. Indoor section shall be ceiling surpended or wall mounted type as per job specification requirement. Duct lines may be connected at the outlet of fan in indoor section with strip heater as per job specification requirement. Remote control unit, thermostat and other standard accessories for successful installation of split type air conditioner shall be included in the scope of successful tenderer. Any additional services required shall be included in line with job specification requirement. Split air conditioner unit shall conform to IS:1391-1992 Part II.
03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

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

93. Make & Model
94. Quantity
95. Capacity in TR
96. Air Flow m³/h
97. Flow direction and volume control grill
98. Material of construction
99. Compressor type
100. Drive details and total power consumption
101. Overall dimensions
102. Refrigerant type
103. Filter efficiency
104. Weight of unit
105. Noise level at 1m distance in dB(A)
106. Fixing details.
107. Vibration level.
16. Accessories included
30.0 **Solid Waste Management System.**

Integrated Iron and steel plant generates various type of waste during manufacturing of saleable products. In addition to the main line of production of iron and steel the allied and associated activities give rise to many waste which differ in composition, characteristics as well as physical state.

Solid waste generated in steel plant can be classified in major two groups. One group will be solid waste, which can be recycled/reused in the iron & steel making process in the plant itself and the other groups contain solid wastes which cannot be used in technological process and has to be disposed. Wherever it becomes unavoidable, the wastes shall be disposed under controlled conditions. Disposal of waste shall be done in such a way that the pressure on land and subsequent land contamination shall be progressively brought to minimum.

All efforts shall be made to minimize the generation of waste and maximize the effective utilization of waste in the plant.

All waste from the pollution control system and treatment shall be used or recycled to the extent possible.

Solid waste generated to be managed as per charter of corporate responsibility for Environment Protection (CREP) for Iron and steel Industries published by Central Pollution control Board (CPCB).

As per Minutes of twentieth meeting of the Peer & core expert committee on Developments of Effluent and Emission standards of Iron & steel plants held on Feb 19, 2007, CPCB circulated the following guidelines:

- Total BF slag, BF flue dust utilization shall be 100% by year 2008
- BF gas cleaning plant (GCP) sludge utilization shall be 50% by 2012, New units shall plan to meet the target of 50% utilization from Inception stage itself
- Total BOF slag utilization shall be 100% by year 2008
- BOF dust/sludge utilization shall be 50% by 2012, New units shall plan to meet the target of 50% utilization from Inception stage itself

Accordingly waste generated in these two plants may be managed.

Hazardous waste generated in the plant shall be handled as per “The hazardous waste (Management and handling) rules 1989 and subsequent amendment.”

Fly ash and Bottom ash generated shall be managed/handled as per latest notification on Ash management by Ministry of environment and forest, Govt of India.

Lead Acid batteries shall be handled and disposed as per Batteries (Management and Handling) Rules 2001.
01 GENERAL

01.01 This specification covers the materials, tools, facilities and quality requirement for surface preparation and painting of steel structures, equipment, piping, ducts, chutes, wood work etc.

01.02 This is only a general guideline of the painting scheme to be followed by the Tenderer. However, in case a specific painting procedure is stipulated in any tendering specification, then this general guideline shall be superceded. Any special case which may arise from time to time shall be dealt with individually on the merit of each case.

01.03 The term “painting” referred herein covers rust preventive, fungus/insects preventive and decorative coating along with surface protection of the following area but not limited to the areas indicated below.

i) Structural steel works
ii) Mechanical equipment
iii) Electrical equipment
iv) Instrumentation and control equipment.
v) Pipe work
vi) Oxygen plant, etc.

01.04 Surfaces made of asbestos, aluminum, brass, bronze, galvanized steel, stainless steel, cast iron and other corrosion resistant alloys and rubber/synthetic polymer/fiber reinforcement plastic and buried pipe work are not required to be painted unless specified except for aesthetic purposes or for identification bands, wherever relevant.

01.05 The complete paint system for any item includes the following basic activities:

i) Proper surface preparation
ii) Application of primer coats
iii) Application of intermediate coats
iv) Application of finished coats

All the above coats shall be of quality paint products and of approved make. The scope of work shall also include supply of all paint materials as per specification described herein.

01.06 If the contractor desires to adopt alternative paint system for any specific item for an improvement or equivalent to the system specified here-in or as per recommendations of paint manufacturer, may do so subject to purchaser’s approval in advance.

02 SURFACE PREPARATION

02.01 Surface preparation required for paint application, shall be such as to clean the surface thoroughly of any material which will be conducive to premature failure of the paint substrates.
02.02 All surfaces shall be cleaned of loose substances, and foreign materials, such as dirt, rust, scale, oil, grease, welding flux, etc. in order that the prime coat is rigidly anchored to the virgin metal surface. The surface preparation shall confirm to pictorial representation of surface quality grade of Swedish Standards Institution SIS – 055900 or equivalent standards such as SSPC – VIS – 1.67 or DIN 55928(Part 4) or BS 4232 or IS 1477 – 1971 (Part I)

02.03 The acceptable surface preparation quality / grade are described under each paint system. The procedures include solvent cleaning, hand tool cleaning, power tool cleaning, blast cleaning, wood surface cleaning, flame cleaning and pickling. This will ensure surface quality as required by the specific primer paint. For ready reference surface preparation quality grade to be adopted in respect of SIS 055900 and DIN 55928 (part-4) is given in Annexure-01.

02.03.01 **Solvent Cleaning**

The surface shall be cleaned by wiping, immersion, spraying or vapour contacting of a suitable solvent or washing with an emulsion or alkaline solution to remove oil, grease, dirt, old paint, etc. Solvent cleaning shall not remove rust, scales, mill scales or weld flux. Therefore, before application of paint, solvent cleaning shall be followed by other cleaning procedures as stated in subsequent clauses.

02.03.02 **Hand Tool Cleaning**

The surface shall be cleaned manually by vigorous wire brushing as per grade St-2 quality of Swedish Standard Institution SIS 055900 and DIN 555928. This method effectively removes loosely adherent materials, but would not affect residues of rust or mill scales that are intact and firmly adherent. Finally the surface is to be cleaned with a vacuum cleaner or with clean compressed air or with clean brush. After preparation the surface shall have a faint metallic shine. The appearance shall correspond to the prints designated St – 2.

02.03.03 **Power Tool Cleaning**

The surface shall be cleaned by electric or pneumatic tools, such as brushes, sanding machines, disc abrasive grinder, rotary disc scaler etc. to St – 3 quality. The tools shall be used carefully to prevent excessive roughening of surface and formation of ridges and burrs. This method will remove loosely adherent materials but would not affect residues of rust or mill scales that are firmly adherent and intact.

02.03.04 **Blast Cleaning**

The surface shall be cleaned by impingement of abrasive materials, such as graded sand at high velocity created by clean and dry compressed air blast as per the grade according to Swedish Standard Institution SIS 055900 .This method will remove loosely adherent materials as well as adherent scales and mill scales. Prior to application of blast, heavy deposit of oil and grease are removed by solvent cleaning excessive
surface scales are removed by hand tools or power tool cleaning. The extent of removal of adherent scales is varied, depending on the application and are defined by the surface quality grades Sa1, Sa2, Sa2.5 and Sa3 in the order of increasing cleanliness. The blast cleaning is not recommended for sheet metal work.

02.03.05 **Flame Cleaning**

The surface is cleaned by rapid heating by means of oxyacetylene flame to loosen the adherent scales, followed immediately by wire brushing. This method will remove loosely adherent materials as well as most of the adherent scales and mill scales. In order to minimize or prevent distortion flame cutting shall not be used on members having thickness of 6 mm and lower.

02.03.06 **Pickling**

In this method the surface is cleaned of mill scales, rust or rust scales by chemical reaction or electrolysis or both.

03. **PAINT APPLICATION**

03.01 **Paints**

03.01.01 Paint shall be applied in accordance with paint manufacturer’s recommendations. The work shall generally follow IS 1477 – 1971 (Part II) for jobs carried out in India and SSPC-PA-1 or DIN 55928 or equivalent for jobs carried out outside India.

03.01.02 General compatibility between primer and finishing paints shall be established by the paint manufacturer supplying the paints.

03.01.03 In the event of conflict between this general procedure on painting and the paint manufacturer’s specification, the same shall be immediately brought to the notice of the Purchaser. Generally in cases of such conflicts, manufacturer’s specifications/recommendations shall prevail.

03.01.04 Before buying the paint in bulk, it is recommended to obtain sample of paint and establish “Control Area of Painting”. On Control Area, surface preparation and painting shall be carried out.

03.01.05 If required, samples of paint shall be tested in laboratories to establish quality of paint with respect to:

(i) Viscosity
(ii) Adhesion/Bond of paint in steel surfaces
(iii) Adhesion/Simulated salt spray test.
(iv) Chemical analysis (percentage of solids by weight)
(v) Normal wear resistance as encountered during handling & erection.
(vi) Resistance against exposure to acid fumes, etc.

03.01.06 Whole quantity of paint for a particular system of paint shall be obtained from the same manufacturer.
03.01.07 The main Contractor shall be responsible for supply of paints and this responsibility shall not be passed on to the sub-contractor.

03.01.08 The painting material as delivered to the Contractor, must be in the manufacturer’s original container bearing thereon manufacturer’s name brand and description. Paint/Painting material in containers without labels or with illegible labels shall be rejected, removed from the area and shall not be used.

03.01.09 Thinners wherever used shall be those recommended by the paint manufacturers and shall be obtained in containers with manufacturer’s name and brand name of thinner legibly printed, failing which the thinner is liable to be rejected and shall not be used.

03.01.10 All paint containers shall be clearly labeled to show the paint identification, date of manufacture, batch number, special instruction, shelf life etc. The container shall be opened only at the time of use.

03.01.11 All paints shall be stored in accordance with the requirements of laid down procedure by the paint manufacturer.

03.01.12 All ingredients in a paint container shall be thoroughly mixed to break-up lumps and disperse pigments before use and during application to maintain homogeneity.

03.01.13 The proposed make, quality and shade of the paint shall have the approval of the client.

03.01.14 The colour code of the finishing paint to be followed shall be intimated to the successful Tenderer after finalisation of order. The undercoat shall have different tint to distinguish the same from the finishing coat.

03.01.15 The Contractor shall furnish paint manufacturer’s test report or technical data sheet pertaining to the paint selected. The data sheet shall indicate among other things the relevant standards, if any, composition in weight percent of pigments, vehicles, additives, drying time, viscosity, spreading rate, flash point, method of application, quality of surface preparation required, corrosion resistance properties and colour shades available.

03.01.16 For details of paint materials refer Annexure - 02

03.02 General

03.02.01 Each coat of paint shall be continuous, free of pores and of even film thickness without thin spots.

03.02.02 Each coat of paint shall be sufficiently dry before application of next coat.

03.02.03 Paint shall be applied at manufacturer’s recommended rates. The number of coats shall be such that the minimum dry film thickness specified is achieved. The dry film thickness of painted surfaces shall be checked with ELCOMETER of measuring gauges to ensure application of specified DFT.
03.02.04 Zinc rich primer paints which have been exposed several months before finishing coat is applied shall be washed down thoroughly to remove soluble zinc salt deposits.

03.02.05 The machine finished surfaces shall be coated with white lead and tallow before shipment or before being put out into the open air.

03.02.06 Areas which become inaccessible after assemble shall be painted before assembly (after obtaining painting clearance from the inspecting authority) after requisite surface cleaning as specified.

03.02.07 Paint shall not be applied when the ambient temperature is 5 deg C and below or 45 deg C and above. Also paint shall not be applied in rain, wind, fog or at relative humidity of 80 % and above unless the manufacturer’s recommendations permit. Applications of paint shall be only be spraying or brushing as per IS 486 – 1983 and IS 487 – 1985.

03.02.08 Primer paint shall be applied not later than 2 – 3 hours after preparation of surface, unless specified otherwise.

03.02.09 Edges, corners, crevices, depressions, joints and welds shall receive special attention to ensure that they receive painting coats of the required thickness.

03.02.10 Surfaces which cannot be painted but require protection shall be given a coat of rust inhibitive grease according to IS 958 – 1975 or solvent deposited compound according to IS 1153 – 1975 or IS 1674 – 1960.

03.02.11 Surfaces in contact during shop assembly shall not be painted. Surfaces which will be inaccessible after assembly shall receive minimum two coats of specified primer.

03.02.12 Surfaces to be in contact with wood, brick or other masonry shall be given one shop-coat of the specified primer.

03.03 Site/Field Painting

03.03.01 Wherever shop primer painting is scratched, abraded or damaged, the surface shall be thoroughly cleaned using emery paper and power driven wire brush wherever warranted, and touched up with corresponding primer. Touching up paint shall be matched and blended to eliminate conspicuous marks.

03.03.02 If more than 50% of the painted surface of an item requires repair, the entire item shall be mechanically cleaned and new primer coats shall be applied followed by intermediate and finishing coats as per painting specification.

03.03.03 All field welded areas on shop painted items shall be mechanically cleaned (including the weld area proper, adjacent areas contaminated by weld spatter or fumes and areas where existing primer paint is burnt).
Subsequently, new primer and finishing coats of paint shall be applied as per painting specification.

03.03.04 The first coat of finish paint at site shall be applied preferable within three months of the shop paint.

03.04 **Structural**

03.04.01 All fabricated steel structure, fabricated steel pipes, etc. shall have a minimum of two coats of primer paint before dispatch to site.

03.04.02 Parts of steel structures embedded in concrete shall be given a protective coat of Portland cement slurry immediately after fabrication and after surfaces of this part is thoroughly cleaned from grease, rust, mill scales, etc. No paint shall be applied on this part.

03.04.03 All structures shall receive appropriate number of primer and finishing coats in order to achieve overall DFT as per design drawings/specification.

03.05 **Hot Surfaces**

03.05.01 Total DFT for heat resistant paints should not exceed 100 – 120 microns, otherwise flaking occurs (as per paint manufacturer’s recommendations).

03.05.02 Heat resistant paints should be applied by brush.

03.05.03 Primer coat should not be applied on the surfaces having temperature condition more that 120 deg C.

04 **PAINTING SCHEMES**

For a complete painting scheme of any item being printed, all types of paints are to be procured from the same manufacturer as approved by the purchaser.

04.01 **Legend**

SP - Surface preparation quality as per SIS standard
2P1 - Two (2) coats of Primer paint type P1
1I1 - One (1) coats of Intermediate paint type I1
2F1 - Two (2) coats of Finish paint type F1
DFT - Dry Film Thickness in microns developed
CRT- Clean and Retouch

Type of paint products like P1 to P9, I1 to I4 and F1 to F10 have been specified under Annexure-02.

04.02 The painting scheme to be followed for various structure/equipment exposed to different condition is briefly given in Annexure-03 for guidance to the tenderer.
04.03 The colour code for different applications are indicated in Annexure-04. Wherever colour codes are not specified, the same is to be mutually agreed between the Purchaser and Contractor.

05. GUARANTEE

05.01 The Contractor shall guarantee that the physical and chemical properties of the paint materials conform with the specification of paint products.

05.02 The Contractor shall submit internal test reports from paint manufacturers regarding the quality of paint whenever asked by the Purchaser/Consultant.

05.03 Guarantee period shall commence from the date of completion of finishing coat of paint. The guarantee period will be indicated depending on the type of surface preparation and system of painting. To fulfill this obligations the Contractor may obtain from the painting manufacturer, guarantee for the performance of paint/painted surfaces.
### Surface Preparation Grade

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Surface Preparation</th>
<th>Swedish Std SIS 055900</th>
<th>DIN Std. Din 55928 (Part 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Blast cleaning to white metal&lt;br&gt;Removal of all visible rusts, mill-scales, paint and foreign matters.</td>
<td>Sa 3</td>
<td>Sa 3</td>
</tr>
<tr>
<td>2</td>
<td>Blast cleaning to near white metal: 95% of any section of surface area is free from all rusts, mill-scales and visible residues.</td>
<td>Sa 2.5</td>
<td>Sa 2.5</td>
</tr>
<tr>
<td>3</td>
<td>Blast cleaning to commercial quality: At least 2/3 of any section of the surface area is free from all rusts, mill-scales and visible residues.</td>
<td>Sa 2</td>
<td>Sa 2</td>
</tr>
<tr>
<td>4</td>
<td>Brush-off blast cleaning: Removal of all loose mill-scales, rust and foreign matters etc.</td>
<td>Sa 1</td>
<td>Sa 1</td>
</tr>
<tr>
<td>5</td>
<td>Power tool cleaning: Very thorough scrapping and wire brushing to remove loose mill-scale, rust and foreign matters to have pronounced metallic shine.</td>
<td>St 3</td>
<td>St 3</td>
</tr>
<tr>
<td>6</td>
<td>Hand tool cleaning: Removal by hand brushing of loose mill-scale, loose rust and foreign matters.</td>
<td>St 2</td>
<td>St 2</td>
</tr>
</tbody>
</table>
PAINT MATERIALS

01. PRIMER PAINTS (P)

Primer paint products shall be applied only on dry and clean surfaces.

01.01 Primer Paint – P1 (Phenolic – Alkyd Based)
A single pack air drying phenolic modified alkyd composition with zinc phosphate as a primer paint conforming generally to IS : 2074.

Air drying time
- About 60 minutes (touch dry)
- Overnight (hard dry)

Dry film thickness (DFT)/Coat
- 40 microns (min)

Temperature resistance
- Upto 100°C dry heat

01.02 Primer Paint – P2 (Chlororubber Based)
A single pack air drying high build chlorinated rubber based zinc phosphate primer.

Percent chlororubber
- 20 to 22 (% Chlorine above 65% in chlororubber)

Air drying time
- About 15 minutes (touch dry)
- Overnight (hard dry)

DFT/Coat
- 50 microns (min)

Temperature resistance
- Up to 65°C dry heat

01.03 Primer Paint – P3 (PVC Copolymer Alkyd Based)
Polyvinyl chloride (PVC)
- Alkyd zinc phosphate – redoxide based primer

Ratio
: PVC copolymer + alkyd resin (1:1)

Pigments
: Zinc phosphate & Fillers

Air drying time
- 24 hours

DFT/Coat
- 80 microns

Temperature resistance
- Upto 80°C dry heat
01.04  **Primer Paint – P4 (Epoxy Based)**

A two pack air drying Epoxy polyamide resin based red oxide-zinc phosphate primer.

- Epoxy content (% wt.) - 15 to 18
- Air drying time - About 30 minutes (touch dry)
  - overnight (hard dry)
- DFT/Coat - 30 microns (min)
- Temperature resistance - Upto 120°C dry heat

01.05  **Primer Paint – P5 (Epoxy Based)**

A two pack air drying Epoxy polyamide with zinc dust of at least 92% zinc dust on the dry film

- Epoxy content (% wt.) - 8 to 10
- Air drying time - Less than 10 minutes (touch dry)
  - Less than 2 hours (hard dry)
- DFT/Coat - 40 microns (min)
- Temperature resistance - Upto 300°C dry heat

01.06  **Primer Paint – P6 (Poly – Vinyl Butyral Resin Based)**

A two pack air drying polyvinyl butyral resin based wash primer with rust inhibitive pigments.

- Air drying time - 5 to 7 minutes (touch dry)
  - 2 hours (hard dry)
- DFT/Coat - 8 microns
- Temperature resistance - Upto 65°C dry heat
- Application for - Galvanised iron, aluminium, light alloys etc. on which the adhesion of conventional paints are poor.

01.07  **Primer Paint – P7 (Ethyl Zinc Silicate, EZS Based)**

A two pack heavy duty zinc dust rich silicate primer which protects the surface with just a single coat.

- Total solids (3 wt) - 84 +/- 2
- Density (g / cc) - 3.07 +/- 0.05
Air drying time - To top coat 16 hours
DFT / coat - 60 microns
Temperature resistance - Upto 450 deg C dry heat

01.08
Primer Paint – P8 (High Build Coal Tar Epoxy)

A two pack cold cured H.B. epoxy coal tar coating – no primer is required.

Mixing ratio - Base: Hardener (4:1 by vol.)
Air drying time - 48 hours (hard dry)
DFT / Coat - 100 microns

01.09
Wood Varnish-P9

Treated oil based primer pigmented with suitable pigments:

Air drying time - 16 hours for application of top coat.
Coverage - 10 to 14 sq. m/litre

02.
INTERMEDIATE PAINTS (I)

These paints shall be applied over primer coats as an intermediate layer to provide weather proof seal of primer coats.

02.01
Intermediate Paint-II (Phenolic alkyd based)

A single pack high build phenolic based paint with micaceous iron oxide (M10).

Air Drying Time - 4 to 6 hours (touch dry) - 2 days (hard dry)
DFT / Coat - 75 microns (min)
Temperature resistance - Upto 100 deg C dry heat
Compatible with - Primer P1

02.02
Intermediate Paint-I2 (Chlororubber based)

A single pack air drying high build chloro based paint with MIO.

Air Drying Time - 15 minutes (touch dry) - 24 hours (hard dry)
DFT / Coat - 70 microns (min)
Temperature resistance - Upto 65 deg C dry heat
Compatible with - Primer P2, P3 & P4

02.03
Intermediate Paint-I3 (PVC – Alkyd Based)

PVC Coploymer - Resin 1 : 1
Pigments - Micaceous iron oxide (MIO)
DFT / Coat - 80 microns (min)
Temperature resistance - Upto 80 deg C dry heat
Compatible with - Primer P2 & P3

02.04 Intermediate paint-I4

A two pack air drying high build epoxy resin based paint with MIO.

Air drying time - 6 to 8 hours (touch dry)
- 7 days (full cure)
DFT / coat - 100 microns
Temperature resistance - Up to 180°C dry heat
Compatible with - Primer P4 & P5

03. FINISH PAINTS (F)

Finish paint costs shall be applied over primer coats and intermediate coats after proper cleaning and touch up of primed surface.

03.01 Finish Paint – F1

A single pack air drying high gloss phenolic alkyd modified synthetic enamel paint suitably pigmented.

Air drying time - 3 to 4 hours (touch dry)
- 24 hours (hard dry)
DFT / Coat - 25 microns (min)
Temperature resistance - Upto 100°C dry heat
Compatible with - Primer P1
- Intermediate I1
Colour - Generally all shades

03.02 Finish Paint – F2

A single pack air drying polyurethane enamel of high gloss and hard finish suitably pigmented.

Air drying time - 2 to 2 ½ hours (touch dry)
- 6 hours (hard dry)
DFT / Coat - 30 microns (min)
Temperature resistance - Upto 100°C dry heat
Compatible with - Primer P1 & P8 and Intermediate I1
Colour - Generally all shades
03.03  **Finish Paint – F3**

A two pack air drying bituminous aluminum paint.

Air drying time  
- 1 to 2 hours (touch dry)  
- 21 hours (hard dry)

DFT/Coat  
- 25 microns (min)

Temperature resistance  
- Upto 100°C dry heat

Compatible with  
- Primer P1 and Intermediate I1

Colour  
- Bright metallic

03.04  **Finish Paint – F4**

A ready mixed oil-alkyd based synthetic enamel paint of high gloss and hard wearing properties.

Air drying time  
- 6 to 8 hours

Coverage  
- 14 to 16 Sq. m /litre

Temperature resistance  
- Upto 60°C dry heat

Compatible with  
- P8

Colour  
- Generally all shades

03.05  **Finish Paint – F5**

A single pack air drying plasticized chlororubber paint suitably pigmented.

Air drying time  
- 30 minutes (touch dry)  
- 24 hours (hard dry)

DFT/Coat  
- 35 microns (min)

Temperature resistance  
- Upto 65°C dry heat

Compatible with  
- Primer P2 & P3,  
  Intermediate I2 & I3

Colour  
- Nearly all shades except few.
03.06 **Finish Paint – F6**  
A PVC – Copolymer alkyd based enamel.  
Density - 1.17 ± 0.05  
Total solids (1 wt) - 55 ± 2  
DFT/Coat - 40 microns  
Compatible with - P2 and P3

03.07 **Finish Paint – F7**  
A two pack air drying epoxy polyamide enamel suitably pigmented.  
Air drying time - 2 to 3 hours (touch dry)  
- 7 days (full cure)  
DFT/Coat - 40 microns (min)  
Temperature resistance - Up to 130°C dry heat  
Compatible with - Primer P4 & P5, Intermediate I4  
Colour - Generally all shades.

03.08 **Finish Paint – F8**  
A single pack synthetic rubber based aluminium paint.  
Air drying time - 2 hours (touch dry)  
- 24 hours (hard dry)  
DFT/Coat - 25 microns (min)  
Temperature resistance - Upto 200°C dry heat  
Compatible with - No Primer paint except primer P6 is applicable in case of non-ferrous substrate.  
Colour - Smooth aluminium.
### Painting Scheme

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Painting Scheme</th>
<th>Total DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td><strong>Steel Structures</strong> <em>(Temp. not exceeding 80°C)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>(Refer Note-1)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Technological steel structures for plant and equipment</td>
<td>SP – Sa 2.5</td>
<td>CRT 130</td>
</tr>
<tr>
<td></td>
<td>Indoor</td>
<td>2P1</td>
<td>2F1</td>
</tr>
<tr>
<td></td>
<td>Outdoor</td>
<td>SP – Sa 2.5</td>
<td>CRT 205</td>
</tr>
<tr>
<td></td>
<td>Outdoor</td>
<td>2P1 1I1</td>
<td>2F1</td>
</tr>
<tr>
<td>1.2</td>
<td>Fabricated steel structures at site for rung ladders, cat-ladders, gates,</td>
<td>SP – St-2 and/</td>
<td>CRT 130</td>
</tr>
<tr>
<td></td>
<td>rolling shutters, etc. (Springs/rubbing surfaces excluded)</td>
<td>or St-3 2P1</td>
<td>2F1</td>
</tr>
<tr>
<td></td>
<td>- Indoor / Outdoor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>Walkways, stairs, platforms etc. which are of wearing surface</td>
<td>SP – St-2 and/</td>
<td>CRT 130</td>
</tr>
<tr>
<td></td>
<td>- Indoor</td>
<td>or St-3 2P1</td>
<td>2F1</td>
</tr>
<tr>
<td></td>
<td>- Outdoor</td>
<td>SP– St2 and/</td>
<td>CRT 205</td>
</tr>
<tr>
<td></td>
<td></td>
<td>or St-3 2P1</td>
<td>2F1</td>
</tr>
<tr>
<td>1.4</td>
<td>Steel doors and windows</td>
<td>SP–St-2 and / or</td>
<td>CRT 215</td>
</tr>
<tr>
<td></td>
<td>- Indoor / outdoor</td>
<td>St-3 2P1</td>
<td>2F2</td>
</tr>
</tbody>
</table>

### Sl. No. Description

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Painting Scheme</th>
<th>Total DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td><strong>MECHANICAL EQUIPMENT</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Mechanical equipment <em>(Temp. not exceeding 80°C)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1.1</td>
<td>Static equipment like storage tanks, vessels,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>bins, bunkers, heat exchangers, coolers,</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## General Technical Specification

### Painting Scheme

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Painting Scheme</th>
<th>Total DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At Shop</td>
<td>At Site</td>
</tr>
<tr>
<td></td>
<td>cyclones, scrubbers, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Indoor</td>
<td>SP – Sa 2.5 2P2/2P3</td>
<td>CRT 2F5/2F6</td>
<td>170/240</td>
</tr>
<tr>
<td>- Outdoor</td>
<td>SP – Sa 2.5 2P2/2P3+1I2/1I3</td>
<td>CRT 2F5/2F6</td>
<td>240/320</td>
</tr>
<tr>
<td></td>
<td>2.1.2 Rotary/moving equipment and machineries like crushers, mills, vibratory screens, bin activators, blowers, fan, air/gas compressors, pumps, gear boxes, machine housings etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Indoor</td>
<td>SP – Sa 2.5 2P3/2P4</td>
<td>CRT 2F6/2F7</td>
<td>240/140</td>
</tr>
<tr>
<td>- Outdoor</td>
<td>SP-Sa 2.5 2P3 + 1I3/1I4</td>
<td>CRT 2F6/2F7</td>
<td>320/340</td>
</tr>
<tr>
<td></td>
<td>3.0 Pipe / Duct work (Overground)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1 Non – insulated (temperature up to 80°C)</td>
<td>SP – St2 and or St3 2P1</td>
<td>CRT 2F1</td>
<td>130</td>
</tr>
<tr>
<td>- Indoor</td>
<td>SP – St2 and / or St3 2P1 + 1I1</td>
<td>CRT</td>
<td>205</td>
</tr>
<tr>
<td>- Outdoor</td>
<td>SP- St2 and/ or St3 1P1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.2 Insulated (hot)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Indoor/Outdoor</td>
<td>SP- St2 and/ or St3 1P1</td>
<td>Remove paint and insulate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.0 Oxygen Plant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1 Outdoor steel structures</td>
<td>SP – St2 and / or St3</td>
<td>CRT</td>
<td></td>
</tr>
</tbody>
</table>
### Painting Scheme

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Painting Scheme</th>
<th>Total DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At Shop</td>
<td>At Site</td>
</tr>
<tr>
<td>4.2</td>
<td>Rotary equipment like air compressors</td>
<td>2P1 + 111</td>
<td>2F3</td>
</tr>
<tr>
<td>5.0</td>
<td>Others</td>
<td>2P4</td>
<td>CRT</td>
</tr>
<tr>
<td>5.1</td>
<td>Standard mobile equipment like chasis of trucks, dumpers, crawler cranes bulldozers, railway rakes, chasis of slag cars, ladle cars, etc.</td>
<td>As per manufacturer’s standards</td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>Laboratory equipment like ovens, screens, magnetic stirrers, samplers, etc.</td>
<td>Stove enamelling</td>
<td>CRT</td>
</tr>
<tr>
<td>5.3</td>
<td>Steel structures partly immersed in water</td>
<td>SP – Sa 2.5</td>
<td>CRT</td>
</tr>
</tbody>
</table>

**Notes:**

1. Painting scheme of all fabricated steel structures, fabricated pipe work, building structure, conveyor galleries, pipe trestles etc. is indicated in the Technical Specification of steel structures.

2. **Primer Paint**

   Primer coat shall be suitable for intended temperature applications as per manufacturer’s recommendation. The primer selection shall be generally in line with the specification laid down in Annexure-02.

3. **Finish Paint**

   In case of Aluminium cladding final painting will not be required.
The colour codes are mentioned for all the items including pipe work. Shades of finish coat of paint applied over respective item indicated below are tentative and subject to alteration as per Purchaser’s request or due to compatible paint system adopted. The service for which colour code/bands are not specified are to be mutually agreed for by the Purchaser & the Contractor.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Items Painted</th>
<th>Colour</th>
<th>Colour No. of IS:5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Structures</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Building frames including bracings, side girts, louvers etc.</td>
<td>Aircraft grey</td>
<td>693</td>
</tr>
<tr>
<td></td>
<td>Crane girders</td>
<td>Azure blue</td>
<td>104</td>
</tr>
<tr>
<td></td>
<td>Crane stops</td>
<td>Post office red</td>
<td>538</td>
</tr>
<tr>
<td></td>
<td>Gutters</td>
<td>Black bituminous aluminium</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Fire escape platforms ladders, etc.</td>
<td>Signal red</td>
<td>537</td>
</tr>
<tr>
<td></td>
<td>General hand railing, top runners</td>
<td>Lemon yellow</td>
<td>355</td>
</tr>
<tr>
<td></td>
<td>Rung ladders</td>
<td>Lemon yellow</td>
<td>355</td>
</tr>
<tr>
<td></td>
<td>All members blocking passages for movement</td>
<td>Lemon yellow</td>
<td>355</td>
</tr>
<tr>
<td></td>
<td>Trestles, towers and pipe bridges</td>
<td>Dark admiralty grey</td>
<td>632</td>
</tr>
<tr>
<td></td>
<td>Conveyor gallery structures</td>
<td>Aircraft grey</td>
<td>693</td>
</tr>
<tr>
<td></td>
<td>Steel chimneys</td>
<td>Aluminium</td>
<td>-</td>
</tr>
<tr>
<td>2.</td>
<td>Equipment and Machinery</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>General indoor equipment</td>
<td>Light grey</td>
<td>631</td>
</tr>
<tr>
<td></td>
<td>General outdoor equipment</td>
<td>Dark admiralty</td>
<td>632</td>
</tr>
<tr>
<td></td>
<td>Crane bridges, trolleys, hooks etc. and other mobile equipment</td>
<td>Base: Lemon yellow, Stripes: Black (100 mm wide)</td>
<td>355</td>
</tr>
<tr>
<td></td>
<td>Furnaces</td>
<td>Aluminium</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tanks</td>
<td>Base: Same as for general equipment, Strips: Same shade as for piping around the tank at half the tank height</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fire-fighting equipment</td>
<td>Signal red</td>
<td>537</td>
</tr>
</tbody>
</table>

3. **Pipe work**

Colours shall be as given below. The base colour shall be applied throughout entire length except on surfaces of materials such as asbestos, aluminium, brass, bronze, galvanized steel, stainless steel and other corrosion resistant alloys and rubber / synthetic polymers. In such cases identification colour bands of at least 500mm width shall be provided near each branch, valve and at distances not exceeding 10m either as local colour coatings or coloured adhesive type of suitable material or label attached to the pipe work. Additional identification bands superimposed over the base colour shall be provided near each branch, valve and at distance not exceeding 10m. The bands shall be atleast 25mm wide except in care of double bands where the first band shall be about 100mm wide. Direction of flow shall be clearly marked on the pipelines at intervals not exceeding 10m and all branches and change of directions.
<table>
<thead>
<tr>
<th>Service</th>
<th>Colour</th>
<th>Colour No. of IS:5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea or river water (untreated)</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>Band - White</td>
<td></td>
</tr>
<tr>
<td>Cooling water</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>Band - White</td>
<td>166</td>
</tr>
<tr>
<td>Boiler feed water</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td>Condensate</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>Band – Light brown</td>
<td>410</td>
</tr>
<tr>
<td>Drinking water</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>First band - French blue</td>
<td>166</td>
</tr>
<tr>
<td></td>
<td>Second band – Signal red</td>
<td>537</td>
</tr>
<tr>
<td>Industrial water</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>Band – Light orange</td>
<td>557</td>
</tr>
<tr>
<td>Compressed air</td>
<td>Base – Sky blue</td>
<td>101</td>
</tr>
<tr>
<td>Instrument air</td>
<td>Base – Sky blue</td>
<td>101</td>
</tr>
<tr>
<td></td>
<td>Band – Light brown</td>
<td>410</td>
</tr>
<tr>
<td>Drainage</td>
<td>Base – Black</td>
<td></td>
</tr>
<tr>
<td>Fuel oil</td>
<td>Base – Light brown</td>
<td>410</td>
</tr>
<tr>
<td></td>
<td>Band – Signal red</td>
<td>537</td>
</tr>
<tr>
<td>Coke oven/BF gas/other fuel</td>
<td>Base – Canary yellow</td>
<td>309</td>
</tr>
<tr>
<td>gases</td>
<td>Band – Signal red</td>
<td>537</td>
</tr>
<tr>
<td>Argon</td>
<td>Base – Canary yellow</td>
<td>309</td>
</tr>
<tr>
<td></td>
<td>Band – French blue</td>
<td>166</td>
</tr>
<tr>
<td>Acetylene</td>
<td>Base – Canary yellow</td>
<td>309</td>
</tr>
<tr>
<td></td>
<td>Band – Dark violet</td>
<td>796</td>
</tr>
<tr>
<td>LP Gas (LPG)</td>
<td>Base – Canary yellow</td>
<td>309</td>
</tr>
<tr>
<td></td>
<td>First band – Signal red</td>
<td>537</td>
</tr>
<tr>
<td></td>
<td>Second band – Traffic green</td>
<td>267</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>Base – Canary yellow</td>
<td>309</td>
</tr>
<tr>
<td></td>
<td>Band – Black</td>
<td></td>
</tr>
<tr>
<td>Oxygen</td>
<td>Base – Canary yellow</td>
<td>309</td>
</tr>
<tr>
<td></td>
<td>Band – White</td>
<td></td>
</tr>
<tr>
<td>Non-acidic slurries</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>Band – White</td>
<td></td>
</tr>
<tr>
<td>Fire-fighting system</td>
<td>Base – Signal red</td>
<td>537</td>
</tr>
<tr>
<td>Rain water down pipes</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>Band – Sky blue</td>
<td>101</td>
</tr>
<tr>
<td>Duct work</td>
<td>Base – Aluminium</td>
<td></td>
</tr>
</tbody>
</table>

**Note**: For these services, hazard marking as per fig. 4C of IS:2379 shall also be provided.
**INSTRUCTIONS FOR FILLING UP:**

1. **QAP** shall be submitted for each of the equipment separately with break-up of assembly/sub-assembly & part/component or for group of equipment having same specification.

2. Use numerical codes as indicated for extent of inspection & tests and submission of test certificates & documents. Additional codes & description for extent of inspection & tests may be added as applicable for the plant and equipment.

3. Separate identification number with quantity for equipment shall be indicated wherever equipment having same specification belonging to different facilities are grouped together.

4. Weight in tonnes (T) must be indicated under column 5 for each item. Estimated weights may be indicated wherever actual weights are not available.

**ABBREVIATIONS USED:**

- CONTR : CONTRACTOR
- MFG : MANUFACTURER

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description (with equipment heading/place of use and brief specification)</th>
<th>Identification No.</th>
<th>Quantity</th>
<th>Manufacturer’s Name and Address</th>
<th>Expected Schedule of Final Inspn</th>
<th>Raw Material and Inprocess stage Inspection</th>
<th>Final Inspection / Test by</th>
<th>Test Certificates &amp; documents to be submitted to MECON</th>
<th>Acceptance Criteria Standards/BS/ASME/Norms and Documents</th>
<th>REMARKS/SAMPLING PLAN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**INPECTION AND TESTS**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description (with equipment heading/place of use and brief specification)</th>
<th>Identification No.</th>
<th>Quantity</th>
<th>Manufacturer’s Name and Address</th>
<th>Expected Schedule of Final Inspn</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- QAP NO. TO BE ALLOTTED BY MECON

For CONTRACTOR / SUB-CONTRACTOR

(Stamp & Signature)

For MECON (Stamp & Signature)

(Stamp & Signature)
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description (with equipment heading, place of use and brief specification)</th>
<th>Identification No.</th>
<th>Quantity</th>
<th>Manufacturer's Name and Address</th>
<th>Expected Schedule of Final Inspection</th>
<th>Test Certificates &amp; Documents to be submitted to MECON</th>
<th>Acceptance Criteria Standards/BS/ASME/Norms and Documents</th>
<th>Remarks/ ( \text{Q.A.P NO. TO BE ALLOTTED BY MECON} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

For CONTRACTOR / SUB-CONTRACTOR

for MECON (Stamp & Signature)
**INSTRUCTIONS FOR FILLING UP:**

1. QAP shall be submitted for each of the equipment separately with break-up of assembly/sub-assembly/part/component or for group of equipment having same specification.

2. Use numerical codes as indicated for extent of inspection & tests and submission of test certificates & documents. Additional codes & description for test may be added as applicable for the plant and equipment.

3. Separate identification number with quantity for equipment shall be indicated wherever equipment having same specification belonging to different facilities are grouped together.

4. Weight in tonnes (T) must be indicated under column 5 for each item. Estimated weights may be indicated wherever actual weights are not available.

**CODES FOR EXTENT OF INSPECTION, TESTS, TEST CERTIFICATES & DOCUMENTS:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Code</th>
<th>Description</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Visual</td>
<td>14</td>
<td>Impulse Test</td>
<td>D1</td>
<td>Approved GA drawings</td>
</tr>
<tr>
<td>2</td>
<td>Dimensional</td>
<td>15</td>
<td>Partial Discharge Test</td>
<td>D2</td>
<td>Approved single line / schematic diagram</td>
</tr>
<tr>
<td>3</td>
<td>Filmt &amp; Alignment</td>
<td>16</td>
<td>Heat run test/Temp. rise Test</td>
<td>D3</td>
<td>Catalogues / Approved data sheet</td>
</tr>
<tr>
<td>4</td>
<td>Physical Test(Sample)</td>
<td>17</td>
<td>Enclosure protection Test</td>
<td>D4</td>
<td>Approved bill of materials</td>
</tr>
<tr>
<td>5</td>
<td>Chemical Test (Sample)</td>
<td>18</td>
<td>Calibreration</td>
<td>D5</td>
<td>Unpriced P.O. copy</td>
</tr>
<tr>
<td>6</td>
<td>Ultrasonic Test</td>
<td>19</td>
<td>Noise &amp; Vibration</td>
<td>D6</td>
<td>Calibration Certificate of all measuring instrument and gauges</td>
</tr>
<tr>
<td>7</td>
<td>Magnetic Particle Test (MPT)</td>
<td>20</td>
<td>Test Certificates for bought out components</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Radiography test</td>
<td>21</td>
<td>Tank pressure Test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Dye Penetration Test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Measurement of R Value : a) Before HV Test</td>
<td>22</td>
<td>Paint shade verification</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) After HV Test</td>
<td>23</td>
<td>Short time rating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>High voltage test/Dielectric test</td>
<td>24</td>
<td>Operation &amp; functional</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>25</td>
<td>Overspeed Test</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>26</td>
<td>Flame proof Test</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>27</td>
<td>Clearance and creepage</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>28</td>
<td>Acceptance Tests</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ABBREVIATIONS USED:**

- CONTR : CONTRACTOR
- MFG : MANUFACTURER

**EQUIPMENT DETAILS**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description (with equipment heading, place of use and brief specification)</th>
<th>Identification No.</th>
<th>Quantity</th>
<th>Manufacturer's Name and Address</th>
<th>Expected Schedule of Final Inspection</th>
<th>Raw Material and Inprocess Tests</th>
<th>Final Inspection/Test by</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**INSPECTION AND TESTS**

<table>
<thead>
<tr>
<th>Raw Material and Inprocess Tests stage Inspection</th>
<th>Final Inspection/Test by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspt</td>
<td>MFR</td>
</tr>
<tr>
<td>-------</td>
<td>-----</td>
</tr>
</tbody>
</table>

**MENTS**

1. Remarks/Stage Inspection
2. Sampling Plan
3. Acceptance Criteria
4. Standards/IS/BS
5. Documents

**QUALITY ASSURANCE PLAN FOR ELECTRICAL EQUIPMENT**

**CONTRACTOR PROJECT ORDER NO. & DATE**

**SUB-CONTRACTOR ORDER NO. & DATE**

**PACKAGE NO.**

**PACKAGE NAME**

**FORM NO. 11.20 (DQM) F-10, REV-0**

For **CONTRACTOR/ SUB-CONTRACTOR**

(Stamp & Signature)
| Sl. No. | Description (with equipment identification, place of use and brief specification) | Identification No. | Quantity | Manufacturer's Name and Address | Expected Schedule of Final Inspection | Raw Material and Inprocess Test Inspection | Final Inspection / Test by Documents to be submitted to MECON | Test Certificates & Acceptance Criteria | REMARKS/

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description (with equipment identification, place of use and brief specification)</th>
<th>Identification No.</th>
<th>Quantity</th>
<th>Manufacturer's Name and Address</th>
<th>Expected Schedule of Final Inspection</th>
<th>Raw Material and Inprocess Test Inspection</th>
<th>Final Inspection / Test by Documents to be submitted to MECON</th>
<th>Test Certificates &amp; Acceptance Criteria</th>
<th>REMARKS/</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>