



Government of India  
**Bhabha Atomic Research Centre**  
Nuclear Recycle Group  
Technology Development Division

WIP, Trombay

Ref: BARC/NRG/TDD/PES/RSWRF/2018/104718

Date: 28/05/2018

**Sub:** Enquiry for “Minor Fabrication Work”

Dear sir,

The following work is required to be carried out on urgent basis:

| Sr. No. | Description of work   | Quantity   |
|---------|---|--|
| 1.      | Fabrication, supply, installation, testing and erection of ventilation system including package Air-conditioning unit, ventilation exhaust blower and Stainless Steel ducting for RSWRF, RSMS, BARC, Trombay as per technical specification and scope drawing”. | As per Schedule B of the technical specification |

You are requested to submit your most competitive quotation in sealed envelope for the above mentioned work. The material should conform to our specifications. The reference no. given above should be clearly mentioned on the sealed envelope.

Quotation shall be complete in all respects with regard to specifications, cost break up, validity of offer etc., and must reach on or before **18<sup>th</sup> June, 2018 by 15:30 hours**. The offers will be opened on the same day at **16:00 hours** in the TDD office, NRG, BARC, Trombay. The enquiries should be sent only by **speed post** and should be addressed to following:

**Yogendra Singh**  
Scientific Officer-D,  
Room No. 309B, Service Building, WIP Complex,  
TDD, Nuclear Recycle Group,  
Bhabha Atomic Research Centre, Trombay, Mumbai-400 085  
Ph no.: 022-25591115 (Direct) / 25591015/25595507 (TDD Office)  
Email: singhy@barc.gov.in /ramakant@barc.gov.in

**The Enquiries sent by any other mode (e.g. manual, courier etc) shall not be accepted.**

Due consideration shall be given to the following aspects while you submit your offer:

1. Technical requirements of the works are mentioned in attached technical specification.
2. Any deviation from specification shall be clearly mentioned in your offer.
3. The contractor shall arrange all equipment and personnel required for the successful completion of the work.
4. Free Issue Material (FIM) will be given by the department as per Schedule A of this work.
5. The work shall be completed within **6 (Six) calendar months** from the date of issue of work order.
6. The above mentioned work will be carried out at RSMS, BARC, Trombay, Mumbai-85.
7. The offer shall be valid for a period of 45 days from the date of opening and in case of placement of the work order, shall remain firm till the completion of the work.

8. The quotation shall be only on letter head of company and GST number & PAN should be mentioned on it. The authorized signatory of the firm should sign the quotation and stamp of company should be put on the same.
9. All taxes, levies and transportation charges if any, shall be mentioned clearly in your offer. The applicable rate of CGST and SGST in case of intra-state transaction i.e. within the same state shall be 2.5% each. The applicable rate of IGST in case of inter-state transaction i.e. from outside the state shall be 5%. BARC will provide exemption certificate for concessional rates of GST.
10. Income tax @ 2% and surcharge on the I.T., as applicable and an educational cess on IT and SC, as admissible will be deducted from your bill.
11. Full payment shall be made only after successful completion and acceptance of the work.

**Enclosed:** Technical specification



**(Yogendra Singh)**  
SO/D, TDD, NRG, BARC  
022-25591115 (Direct)  
022-25591015  
022-25595507 (TDD Office)  
singhy@barc.gov.in

**TECHNICAL SPECIFICATION**  
**FOR**  
**PACKAGED AC UNIT, EXHAUST BLOWER AND DUCTING WORK FOR RSWRF, RSMS**

**Contents**

|   |     |
|---|-----|
| 1.SCOPE OF WORK: .....  | 1   |
| 2.GENERAL REQUIREMENTS:.....  | 1   |
| 3.AIR CONDITIONING PACKAGE UNITS SPECIFICATION .....                      | 3   |
| 4.TECHNICAL SPECIFICATIONS FOR VENTILATION EXHAUST BLOWER.....            | 9   |
| 5. SPECIFICATION FOR FABRICATION OF STAINLESS STEEL DUCT .....            | 16  |
| 6. SPECIFICATION FOR DAMPER FOR VENTILATION SYSTEM.....                   | 20  |
| 7.DUCT INSULATION SPECIFICATIONS .....                                    | 204 |
| 8. DATA TO BE FURNISHED BY THE CONTRACTOR AFTER THE AWARD OF CONTRACT ... | 24  |
| 9. SUB-CONTRACTORS/SUB VENDORS:.....                                      | 25  |
| 10. DOCUMENTATION:.....   | 25  |
| 11. COMPLETION PERIOD .....   | 25  |
| ANNEXURE –I DATA SHEET: PACKAGE AIR CONDITIONER UNIT .....                | 26  |
| ANNEXURE-II PROFORMA FOR TEST RESULTS OF PACKAGE AC UNIT.....             | 29  |
| SCHEDULE –A .....   | 30  |
| SCHEDULE – B.....   | 30  |
| Appendix-I: Ventilation Layout .....                                      | 32  |

**TECHNICAL SPECIFICATION**  
**FOR**  
**PACKAGE AC UNIT, EXHAUST BLOWER AND DUCTING WORK FOR RSWRF, RSMS**

**1. SCOPE OF WORK:**

- a. Design, manufacturing, assembly, inspection, factory testing, painting, packaging, delivery at site RSMS, BARC, Trombay, Mumbai, installation, commissioning and performance testing at site of refrigerant R-410A or R-407C (Ecofriendly) based package AC unit including double skin type Air Handling Unit (consist of pre and HEPA filter, cooling coil, mist eliminator, supply fan), outdoor air cooled condensing unit (approved make: BLUE STAR / VOLTAS / HITACHI / CARRIER or equivalent) along with all accessories and control system (built-in controls like HP/LP/OL/UL /Temperature, SPP, Phase Sequence Relay and display of same) as per technical specification. Fan Capacity: 2500 CMH & static 140 mm WCg, Cooling capacity 12 TR as per details given in Annexure-I.
- b. Fabrication, assembly, inspection, shop testing, supply and safe delivery of **1 nos. of ventilation blowers** at RSMS, Trombay as per these specifications. The scope of work includes supply of following accessories for blower as per this specifications.
  1. Electric motor along with suitable starter
  2. Base frame
  3. Foundation bolts
  4. Inlet and outlet flexible connections
  5. Vibration isolator pads
  6. Inlet and outlet Counter flanges
  7. VIV manually operated damper at inlet
  8. Outlet multi lover damper
  9. V belt with guard
- c. Supply of supporting structures (angle/ channel/ plate/ rod/ fasteners), fabrication, epoxy painting and installation for duct, equipment and duct reinforcements.
- d. Procurement of raw materials, inspection, fabrication, supply, installation, testing and commissioning of Stainless Steel duct with insulation for supply of conditioned air.
- e. Supply, installation and testing of flow balancing manual dampers.
- f. Supply, installation and testing of isolation electrically operated dampers.
- g. Supply, installation and testing of air supply grills with volume control dampers (VCD), rectangular, double deflection type.
- h. Supply, installation and testing of air return grills with volume control dampers (VCD), rectangular type.

**2. GENERAL REQUIREMENTS:**

The work shall be carried out in accordance with the tender & approved fabrication drawings and the documents/codes/standards of issue in effect on the date of the pertinent tender documents as specified in Technical Specifications. In the event of any conflict between any requirement as given in this specification and that of the applicable codes and standards, the governing requirement shall be as per the discretion of the Purchaser.

**2.1 DRAWING:**

Ducting is required to be done as per the GA drawings. The contractor is required to study these drawings, take site measurement and generate the ducting layout drawing.

**2.2 APPLICABLE CODES AND STANDARDS**

In particular, the AHU, Ducting and exhaust fan work shall conform to the following standards:

|                        |  |
|------------------------|--|
| ASHRAE 33              | Method of Testing - Forced Circulation Air Cooling and Air Heating Coils                           |
| ASHRAE 52.2            | Method of Testing General Ventilation Air-cleaning Devices for Removal Efficiency by Particle size |
| ARI 410                | Forced-Circulation Air-Cooling and Air-Heating Coils   |
| ARI 430                | Performance Rating of Central Station Air-handling Unit Supply Fans                                |
| AMCA 210               | Laboratory Methods of Testing Fans for Aerodynamic Performance Rating                              |
| NFPA 90A               | Installation of Air-conditioning and Ventilating Systems   |
| IS 277                 | Galvanized Steel Sheets (Plain and Corrugated)   |
| IS 737                 | Wrought Aluminum and Aluminum Alloy Sheet and Strip for General Engineering Purposes               |
| SMACNA                 | HVAC Duct Construction Standards - Metal and Flexible  |
| SMACNA                 | HVAC Air Duct Leakage Test Manual  |
| SMACNA                 | HVAC Systems - Testing, Adjusting and Balancing  |
| ASHRAE                 | Duct design method   |
| ASHRAE 70              | Method of Testing for Rating the Performance of Air Outlets and Inlets                             |
| IS2062 Ed 2011         | Structural steel   |
| ASTM A 240             | SS304L plates & sheets   |
| ASTM A 312             | SS304L Welded Pipes  |
| ASME Section IX        | Welding Qualifications   |
| ASME Section II Part A | Ferrous Material Specification   |
| ASME Section II Part C | Specifications for Welding Rods, Electrodes, and Filler Metals                                     |
| ASME Section V         | Non-destructive Examination  |

### 2.3 MATERIALS:

- 2.3.1 All materials and components, like SS sheet, SS strips, pipes, flanges, gaskets, valves, structural materials, insulation materials etc are under the scope of supply of the fabricator and these shall be of genuine quality and relevant standards. The fabrication work shall commence only after obtaining due approval from BARC on the raw material/components procured by the fabricator.
- 2.3.2 Ducting shall be fabricated from Stainless Steel Sheets.
- 2.3.3 Insulation material for duct shall be closed cell elastometric nitrile rubber or cross linked polyethylene (XLPE) CFC free foam. Minimum thickness of the insulation shall be **19 mm for supply air ducts.**

### 2.4 FABRICATION:

- 2.4.1 Fabricator shall prepare fabrication drawings, bill of materials, manufacture, inspect, test, pack and deliver the AHU at site as per details given in this specification. The Air handling unit along with accessories should be guaranteed for 12 months from the commissioning date.
- 2.4.2 Detailed QA plan shall be submitted for approval of the Purchaser prior to start of fabrication.
- 2.4.3 All supports for duct shall be provided with carbon steel (angle/ channel/ plate/ pipe/ rod/fasteners), machine bolts, nuts in accordance with applicable codes.

## **2.5 PAINTING OF STRUCTURAL SUPPORTS:**

All MS supports shall be given two coats epoxy paint after applying primer of suitable grade.

## **3. AIR CONDITIONING PACKAGE UNITS SPECIFICATION**

### **3.1 AIR HANDLING UNIT (AHU) SECTION:**

#### **3.1.1 CONSTRUCTION FEATURES**

The AHUs shall be once through type as specified in **Annexure-I** of this technical specification. The unit shall comprise of various sections such as cooling coil, filter, fan, etc.

#### **3.1.2 CASING**

Casing shall be of double skin construction as specified in Annexure-I.

##### **3.1.2.1 Double Skin Construction**

AHU shall be of sectionalised construction fabricated out of thickness not less than 1.6mm (16Gauge) Galvanised Steel Sheet (GSS) or Cold Rolled Cold Annealed (CRCA) sheet. Double skin wall panels shall be min. 25 mm thick made of GSS, pressure injected with polyurethane foam insulation of density 48 Kg/M<sup>3</sup> and K factor not exceeding 0.02W/M<sup>2</sup>C. Double skin wall panels shall be fixed to 2.5 mm thick aluminium alloy twin box section structural framework with stainless steel screws. Outer sheet of the panels shall be made of 0.8 mm thick GSS pre-plasticised or powder coated. Inner sheet shall be 0.8 mm thick plain GSS.

The entire frame work shall be mounted on a 100 mm (minimum) aluminium alloy channel base. The panels shall be sealed to the frame work by heavy duty "O" ring/flat neoprene gasket held in the frame. All panels shall be detachable or hinged. Hinges shall be made of die cast aluminium with stainless steel pivots. Handles shall be made of hard nylon and be operational from both inside and outside of the unit. Units supplied with various sections shall be suitable for on-site assembly match drilled, with bolts, nuts and continuous neoprene rubber gaskets. All fixing and gaskets shall be concealed.

Floor and roof panels shall be double skin type and shall be of same construction as the wall panels.

AHUs shall have hinged quick-opening insulated access door on fan and filter sections. Access doors shall be double skin type and shall be of same construction as the wall panels.

Four (4) lifting lugs shall be bolted to each base section for lifting or placing the AHU in place.

All connecting fasteners and related hardware and its accessories shall be in stainless steel.

**3.1.2.2** Sloping condensate drain pan shall be fabricated from 18G GSS. It shall be isolated from bottom floor panel through 25 mm thick heavy duty Treated for Fire (TF) quality expanded polystyrene or polyurethane foam. Drain pan shall extend beyond the coil. A U loop should be provided at the condensate pipe with adequate liquid seal height.

**3.1.2.3** Casing shall be of air-tight construction and sufficiently rigid to exclude vibrations, throughout the working capacity range of the AHU.

**3.1.2.4** Lugs should be provided for lifting/easy handling of machine.

#### **3.1.3 COOLING COILS:**

**3.1.3.1** Cooling coils shall have 12.5 to 15 mm diameter Copper tubes of minimum 24G thickness with sine wave aluminium fins firmly bonded to copper tubes assembled in zinc coated steel frame of 1.5 mm thickness. Face and surface areas shall be such as to ensure rated capacity from AHU. The coil face air velocity across the coil shall not exceed 2.54 metres per second. The coil shall be pitched in the AHU

casing to ensure proper drainage. Each coil shall be factory tested to 21 Kg/cm<sup>2</sup>(g) air pressure under water. Tube shall be mechanically expanded for minimum thermal contact resistance with fins. Fin spacing shall be 4 to 5 fins per cm. Coil piping shall be extended through the casing wall approximately 150 mm and provided with brazed joint. In case, multiple coil sections are provided, the coil inlet and outlet connections shall be headered inside or outside the AHU and only one (1) common inlet and outlet connections shall be provided for the coils outside the AHU. A packing gland is required at the casing wall to provide an air tight seal around the opening. Coil piping connection side shall be determined by final layout and design arrangement.

**3.1.3.2** Coils shall be sealed in polythene bags and packed in crates properly. Coils with damaged fins shall not be accepted.

### **3.1.4 AIR SUPPLY FAN**

**3.1.4.1** Fans shall be of Double Width Double Inlet (DWDI) centrifugal type with backward curved blades as specified in Annexure-I. The fan with lower speed shall be preferred and fan outlet air velocity shall not be more than 11 metres per second. Fan casing and impeller shall be made of galvanised steel or epoxy painted carbon steel. Fan shaft shall be made from EN- 8 steel and supported in self aligning Plummer block, operating at less than 75% of first critical speed with grease lubricated bearings. Impellers and pulleys shall be individually tested and precision balanced statically and dynamically. Fans shall be tested for performance at manufacturer's works as per AMCA 210 and at site.

### **3.1.5 SUPPLY FAN MOTOR**

**3.1.5.1** Motors shall drive heavy duty V-belt, constant speed, fixed pitch drive sheaves, selected at 1.5 service factor with a minimum of two (2) grooves to prevent start-up slippage and pre-mature belt failure. Motors shall be specially designed for quiet operation and motor speed shall not exceed 1440 rpm. Belts shall be of oil resistant type. Belt guard shall be provided with enough space on motor side to fit in the largest pulley for maximum speed. Also provision shall be made for adjusting the motor side of the belt guard in relation with the motor adjustment. Isolation shall be provided from the AHU casing by combination spring and rubber anti-vibration mounts having a 70 to 80% vibration dampening efficiency and flame retardant, water proof neoprene impregnated flexible connection on fan discharge.

**3.1.5.2** The AHU motor shall be three phase induction motors and shall comply with the following requirements. The motor shall be of reputed make like siemens/Bharat Bijlee or equivalent. The make of motor shall be approved by the purchaser.

Technical Specification for motors: The squirrel cage, induction motors shall comply with the latest addition of IS-325 & the following specifications.

(I) Motors shall be designed to deliver rated output at rated power factor, continuously with:

- (a) Terminal voltage variations from 415 V by +/- 10 %
- (b) Frequency differing from 50 Hz by +/- 5%

(II) The class of insulation provided shall be class F with the enclosure type TEFC IP55. The temperature rise determined by resistance measuring method shall not be more than 75<sup>0</sup>C over an ambient of 45<sup>0</sup>C

(III) The motor shall be capable of withstanding for 15 seconds without stalling or Abrupt changes in speed (under gradual increase of torque), an excess torque of 60% of the rated torque, with the voltage and frequency being maintained at their rated values. Further, the motor shall be designed for full voltage direct on-line starting.

(IV) Motor vibration shall be within limit as per IS 4729 and normal class of IS 12075. The permissible noise level should not exceed 75 dB.

(V) Motor efficiency and power factor shall be as per Class IE2 of 12615.

(VI) Routine and type test certificates as per IS-325, IS 4029 and IEC 60034-1 shall be submitted. Motor shall be provide with cooling fan, preferably made of Cast Aluminium. Provision for handling of motors shall also be provided.

(VII) Datasheet for motor shall be submitted for approval.

(VIII) Quotation must be complete with full technical particulars viz. Rated voltage, kW rating , F.L. speed, rated and starting current, F.L. losses, efficiency, power factor, F.L. torque, pull up, pull out and starting torque, noise, starting time etc. Also complete details of motor such as make, model, design code/standards followed, frame size, mounting and coupling details etc. shall be furnished.

### 3.1.6 AIR FILTER

- A. Two levels of filtration using pre filter and HEPA filter is required. HEPA filter combination with Pre-filter shall be provided before cooling coil in AHU.
- B. One (1) set of filters of air handling unit shall be provided along with the supply of AHU.
- C. Filter frame shall be such that filters shall be easily accessible for removal/installation through access panels or doors.
- D. HEPA Filters shall be MERV 17 efficiency (99.97 % efficient on 0.3 micron particle size) and pre-filter shall be MERV 8 in accordance with ASHRAE Standard 52.2.

### 3.1.7 Mist eliminator

Manufacturer shall provide three bend four pass PVC or better configuration mist eliminator after the cooling coil in AHU to remove the excess water contents from the supply air.

## 3.2 OUTDOOR UNIT SPECIFICATION

### 3.2.1 COMPRESSOR SECTION

1. Compressor should be two in numbers having independent refrigerant circuit each rated for 50% capacity i.e. 6 TR.
2. The compressor should be REPUTED make hermetic/semi-hermetic sealed type.
3. Compressor should be suitable for operation on R-410A or R-407C (Ecofriendly) refrigerant.
4. Compressor Motor should be suitable for operation on 415V + 10% variations, 50Hz. 3 phase AC supply.
5. The compressors should be located in such a way that removal of one compressor should not affect the operation of the other circuit.
6. Compressors should be installed on spring mounted floating platform/rubber pads or manufacturer's recommended approved mounting.
7. Overload protection should be provided in compressor.
8. Gauge Ports should be provided in each compressor.
9. Compressor should be fitted with electrically operated oil heaters. Heaters should be automatically actuated when the compressor is stopped.
10. Accumulator of appropriate capacity is to be provided along with each compressor.

### 3.2.2 AIR COOLED CONDENSER

For packaged air conditioner unit there should be two air cooled condenser unit each having a matching heat rejection duty for one refrigerant circuit. These two condensers shall be preferably housed in a single unit.

Each Condenser unit should incorporate the following:-



- a) A heat rejecting coil block constructed from copper tubes of not less than 0.355mm (29 gauge) thick expanded on to straight aluminium fins. Approximately 12 number of fins/inch should be provided. Fin thickness should not be less than 0.16 mm.
- b) The fan should be 2 or 4 in numbers and should be selected for low speed quiet operation. The fan should be directly driven by a motor and constructed from sheet or cast aluminium.

The condenser should be vertical mounting type with horizontal throw of air forced draft type ensuring even air flow over the coil block.

All the foregoing items should be factory assembled with body made out of 1.6mm (16 SWG) M.S. Sheet (Powder Coated) and should be provided with an isolator.

The entire assembly should be supported by a corrosion treated frame having legs for installation.

The condenser motor should be of variable/two speed. The speed should vary through a controller depending upon refrigerant discharge pressure. As a third alternative, arrangements with fans having single speed motors with following provisions shall also be accepted.

1. Each fan should be able to suck air from both the coils provided independently for each refrigerant circuit.
2. Operation of the fans should be controlled by the discharge pressure to ensure working of the compressor against optimum discharge pressure.

Separate MCB of suitable rating and having a Rupturing capacity of 9 KA for each motor near its vicinity in suitable weatherproof enclosure should be provided.

### **3.3 DEHUMIDIFICATION FEATURE**

It should be possible to achieve Dehumidification by reducing effective coil area by solenoid valve arrangement. Whenever dehumidification is required, the control system enables a solenoid valve to limit the exchange surface of the evaporating coil, thus providing a lower evaporating temperature. Constant airflow rate is to be maintained even during dehumidification.

### **3.4 REFRIGERANT PIPING**

There should be two self-contained independent refrigerant circuits in package air conditioner. A totally independent piping hook up for each combination of compressor evaporator and air cooled condenser constituting one refrigerant circuit.

Each refrigerant circuit should be suitable for operation on R-410A or R-407C (Ecofriendly) and should include the following items:

- a) Thermostatic Expansion Valve with external Pressure equalization.
- b) Removable liquid line drier/filter.
- c) Liquid Line Sight Glass with Moisture indicator.
- d) Hand shut off valves.
- e) Liquid Receiver with safety valve-purge valve, manufacturer calibrated & sealed with test certificate. The capacity of receiver should be suitable for each circuit. Liquid receiver shall be suitably treated for weather protection, corrosion and shall be powder coated.
- f) Suction and discharge valves for isolation of each Compressor.

The serviceable/removable components should have union connections for easily removable/assembly.

All pipe works should be carried out with refrigerant quality copper tubes and where bends are required these should be completed using either a proprietary bending tool or radius fittings. The minimum thickness of pipe should be 1.6mm (16 SWG).

### 3.5 ELECTRICAL SYSTEM

- 3.5.1. The Electrical power system should conform to relevant IS standard.
- 3.5.2. Within the panel individual power loads should be distributed equally across the three phases.
- 3.5.3. All individual wires should be of copper and colour coded or should be numbered at their point of termination to facilitate servicing.
- 3.5.4. Low voltage control wiring and power wiring should be segregated from each other.
- 3.5.5. The following should be incorporated:
  - 1) MCB of suitable rating and having a rupturing capacity of 9 KA should be provided for each sub-circuit.
  - 2) Contactors for motors of suitable rating.
  - 3) Single phase preventor (operating on negative current sensing principle) in main incoming supply.
  - 4) Separate S.P.P combined with over load protection for all 3-Ø motors.

#### 3.5.6. Indicating Panel

- 1) The followings should be incorporated in the indicating panel:
- 2) The following indications should be provided in the indicating panel.
  - (a) Each compressor ON and OFF.
  - (b) Evaporator fan ON and OFF.
  - (c) Each condenser ON and OFF.
  - (d) HP cut out for each compressor.
  - (e) LP cut out for each compressor.
  - (f) Reset push button in case of alarm.
- 3) For 'ON' indications green LEDs should be provided.
- 4) For 'OFF' indications red LEDs should be provided.
- 5) The position of indicating lamp should be at the eye level and also just above their respective start/stop push buttons.

3.5.7 Protective fuses of suitable ratings should be provided in the circuits.

### 3.6 CONTROLS:

Following controls should be provided:

- 1. High pressure trip - Manual reset (for each compressor)
- 2. Low pressure trip - Manual reset (for each compressor)
- 3. The thermostat and humidistat to control the operation of the unit.

### 3.7 SAFETY INTERLOCKS:

- 3.7.1 Interlock between condenser fan motor and compressor motor to prevent starting of compressor without condenser fan in operation.
- 3.7.2 Condenser fan should stop along with compressor.
- 3.7.3 Provision should also be made to operate the evaporator fan without the operation of condenser and compressor.
- 3.7.4 TIME DELAY of minimum three minutes shall be there for restart of compressor.

### 3.8 DAMPERS

Dampers of AHU shall be of opposed blade type. Blades shall be made of double skin airfoil extruded aluminium sections with integral gasket and assembled within a rigid extruded aluminium alloy frame. All linkages and supporting spindles shall be made of aluminium or nylon, turning in teflon bushes. In case of automatic dampers, sealed ball bearings shall be provided, in place of teflon bushes. Manual dampers shall be provided with a bakelite knob for locking the damper blades in position. Damper frames shall be sectionalized to minimize blade warping. Air leakage through dampers when in the closed

position shall not exceed 1.5% of the maximum design air volume flow rate at the maximum design air total pressure.

### **3.9 QUALITY CONTROL AND INSPECTION**

(i) Material Inspection:

G.I. Sheets, CRCA sheet, shafting, insulating material bearings and hardware for various parts of AHU shall be inspected by the departmental representatives. Linkable test certificates shall be provided as per respective codes /standards to verify the conformity of materials used with the specification. In the absence of such documents the contractor shall arrange required test at his own cost. Copies of test certificates shall be furnished to the department.

(ii) Cooling Coil Capacity:

(a) The Supplier shall furnish design details for the approval prior to manufacture.

(b) The contractor at his works, at his cost, to demonstrate the capacity of the coil shall arrange full load test. In case full load is not available, the supplier shall give data/charts etc. to fully satisfy the purchaser for its full load performance on basis of part load.

(c) Hydrostatic pressure testing of coils shall be carried out at 21 Kg/cm<sup>2</sup> by the supplier.

(iii) AHU Fan Capacity:

(a) The supplier at site shall carry out vibration test after erection.

(b) The supplier shall carry out noise test during commissioning.

(iii) Motor Testing: Review of test certificates.

(iv) Fabrication & dynamic balancing:

The unit shall be visually inspected during fabrication. The certificates of static & dynamic balancing of rotating assembly including shaft, impeller and pulley shall be reviewed. Copy of Test certificates shall be furnished to the Department.

### **3.10 INSTRUMENTATION:**

All instruments and quantity required has been indicated and described below:

All instruments described herein shall be of approved reputable make. Gauges shall be calibrated. The assembly shall be complete with

(a) Pressure gauges:

2 Nos. Pressure gauges shall be provided at the inlet and outlet refrigerant pipelines of air-handling unit. Dial diameter shall be at least 100 mm. All required valves/cocks to isolate the gauge and facilitate its removal without disturbing main lines flow. Pressure gauges shall be isolated during pressure testing. Suitable manometers shall be provided to read pressure drop across filters and coils.

(b) Thermometers:

2 Nos. Thermometers shall be direct reading industrial type having 0 to 50 °C range with 0.5 °C graduations. Thermometers shall be installed in suitable thermo-wells provided in respective lines. Thermo-wells shall either be bronze or S.S. One thermometer shall be provided on inlet and one on outlet of refrigerant line of each AHU.

### **3.11 INSTALLATION, TESTING & COMMISSIONING:**

The supplier will carry out the installation of AHU and outdoor condensing unit as indicated in the drawing along with insulated refrigerant piping and complete instruments and control system. The AHU

and condensing unit shall be tested for their design performance and the test results shall be furnished as per proforma mentioned in Annexure-II. The AHU shall be tested for performance and endurance test for 72 hours round the clock.

Sound level shall be 55 decibels max. 1.5 meter from AHU and outdoor condensing unit. The AHU will also be tested for vibration free operation and noise level and is to be installed at the place as indicated in the drawing.

#### 4. TECHNICAL SPECIFICATIONS FOR VENTILATION EXHAUST BLOWER

This specification establishes the technical requirements for 'Fabrication and Supply of Ventilation blowers for the RSWRF facility, Trombay, Mumbai'.

##### 4.1 Applicable Standards/Codes

|  |   |
|--|---|
| AMCA standard 210  | Test code for air moving devices                |
| AMCA standard 211A   | Certified rating program air performance        |
| AMCA standard 300  | Test code for sound rating                      |
| IS 4894: 1968  | Specifications for centrifugal fan testing      |
| ASME code sec. VIII DIV I and Sec IX   | Procedure for welding & welder's qualifications |
| ASME sec. V  | NDT requirement                                 |
| BIS 210  | Specification for C.I. castings                 |
| VDI 2060   | Balancing of rotors                             |
| VDI 2056   | Vibration criteria chart                        |
| ISO 1940   | Balancing quality requirement                   |
| IS 1363 & IS 1367  | For all threaded fasteners                      |
| <b>Material specification-</b><br>MS Sheets<br>MS Structural members<br>MS hollow square section<br>Structural steel (carbon Steel/MS) | IS 1079<br>IS 808<br>IS 4923<br>IS 2062         |

##### 4.2 Site Operating Condition

###### Site Conditions

- (i) Dry bulb temperature : 38 degree C  
(ii) Wet bulb temperature : 30.9 degree C

###### Services Available at Site

- (i) 415 V +/- 6% 50 C/S +/- 3%, 3 phase, 3 wired, grounded A.C.  
(ii) 240 V +/- 6% 50 C/S +/- 3%, single phase A.C.

### 4.3 MATERIALS & WORKMANSHIP

4.3.1 Material of construction shall be as per the following table.

| Sr. No. | Item           | Material of construction |
|---------|----------------|--------------------------|
| 1       | Casing/Housing | CS                       |
| 2       | Back plate     | CS                       |
| 3       | Shroud         | CS                       |
| 4       | Impeller       | CS                       |
| 5       | Shaft          | EN 8                     |
| 6       | Base frame     | MS                       |

4.3.2 All materials used must confirm with the applicable standards & codes listed in these specifications must be new in all respects. All parts shall be free from flaws & objectionable imperfections and shall be machined true in workmanship like manner. Wherever materials are not specified, they shall be properly selected by the contractor to the best standards followed in the industry for the particular applications subject to the approval of the purchaser.

4.3.3 The blowers shall be built to the industry's highest standards of quality to ensure maximum mechanical & electrical reliability. All nuts & bolts shall conform to IS-1367; self-tapping screws shall not be used. All welding shall conform to the requirements of ASME SEC. IX. All Welding procedure & details shall be subject to the approval of the purchaser & adhering to ASME code, Section-IX.

4.3.4 All the inside and external metal surface of housing, impeller etc. shall be given two coats of epoxy primer and 3 coats of epoxy painting of approved colour. Before painting, surface shall be thoroughly cleaned & checked, rough edges or weld spatter removed and then cleaned with non-chlorinated solvent and dried. The VIV blades and inlet cone surfaces of the blowers which contacts incoming air shall be powder coated.

### 4.4 DESCRIPTIONS OF BLOWERS

#### 4.4.1 Specific requirements of blowers

The specific requirements of ventilation blowers are summarized in following table:

| Sr.no. | Parameter   | Description  |
|--------|---|--|
| 1      | Quantity of blowers   | 01 (One)   |
| 2      | Type &characteristic  | SISW, backward inclined, high efficiency limit load design |
| 3      | <b>Capacity at std. air density and at 760 mm Hg. Barometric press. and 20°C dry bulb temp.</b> | <b>3,000 CMH</b>   |
| 4      | <b>Static pressure</b>  | <b>150 mm of WC(g)</b>                                     |
| 5      | Preferred operating speed   | Less than 2000 RPM   |
| 6      | VIV with manual control   | yes  |
| 7      | Inlet condition   | SISW as per Arrangement-1A (Upward                         |

| Sr.no. | Parameter                                | Description                                    |
|--------|--|--|
|        |  | discharge)                                     |
| 8      | Min construction class                   | Class-IV                                       |
| 9      | Outlet velocity (m /sec.)                | Not to exceed 15 m/sec                         |
| 10     | Flexible connection with counter flanges | yes  |
| 11     | Discharge type / direction of rotation   | Side blast/ Anticlockwise.                     |
| 12     | Fan-motor connection                     | Through V belt                                 |
| 13     | Service                                  | Continuous                                     |
| 14     | Air temp. & condition                    | 40 <sup>0</sup> C D.B. & humid                 |
| 15     | Vibration isolators                      | Isolators of Dunlop type or equivalent         |
| 16     | Noise level                              | Not to exceed 80 dB, at 1 m. from the fan body |
| 17     | Balancing Grade                          | Grade 6.3 after installation at site.          |
| 18     | Vibration level                          | As per VDI 2056                                |

#### 4.4.2 General Design Features

At no level the operation of blowers should become unstable in the operating range specified i.e. good pressure/ volume characteristics. The blower shall be suitable for handling air at 60 °C (Max.). The general selection of class of construction shall be of one class higher than class for static pressure as selected.

#### 4.4.3 Housing

The housing shall be fabricated of Mild Steel heavy gauge steel plates, accurately cut & formed and continuously welded throughout for added strength & total air tight construction. No lock seam joints shall be allowed.

Access doors bolted type shall be provided with due gaskets. The blower housing shall be of split construction and shall be with flanges and gaskets provided for leak tight bolting .The cut off shall be so designed to give smooth quite and efficient performance of air from blower outlet.

The supporting structure of blower and bearing blocks shall be designed for sturdy and vibration free operation. Proper bracing and stiffening shall be done inside and outside and shall be clearly shown in the drawing submitted for approval.

The housing shall be painted as mentioned in this specification.

#### 4.4.4 Impeller

Full rotating assembly including shaft, impeller and pulley shall be both statically and dynamically balanced for the close level of vibration & noise free operation at specified speed nearest to the fair limit but not exceeding fair limit. The **balancing Grade shall be 6.3 as per VDI 2060**. In no case vibration shall exceed fair limit, it shall be nearest to good limit as defined in vibration chart against the speed.

As stated, the impeller blades shall be of **backward inclined design**. The section of blades shall be accurately formed from single sheet of steel and welded at the trailing edge. The impeller blades shall be mild steel and securely welded to both the back plate and shroud. The critical speed of the fans shall be at least 1.30 times the operating speed. For class-III and heavier blades there shall be internal blades reinforcing. The shroud shall be spun and of radial design. The hub shall be liberally designed with over size flanges and heavy cross section for keeping the wheel rigid to run straight & true.

#### 4.4.5 Shaft

Shaft of the fan shall be of material EN-8 or IS equivalent or better and suitably designed to take up the various torque & bending moments of the total systems. Raw material test for checking chemical properties for shaft material shall be carried out. It should be well designed with fillets & radii to take discontinuous stress at various section changes. The shaft shall be UT tested as per ASTM A-388. Shaft shall be D.P. tested after machining. Acceptance of UT will be as per below:

- a) Any **indication** larger than 20% of reference back reflection is not acceptable.
- b) Any **area** showing loss of back reflection larger than 20% of reference back reflection is not acceptable.

#### 4.4.6 Bearings

The bearing of the shafting shall be of spherically seated, roller, anti friction self-aligning, grease packed, pillow type of SKF / FAG or reputable make. They shall be designed to run continuously for a year between greasing. The life of the bearings shall be at least 50,000 hours. The grease capacity shall be such that fans are suitable for continuous operation of at least 12 months before re-greasing and required minimum maintenance. An integral housing for housing two bearings will be preferred and if offered the bores for both the bearings shall be true and shall be bored in one single setting.

#### 4.4.7 Variable Inlet Guide Vane

The variable inlet guide vans shall be designed of heavy gauge sheet. The VIV shall be so placed in the fan inlet that it does not hamper removal of the bearings etc. It will be as a complete assembly like unit with flanged connection so that it can be fixed to fan inlet having the flange. The operation of the VIV shall be manual.

All the linkage employed shall be of heavy duty machined and provided with ball and socket joints wherever necessary thrust bearings shall be provided. Entire assembly shall ensure minimum friction. It should be suitable for both manual and automatic operation. No leakage should be in path of the air. The inlet vanes shall be formed such that with minimum turbulence, it will impart initial spin to the inlet air to save power. Supplier shall clearly specify the VIV's characteristics relating to flow and pressure drop at the inlet. It should be substantiated by enough data of curves and technical details. VIV blades & liners should be powder coated. The bearings of individual louvers at both the ends shall be of sealed stainless steel / permanently lubricated sintered graphite type.

#### 4.4.8 Shaft Seals

Shaft seals shall be provided and shall be of labyrinth type and filled with pure Teflon braided. It shall ensure minimum leakage along the shaft and easy replacibility of packing. The purchaser shall approve the design of seals.

#### 4.4.9 Flexible Connectors

At inlet and outlet of the blowers flexible connectors shall be provided with acid and pressure resistant flexible connections of approved design. The connection shall be preferably of the two layers of synthetic cloth sandwiched with fiberglass thin filter padding. The design of connection shall be such that replacement is easier.

#### 4.4.10 V-Belt Drive

The blowers shall be of V-belt type drive. All the belts shall be selected to transmit the full horsepower using service factor of not less than 2.5. V-belt drive shall be equipped with removable screen cover of heavy-duty wire mesh. At least one belt shall be spare belt in the belt drive. The belt shall be of Fenner or equivalent in matched sets. All the blower pulleys shall be statically & dynamically balanced. Pulleys shall be of approved brand of standard size as per the I.S. Fan & motor pulleys shall be mounted on shaft via Taper Lock Bushes.

#### 4.4.11 Foundation

Blowers will be mounted on M.S structural platform. Vibration isolators, foundation bolts, padding & all necessary hardware will be in the scope of the supplier. The hardware shall be such that it ensures minimum vibration at the site and easy for installation. Vibration isolators shall be of Dunlop make of adequate damping capacity.

#### 4.4.12 Welding

Welding of parts shall meet the high standard and all M.S. welding should be done by manual metallic arc process with coated electrodes. The welding equipment shall be standard and welders shall be qualified as per ASME sec. IX for the required work. Test specimen of welding shall be furnished for purchaser's approval. Welding procedures for square butt, V butt and fillet joints shall be qualified before start of manufacture. The supplier shall specify all necessary stage inspections and purchaser will at his option approve the different stage. The weldments on impeller and casing shall be subjected to D.P. test.

#### 4.4.13 Balancing

All rotating parts shall be statically & dynamically balanced individually and as an assembly itself shall be put to balancing by appropriate method to ensure and guarantee vibration level of agreement. **The critical speed shall be at least 50 % more than the speed selected.** The balancing level shall be as per **VDI 2060 Grade 6.3.**

### 4.5 ELECTRIC MOTOR

Electric motor requirement for the centrifugal fans shall meet the following requirements.

- a) Acceptable make: M/s Crompton, M/s Bharat Bijlee, M/s ABB, M/s Siemens.
- b) Type of enclosure & degree of protection: T.E.F.C., IP 55 as per IS – 4691.
- c) Type of Duty: Continuous.
- d) No. of phases: 3 phase
- e) Rated Voltage : 415 V +/- 10%
- f) Frequency: 50 Hz. +/- 5%
- g) Class of Insulation : F, Temperature rise limited to class B
- h) Speed of Revolution: Shall be compatible with Blower.
- i) Direction of Rotation: The Motor shall be suitable for bi-directional rotation.
- j) Earthing: Two nos. of earthing terminals of proper size shall be provided.
- k) Rotor: Squirrel Cage
- l) F.L. Starting current : Not exceeding 600 % of FL current ( DOL Starter )
- m) Winding : Copper wound.



- n) Fault Capacity of System to which motor is to be connected : 35 MVA
- o) Rating of motors shall be suitable to the Blower.
- p) Terminal Box shall be of adequate size to accommodate cable one size higher than the minimum recommended. Shall be possible to change orientation of cable box to suite condition for entry of cable.

#### **4.6 CLEANING, PROTECTION AND PAINTING**

All equipment shall be neatly finished in workman like manner. All exposed metal surfaces shall be smooth and free from burrs. Finished surfaces shall be protected against corrosion and mechanical damage. All steel and cast iron surfaces shall be thoroughly cleaned to remove mill scales rust etc. The colour of which shall be approved before hand to purchaser. After cleaning all interiors all openings shall be properly closed with blank flanges caps etc. to prevent entry of water dirt etc. All parts shall be properly boxed and protected to prevent all possible damage during transportation. Painting shall be tested by a standard pill off test and procedure shall be got approved.

#### **4.7 INSPECTION AND TESTING**

Quality Assurance Plan, manufacturing drawings, inspection & testing procedures, testing setup drawing etc. shall be got approved from the purchaser before start of manufacturing .

##### **4.7.1 Stage Inspection**

The following stage inspections shall be carried out at suppliers shop.

Welders shall be qualified as per ASME Sec. IX before start of manufacturing.

1. D.P. testing of all weldments of casing and impellers.
2. Visual testing and D.P. testing of all machined surfaces
3. Dynamic balancing of the impellers with the fan shaft and pulley
4. Surface finish, painting and powder coatings of the surfaces
5. Dynamic balancing of motor pulley.

Supplier shall submit Inspection/Test reports for approval to BARC.

##### **4.7.2 Inspection of Bought Out Items**

All brought items shall be inspected and test certificates shall be produced for verification to the purchaser. Items may be included are Pulley, V belt, vibration isolators, bushes & bearings, bearing blocks, flexible connections. The electric motor shall be tested at the supplier shop in presence of purchaser.

##### **4.7.3 Mechanical Run Testing**

This test shall be carried out on each unit at manufacturer's work to examine vibration & noise after assembly. Each blower unit shall be run at various (around operating) VIV positions. The amplitude & frequency of vibration shall be measured with strobos at various locations on the fans. The maximum severity of vibrations should not exceed fairness limit and shall lie close to good limit as per the chart. The vibration level shall be as per VDI 2056. Background level of noise (In dB) & noise level with blower in operation shall be recorded to determine the noise level of the blower and it should not exceed 80 DB. Sound ratings for the blower, based on the data obtained in accordance with AMCA 300 and reported in accordance with AMCA 301 shall be furnished.

Each blower unit shall be run for an hour to check whether any rotating parts foul with the stationary parts. The blower shall then be stopped and all fasteners shall be checked. The blower shall then be run for Six hours during which the bearing temperature, motor current, supply voltage frequency shall be monitored. At the end of this the various alignments shall be checked.

#### **4.7.4 Performance Type Testing**

The performance test shall be carried out on each blower conforming to AMCA-210 codes. This test shall be essentially to draw up the blower characteristics, which will then be compared with those specified. The duration of test shall be sufficient to demonstrate that the blowers are in first class operating condition. The test results shall be submitted to purchaser for his verification and comments. Test setup drawing along with procedures shall be got approved from purchaser.

#### **4.7.5 Leak Testing (Air Bubble test)**

The blowers shall be tested for leakage after complete assembly of units. This test shall consist of blanking the ends of the blower casing, pressurizing the interior to 1.5 times the static pressure and soap bubble testing of all joints using soap solution.

#### **4.7.6 General Inspection**

The blowers shall be subjected to inspection to cover dimensional accuracy, material used, workmanship, make and quality of bought out items. The supplier shall furnish the relevant test certificates on bought out items.

#### **4.7.7 Documents of Testing**

A report giving a description and results of qualification tests shall be furnished to the purchaser. The report shall include all calculations, a description of any analytical or mathematical modeling techniques, a description of any computer code used, or other tests made in conjunction with the certification or qualification of the blower or blower assembly.

### **4.8 DOCUMENTS TO BE SUBMITTED BEFORE FABRICATION**

After receipt of work order, the supplier shall submit to the purchaser for his approval 4 copies of the followings:

- Certified dimensional drawings of the blower motor assembly
- Characteristics curves for blowers along with and VIV
- Materials of construction, make, type specification of bearings, V- belt, pulleys, shaft seal.
- Design information to support the correctness of selection of shaft critical speed.
- Quality Assurance Plan
- All inspection and testing procedures.
- The supplier shall furnish a detailed schedule of manufacture & delivery.
- Cleaning, painting and paint testing procedures.

The fabrication and use of the parts shall start only on receipt of purchaser's approval on these.

### **4.9 DOCUMENTS TO BE SUBMITTED AFTER COMPLETION OF THE FABRICATION**

- A report giving a description and results of qualification tests shall be furnished to the purchaser.

- The report shall include all calculations, a description of any analytical or mathematical modeling techniques, a description of any computer code used, or other tests made in conjunction with the certification or qualification of the blower or blower assembly.
- The supplier shall furnish 4 copies of instruction manuals to cover installation, operation, and maintenance, drawings for blower. The Manual shall include instructions on alignment, lubrication details, specifications of parts etc. The purchaser shall approve the manual before fully supply is made.

#### 4.10 Packing and Shipment

The blowers shall be shipped to BARC Trombay, Mumbai only after obtaining a shipping release from the purchaser or his authorized representative. The supplier shall be fully responsible for protective measures to ensure the safe delivery of blowers by this specification to WIP Stores, BARC Trombay. All exposed metal surfaces shall be smooth and free from burrs etc. All the parts shall be packed properly boxed and protected to prevent all possible damage during transportation. The supplier shall consult the representative of the purchaser to satisfy himself that adequate measures have taken.

### 5. SPECIFICATION FOR FABRICATION OF STAINLESS STEEL DUCT

#### 5.1 GENERAL:

- a. The area in which SS fabrication is being carried out shall be maintained clean for the entire period of fabrication activities.
- b. All staff, technicians, supervisors, engineers, etc., deployed for the above work shall be familiar & experienced in handling and fabrication of stainless steel jobs.
- c. An exclusive and adequate stock of tools, tackles, consumables, grinding wheels, sanding discs, etc., shall be deployed for the SS job.
- d. Stainless steel wire brushes, wire brush wheels, acetone, etc., shall be provided to the welders for proper pass-by-pass cleaning of weld beads.
- e. Filler wires shall be kept in clean dispensers and should be stored at dry enclosed area. **All the filler wires shall be cleaned by acetone prior to use.**
- f. The stainless steel raw material procured shall be stored under covered, dry and separate area. Suitable measures shall be taken to avoid cross contamination by Carbon Steel and physical damage to SS material.
- g. All stainless steel raw materials shall be in clean condition prior to any fabrication (viz., bending, forming, cutting, welding, etc.) activity. Further, all stainless steel material shall be properly cleaned and passivated after any forming process. The cleaning shall comply with approved procedure.
- h. All welds on SS duct shall be carried out by providing suitable Argon gas back purging arrangement.
- i. All welds on SS ducts shall be carried out by using 3 mm thk. backing strips.
- j. No grinding is permitted adjacent to the weld seam or on the base metal unless found extremely necessary. Any such grinding shall be carried out with concurrence of the Purchaser.

#### 5.2 DEGREASING AND ACID CLEANING OF SS304L MATERIALS:

All the piping members and other structural members are required to be degreased and cleaned by the approved procedure before installation and erection. The step wise approach of the cleaning methodology is as given under:

- a. **Degreasing:** All Stainless Steel plates, pipes and duct materials shall be degreased prior to acid cleaning using approved detergent in clean water medium.
- b. **Cleaning:** All Stainless Steel plates, pipes and duct materials shall be thoroughly cleaned by immersing in Nitric Acid as per approved procedure. The material shall be rinsed and cleaned to ensure total removal of all foreign matter like scale, rust, paint, oil, weld spatter, etc. Stainless Steel wire brushes shall be employed for effective scrubbing of the surfaces if needed.
- c. **Passivation:** All Stainless Steel plates, pipes and duct materials shall be thoroughly passivated after the cleaning process as above using nitric acid as per approved procedure.
- d. **Rinsing:** All Stainless Steel plates, pipes and duct materials shall be thoroughly rinsed using clean water to rinse and remove traces of acids on the cleaned and passivated surfaces.
- e. **Local Passivation of welds:** Local passivation of welds on SS ducting and SS piping shall be carried out using nitric acid as per instructions of engineer-in-charge at site of work. Thorough rinsing using clean water shall be carried out to remove traces of acids on the locally passivated surfaces.

### 5.3 WELDING:

#### 5.3.1 Welding Procedures & Qualifications Tests

- a. Only qualified welders in GTAW welding shall be employed for all welding jobs.
- b. Welding procedures shall be qualified on the same grade of stainless steel to be used in actual production.
- c. No production welding shall commence until procedure qualification is completed and welders are approved by the QA, NRG, BARC. Fabricator shall submit to the Purchaser copies of the approved procedure and performance qualification reports. All test coupons/specimens shall be properly stamped and retained by the fabricator till completion of work.
- d. Cost of conducting all the tests required for qualification shall be borne by the fabricator. Purchaser shall have the right to call further qualification tests from time to time for any welder who is not producing welds of required quality or who has discontinued welding by the particular process for more than three months.
- e. Tests for welding procedure & performance qualification shall be carried out in conformity with requirements of ASME Sec IX together with additional requirements included in this specification.

#### 5.3.2 Welding Requirements:

- a. Welding fixtures, clamps or fixtures should not have any surfaces made from lead, zinc or copper/copper alloy that can cause contamination of the stainless steel work-piece. All fixtures shall be lined suitably to avoid any iron contamination of the material.
- b. Welding plant, equipment and machinery shall be of good quality and shall be maintained in efficient working condition. The fabricator shall be required to produce documents, if desired, by the Purchaser's Quality Surveyor, in support of proper calibration of the equipment.
- c. Fabricator shall ensure that there is a regular and systematic supervision of all welding work. The fabricator shall institute a system whereby all welds can be traced to the welder responsible for their production.
- d. Full penetration (FP) pipe welds shall be continuously back purged with High purity Argon gas throughout during welding. The Argon Gas back purging shall be maintained for all the weld passes of the joint. Purging method will be demonstrated by the contractor to QA, BARC.

- e. Haphazard striking of electrode/weld torch on base metal or weld material for establishment of arc shall not be permitted. High Frequency units shall be used for arc starting. In case inadvertent arc strikes occur, the affected area shall be ground flush and surface examined by dye penetrant test.
- f. Necessary precautions shall be taken to avoid distortion.
- g. Suitable welding fixtures shall be used in achieving the requisite fit-ups for welding.
- h. Due care shall be taken in weld edge preparation by grinding.

### **5.3.3Welding Documentation:**

Fabricator shall submit to the Purchaser for his perusal / approval and retention, a complete set of welding records whereby any weld can be traced to the welder responsible for its production, together with the heat/batch number(s) of the electrodes/filler wires used and the welding technique adopted.

### **5.4 INSPECTION AND TESTING OF WELDS:**

- a. The Contractor shall be responsible for and shall provide and perform all the inspection and testing required as per this specification. The contractor shall have a quality assurance set-up along with adequate testing equipment required for LPE and qualified staff to carry out the tests. If any part of the quality assurance work is to be sub-contracted to the outside agencies the same shall be clarified in the offer.
- b. The fabricator shall submit a detailed Quality Assurance Plan (QAP) covering all the items and stages of inspection for purchaser's approval. The QAP shall include all sequences and procedures to be followed for achieving the quality required to meet the stipulations of codes and specifications. Clearly identifying witness point, hold point, review point etc.
- c. BARC QA or his authorized representative shall have complete access to the work areas of the fabricator and shall have the right to intervene wherever incorrect practices are detected.
- d. Weld joints, not meeting the minimum requirements of the applicable specification or code, shall be repaired or replaced at fabricator's expense.

### **5.5 INSPECTION OF WELDS:**

- a. The Contractor shall provide all the testing & inspection services, facilities, manpower, except where otherwise specified, for the inspection and testing requirements covered under the scope of this specification.
- b. Contractor shall submit all the inspection & testing procedures, WIR, etc and get the same approved through Engineer-In-Charge.
- c. Inspection by the Engineer-In-Charge or his authorized representative shall not relieve the contractor of inspection and conformity to this specification.
- d. All the material procured by the contractor including welding consumables, liquid penetrant material, etc. shall be of required quality as designated by applicable standards and this specification.
- e. All welds shall be LP examined after root and final pass as per ASTM E 165. The LPE material shall be of quality suitable for stainless steel material.
- f. Prior to start of welding, inspection procedures shall be established in accordance with the applicable code and this technical specification. Written procedures for each inspection method and technique (including acceptance criteria) shall be submitted to BARC for approval.
- g. General requirements and extent of examination:

- i. 100% dye penetrant test on root and finished weld on SS welds.
- ii. Outer surface of the welds shall have smooth and uniform crown. Maximum permitted weld reinforcement on finished weld is +10% of pipe or plate thickness.
- iii. Inside surface of the welds shall be free from oxide formation by providing adequate Argon purging.

#### **5.6 VISUAL INSPECTION:**

Visual inspection shall be carried out for following:

- a. Materials and components to ensure that these are as per the specification and are free from defects.
- b. Joint preparation and cleanliness.
- c. Fit-up, joint clearance and internal alignment prior to joining.
- d. All welds shall be visually inspected by BARC QA after completion.

#### **5.7 DYE PENETRANT EXAMINATION:**

**(Also called Liquid Penetrant Examination or LPE)**

Dye penetrant examination method shall conform to ASME Sec. V and acceptance standards shall conform to ASME Sec. VIII together with requirements specified in succeeding paragraphs. Only visible dye-penetrant solvent (removable type) method shall be employed for all welds, and other metallic surfaces. When used on austenitic stainless steel surfaces, the penetrant materials (penetrant, developer and cleaner), sulphur and total Halogens content shall be less than 1% and 25 ppm respectively.

Following defects/discontinuities as revealed by DP are not acceptable:

- a. Lack of Fusion (LOF), lack of penetration, cracks etc.
- b. All linear indications.
- c. Single rounded indications more than 0.8 mm diameter on the outside surface or any cluster of indications.

#### **5.8 PRESSURE TESTING:**

- a. SS ducting system shall be leak tested as per procedure approved by BARC at 1.5 times the maximum static pressure of exhaust fan of the system.
- b. These installed ducting systems shall be subject to pneumatic tests to ensure integrity of the erected system.
- c. Pressure testing shall be carried out only after the completion of non-destructive testing of welds.
- d. Contractor shall provide all isolations, temporary blanking, additional supports testing equipment, calibrated pressure gauges as needed for the job.
- e. After satisfactory completion of the leak test, the system shall be gradually de-pressurized.

#### **5.9 CLEANING AND FLUSHING OF DUCTING:**

- a. During fabrication and installation, the Contractor shall prevent foreign materials such as oil, grease, sand, dirt, scale, loose particles from cutting, grinding, etc from entering the duct or duct component. If foreign materials have entered the duct or ducting component, they shall be removed immediately before the assembly of the parts by a suitable cleaning method such as wire-brushing, blowing through with air or degreasing using a suitable cleaning agent or

solvent. Before cleaning with a solvent, the Engineer-In-Charge shall be consulted regarding suitability of the agent especially when alloy or stainless steels are involved. Wire brushes used on stainless steel parts shall be of stainless steel.

- b. Cleaning of erected ducting shall be accomplished by clean dry air.
- c. Cleaning and flushing operations shall be done through open duct ends or branches and not through equipment. The cleaning and flushing operations shall be carried out until all trash and construction debris are removed from the ventilation systems.

## 6. SPECIFICATION FOR DAMPER FOR VENTILATION SYSTEM

|            |   |
|------------|---|
| <b>6.1</b> | <b>FLOW BALANCING DAMPERS FOR DUCT BRANCHES</b>   |
| 6.1.1      | Flow balancing dampers shall be of multi, opposed blade type, fabricated from minimum 3 mm thick extruded anodized aluminum and shall be of robust construction. The position of splitter damper shall be adjustable by use of the splitter rod. FBDs shall have a locking device mounted outside the duct to hold the FBDs in a fixed position without vibration. Fully open and fully closed position shall be marked for easier operation of FBDs. |
| 6.1.2      | FBDs shall be provided with Teflon or brass bushing for blade shaft.  |
| <b>6.2</b> | <b>DIFFUSERS/Air supply grills</b>  |
| 6.2.1      | The type and quantity of diffusers and grilles shall be provided as per the specifications. The CONTRACTOR shall ensure that the diffusers and grilles offered are of requisite capacity, throw and terminal velocity. Diffusers and grilles shall be fabricated from 18G extruded anodized aluminum section with powder coating  |
| 6.2.2      | Whenever VCD is provided with diffusers or grilles it shall be located within the duct collar. All the supply air grills/diffusers shall be of double deflection type for better air distribution. Diffusers and grilles shall be of flush or stepped pattern.  |
| 6.2.3      | Ceiling diffuser shall be equipped with fixed air distribution grids, removable key operated volume control dampers and anti-smudge rings. The extruded aluminum diffusers shall be provided with removable central core and concealed key operation for volume control damper.   |
| 6.2.4      | Linear diffusers/supply air grills shall be of 18G extruded aluminum section construction.  |

### 6.3 LEAK TIGHT ISOLATION DAMPERS

The scope of the specification cover, procurement of the raw material, manufacture, assembly, inspection, shop testing, packing and safe delivery of Leak tight Isolation dampers at RSMS, BARC, Trombay, Mumbai. These are required to be provided at discharge of the exhaust and supply fan.

#### 6.3.1 APPLICABLE CODES AND STANDARDS:

All the materials used specified & unspecified shall be new and follow relevant BIS or equivalent International codes & standards as indicated below. However, the purchaser's clarification in conflict shall be binding to the supplier.

|              |   |
|--------------|---|
| ANSI N509    | Leak Testing of dampers                   |
| ANSI N 510   | Testing of nuclear air cleaning system    |
| AMCA 500     | Testing of dampers                        |
| ASME AG1     | Nuclear air and gas cleaning system       |
| IS 2062      | M.S. Plate structural steel quality       |
| ASME SEC- IX | Welding Qualifications and procedures     |
| ASME SEC- V  | Non Destructive Testing                   |
| ASTM         | Standards for various tests and materials |

### 6.3.2 GENERAL REQUIREMENTS

- a. All materials used must confirm with the applicable standards & codes listed in these specifications must be new in all respects. All parts shall be free from flaws & objectionable imperfections and shall be machined true in workmanship like manner. Wherever materials are not specified, they shall be properly selected by the contractor to the best standards followed in the industry for the particular applications subject to the approval of the purchaser.
- b. The units shall be built to the industries highest standards of quality to ensure maximum mechanical reliability. All nuts & bolts shall conform to IS-1367, self-tapping screws shall not be used. All welding shall confirm to the requirements of ASME SEC. IX.
- c. All the inside and external metal surface of dampers shall be given two coats of epoxy primer and three coats of epoxy painting of approved colour. All the surface shall be thoroughly cleaned & checked, rough edges or weld spatter removed and then cleaned with non-chlorinated solvent and dried before painting.
- d. Pair of matching companion flanges with bolts, nuts, gaskets etc. shall be provided for each damper.

### 6.3.3 TECHNICAL REQUIREMENTS

- a. The construction of the damper shall be as per ANSI N 509–Class-B and leakage class I. The damper shall be flexible metallic S.S. seal type. The damper shall be provided with good quality SS spring steel sealing element to ensure good air leak-tightness in a moist air stream without replacing the sealing element for longer period of operation.
- b. The dampers shall be designed to withstand a minimum pressure differential of 200 mm WG for all types of dampers and other conditions as laid down in the schedule of requirement.
- c. The damper shall be engineered for ON and OFF operation with Gear operators with complete details of linkages, supports, extension of stem, etc.
- d. The damper shall have facility to lock them in fully closed or fully open position as well as at an angle from 0 to 90 degree in multiples of 10 degree.
- e. All the parts not in air stream such as linkages, brackets, linkage connecting rods, unless and otherwise mentioned shall be hot dip galvanized or with hard chrome plating. All fasteners on the damper shall be of stainless steel material.
- f. Rubber material used as gasket etc shall be of neoprene and a low shore hardness to give leak tight joint at low bolting down force.
- g. Tapings of 8mm with blind plug shall be provided before and after the louver for measuring the pressure drop across the damper.
- h. The supplier will give full design details for achieving leak tightness for the operating shaft which comes out of a damper and which operates the louver of the dampers.



**6.3.4 MATERIAL OF CONSTRUCTION**

|   |   |   |
|---|---|---|
| Body                                    | : | Structural steel sections IS-2062 minimum thickness 6 mm., epoxy painted                                    |
| Disc                                    | : | Structural steel sections IS-2062 minimum thickness 5 mm., epoxy painted                                    |
| Sealing element                         | : | 0.5 thick , SS 316 flexible metallic seal   |
| Seating surface / landing bar           | : | S.S. 304 L, minimum thickness 8 mm  |
| Shaft                                   | : | 20 mm. dia. EN-8  |
| Pressure tapping                        | : | 1/4 inch NPT (F)  |
| Nuts and bolts, screws, studs<br>Washer | : | SS 304  |
| Quadrant plate and<br>operating handle  | : | C. S. with hard chrome plating  |
| Stem seal bush, gland packing           | : | Teflon (PTFE) filled with suitable material for properties of wear and corrosion resistance and springiness |
| Shaft bearing                           | : | Anti friction ball bearing  |
| Companion flanges                       | : | IS 2062, thickness 8 mm   |

**6.3.5 FABRICATION:**

- a. Frames shall have all welded joints. SMAW welding shall be carried out with proper grade of electrodes. This is to ensure proper integrity, strength and leak tightness. All excess welding shall be evened, ground and finished. All the care should be taken while welding to avoid warping. M.S. to S.S. welding should be done by electrode E 309L.
- b. The tolerance for the overall size of the damper shall be +2 mm on outer dimensions and +2 mm for inside dimensions.
- c. No fabrication shall be carried out unless the purchaser approves detailed design drawings. All the minor modifications suggested to meet the specification requirements should be carried out with no extra cost.
- d. All M.S. surfaces to be painted with approved epoxy paints with 3 coats after 2 coats of enamel primer.

**6.3.6 GEAR ACTUATORS:**

Damper shall be provided with gear for manual operation with proper brackets and shall be of easy removable type. Operators composed of worm and worm wheel type gearing shall be totally enclosed in a gear case and shall have gears of bronze and worms of hardened steel that operate in a lubricant.

**6.3.7 TECHNICAL DATA SHEET:**

|                    |                                |
|--------------------|--------------------------------|
| Location           | Indoor                         |
| Fluid flow         | Air at max. 45 °C temperature. |
| Diff. Pressure     | 200 mm of W.G.                 |
| Air flow direction | Horizontal / vertical          |
| Type of operation  | ON / OFF                       |

|                      |                         |
|----------------------|-------------------------|
| Actuator type        | Electrical              |
| Louver               | Single / multi louvered |
| Leak tightness       | 99.8 %                  |
| Mounting             | Horizontal / vertical   |
| Shaft                | Horizontal              |
| Shaft bearing        | Anti friction bearing   |
| Leakage Class Rating | Class-I                 |
| Construction Class   | B                       |

### 6.3.8 INSPECTION AND TESTING:

#### 6.3.8.1 PERFORMANCE TESTING OF ISOLATION DAMPERS:

- (i) All the dampers shall be tested at manufactures work along with gear operators for dimensional check up, its operation, leak tightness and adherence to the requirements of the specifications. Dampers shall be tested for leak tightness and other function as per ANSI N 510 and AMCA 500. The supplier shall arrange all the facilities and instrument for the leak tightness testing of the dampers at his workshop.
- (ii) Supplier shall prepare QA and inspection and testing procedure for approval before start of manufacture.
- (iv) Test for leak tightness through the shaft seal and metallic gasket seat seals shall be done by pneumatic test. The allowable leakage rate shall be 99.8% on Cross sectional area (CSA). Testing shall be done at 200 mm WG pressure.
- (v) All facilities shall be provided by supplier and got approved by purchaser before testing.

#### 6.3.8.2 TYPE TEST:

Each and every damper shall be tested for 50 cycles ON /OFF operations to check integrity of sealing element, shaft seal and actuators. It should meet the specification of performance even after cycle test.

#### 6.3.8.2 FABRICATION DRAWINGS:

- i. All drawings submitted by the vendor shall be in sufficient detail to indicate the general arrangement with dimensions, bill of materials, components, weight of each unit, packing and shipment, installation plan and any other information specially requested.
- ii. After the award of the contract, the vendor shall submit copies material specifications and detailed drawings as called for in the equipment specification for the purchaser's review.
- iii. Drawings prepared by the vendor and approved by the purchaser shall be considered as a part of the specification. However examination and approval of the drawings by the purchaser shall not relieve the vendor of his responsibility for engineering, design, workmanship and material under the contract.

### 6.3.8.3 INSTRUCTION MANUALS :

The vendor shall submit to the purchaser preliminary instruction manuals for all types of dampers before the inspection of equipment. The final instruction manuals complete in all respect shall be submitted by the shipment of the equipment. The instruction manual shall contain detailed diagram, component rating, trouble shooting flow charts, erection procedure, testing procedure, O & M procedures of the equipment.

### 6.4 BALANCING

6.4.1 The air distribution system shall be tested and balanced so that the requisite temperature and air flow are maintained throughout the space to be air-conditioned or ventilated

## 7. DUCT INSULATION SPECIFICATIONS

Air-conditioned area supply ducts shall have thermal insulation as per specification given below. The thermal insulation shall be carried out only after successful erection and testing of the ducts and approval from the user. The scope of contractor includes procurement, supplies, application of nitrile rubber insulation on A/C ducts to avoid heat transfer. Details of insulation and general guidelines have been indicated below.

### 7.1 Ducting Insulation Make:

Nitrile rubber or cross linked, polyethylene (XLPE) CFC free foam: Superlone / Trocelline /or equivalent make approved by Client.

### 7.2. Thermal Insulation for Ducts:

#### 7.2.1. General

Insulation work shall be carried out for ducts as per latest BS/American equivalent IS standards for thermal insulation materials and finishing materials and also codes of practice for industrial applications.

#### 7.2.2. Material

Insulation material shall be closed cell elastometric nitrile rubber or cross linked, polyethylene (XLPE) CFC free foam backed by aluminum foil. Thickness of the insulation shall be **19 mm minimum thickness for supply air ducts.**

7.2.3 Adhesive used for setting the insulation shall be SR 505/SR 998 to give proper bonding between the insulation joints.

#### 7.2.4. Application

Thermal insulation on ducts shall be provided as follows:

Clean the surface with wire brush to remove dirt, rust etc. Apply 2 coats of adhesive. Fix insulation on the duct before adhesive dries out. All the longitudinal and transverse joints of insulation shall be covered by applying 50 mm wide self adhesive tapes. All duct flanges shall be covered by 100 mm wide strip of insulation of the same thickness as required for duct.

## 8. DATA TO BE FURNISHED BY THE CONTRACTOR AFTER THE AWARD OF CONTRACT

1. List of drawings and documents to be submitted for review, approval and information with scheduled submission dates.
2. Quality Assurance Plan (QAP)

3. Detailed P&I diagram showing clearly the scope of supply of equipment, ducting with material specifications, valves, dampers, specialities, instrumentation and control and all accessories. This drawing or documents mentioned under following clauses shall include design data and information furnished in **data sheets A**. The makes of all major components and controls shall be indicated.
4. Overall space and head room requirement with details of handling during erection, operation and maintenance.
5. Performance curves and selection charts for fans etc. and selection charts and calculation for cooling coil.
6. Operation and maintenance manual with lubrication schedule
7. Catalogues furnishing detailed technical data for fans and coils etc.

## **9. SUB-CONTRACTORS/SUB VENDORS:**

- 9.1 Sub-contracting of the entire work shall not be permitted. Bidder shall make clear in his offer the names and full details of the sub-vendors whom they propose to employ for part of the entire work and also specify those parts of the work which are proposed to be sub-contracted.
- 9.2 The facilities of the sub-vendor/sub-contractor including skilled manpower shall be subject to inspection and approval of the BARC before start of fabrication. Written procedures with regard to the work to be carried out by the sub-vendor/sub-contractor shall be submitted by the contractor to BARC for formal approval.
- 9.3 However the overall responsibility of completing the job as per this specification lies with the bidder on award of contract.

## **10. DOCUMENTATION:**

The fabricator shall compile a Completion Document (in bound form and soft form) in respect of AHU, ducting and chilled water piping etc and submit 4 copies (in bound form) to the Purchaser. The document shall contain the following information:

- a. All test certificates relevant to the material used in fabrication of AHU, ducting and chilled water piping & support etc.
- b. Four copies of Mill test certificates for pipes, valves, flanges and welding electrodes shall be furnished along with the material.
- c. Approved fabrication drawing.
- d. As built drawing for each part/component on paper and soft copy on CD/DVD.
- e. Detailed Inspection and QAP
- f. Procedure for tests such as DP, and hydrostatic test etc.
- g. Approved copies of WPS, PQR, WPQ, etc as per ASME Section IX requirements.
- h. Stage wise inspections carried out by QA, BARC.
- i. DCR and NCR issued if any.

## **11. COMPLETION PERIOD**

The work covered by this order shall be completed within **6 (Six) month** from the date of issue of Work Order.

**ANNEXURE –I****DATA SHEET: PACKAGE AIR CONDITIONER UNIT****DATA SHEET: Air Handling Unit**

| <b>Sr No</b> | <b>Description</b>                            | <b>Details</b>  |
|--------------|---|---|
| 1.           | <b>Designation :</b>                          | <b>AHU for RSWRF, RSMS</b>  |
| 2.           | Number required                               | <b>1</b>  |
| 3.           | <b>Type:</b>                                  | <b>Once through</b>   |
| 4.           | <b>Cooling capacity</b>                       | <b>12 TR</b>  |
| 5.           | <b>Fan capacity :</b>                         | <b>2500 CMH</b>   |
| 6.           | <b>Static pressure</b>                        | <b>140 mm WG</b>  |
| 7.           | Available floor space                         | 1.2 meter X 3 meter   |
| 8.           | Fan type                                      | Backward curved   |
| 9.           | Fan make                                      | Kruger or equivalent  |
| 10.          | Casing  | Double skin (22G powder coated outside and 22G galvanized sheet inside with 25mm thick P.U) |
| 11.          | Location                                      | indoor  |
| 12.          | Duty :  | continuous  |
| 13.          | Room design condition                         | 25 +-1°C & 50% RH   |
| 14.          | Apparatus dew point temp.                     | 13 °C   |
| 15.          | Entering air temp (°C)                        | 35 db& 28.3wb   |
| 16.          | Leaving air temperature                       | As required   |
| 17.          | Leaving relative humidity                     | 50%   |
| 18.          | Face velocity across the cooling coil         | ≤ 2.5 m/sec   |
| 19.          | <b>Type of coil :</b>                         | <b>Refrigerant coolant</b>  |
| 20.          | Refrigerant                                   | R-410A or R-407C (Eco friendly )  |
| 21.          | Number of rows deep of cooling coil           | 8   |
| 22.          | Eliminator plates required after cooling coil | yes   |
| 23.          | Discharge direction                           | Vertical  |
| 24.          | Air Inlet damper required                     | Yes   |
| 25.          | Air outlet damper required                    | Yes   |

| Sr No | Description                                  | Details   |
|-------|--|---|
| 26.   | noise level at a distance of 1.5 metres      | 65 dB   |
| 27.   | Lighting Requirement                         | LED light inside the fan compartment<br>LED light in PRE filter compartment<br>LED light in HEPA filter compartment   |
| 28.   | Painting of fan and MS structural frame work | epoxy   |
| 29.   | Pre-filter required                          | Yes   |
| 30.   | HEPA filters required                        | Yes   |
| 31.   | Vibration isolators                          | Yes   |
| 32.   | Fan drive                                    | V-Belt driven   |
| 33.   | Motor  | To be Provided  |
| 34.   | Power supply                                 | 415V/3Ph/50Hz   |
| 35.   | Fan RPM                                      | To be provided. (Lower rpm shall be preferred)  |
| 36.   | Fan outlet air velocity                      | Not more than 11 m/sec  |
| 37.   | Temperature sensor                           | Install in outlet of AHU.   |
| 38.   | Control                                      | HP/LP/OL/UL/TEMPERATURE, SPP, PHASE SEQUENCE RELAY AND DISPLAY OF SAME  |
| 39.   | Controller                                   | Microprocessor based with LCD display.  |
| 40.   | Accessories provided                         | 1. Butterfly valves & globe valves<br>2. Pressure gauges<br>3. Temp. Gauges<br>4. Inclined Tube Manometers.   |
| 41.   | AHU testing                                  | Performance and endurance test for 72 Hrs.<br>Cooling coil testing: Hydro test at works.<br>Fan testing: Performance, Mechanical run, static & dynamic balancing of impellers at works. |

### **OUTDOOR CONDENSING UNIT (ODU)**

1. Compressor type: Hermetically sealed scroll (high energy efficient)
2. Condenser type : Air cooled Finned Tube Heat Exchanger (FTHX)
3. Condenser fan type : Propeller
4. Power supply: 230V, single phase,50hz or 3 Phase 440 V 50 Hz
5. The unit shall be designed to operate effectively at higher ambient temperature, up to 50 deg C.

**NOTE:**

1. Packaged AC unit shall be fully charged with refrigerant at site.
2. Hard drawn copper tube and insulation tube - 15 m (each size) of suitable diameter along with elbows and G.I. supporting structure.
3. Four core (2.5 sq.mm) suitable FRLS electrical cable from IDU to ODU of make Finolex/Fine Cab/ equivalent - 15 m
4. Four core (4.0 sq.mm) electrical cable (armoured) of make Finolex/Fine Cab/ equivalent - from departmental power supply to IDU - 10 meter
5. PVC drain of suitable diameter with fittings and clamping - 10 meter
6. Air cooled condensing unit discharge and liquid lines valves shall be fixed
7. Suitable MS stand for ODU (minimum 45 mm angle)
8. Approved makes: BLUE STAR / VOLTAS / HITACHI / CARRIER

**ANNEXURE-II****PROFORMA FOR TEST RESULTS OF PACKAGE AC UNIT**

| <b>Sr.No.</b> | <b>Description</b>  | <b>Parameter</b>   | <b>Test results</b>             |
|---------------|---|--|---------------------------------|
| 1.            | Ambient Conditions  | D.B. Temp. (°C)<br>W.B. Temp. (°C)<br>R.H. (%)   | :<br>:<br>:                     |
| 2.            | Compressors   | Speed (RPM)<br>Refrigerant gas suction pressure<br>(kg/sq. cm)<br>Refrigerant gas discharge pressure<br>(kg/sq. cm)  | :<br>:<br>:                     |
| 3.            | Compressor motor  | Speed (RPM)<br>Voltage (Volt)<br>Current (Amp.):<br>i) At 100%load<br>ii) At partial load<br>a)<br>b)<br>c)  | :<br>:<br>:<br>:<br>:<br>:<br>: |
| 4.            | Condensers  | Airflow rate (CMH)<br>Air temp. (°C)<br>Entering<br>Leaving  | :<br>:<br>:<br>:                |
| 5.            | Cooling coil  | Total air quantity across coil (CMH)<br>Coil face area (sq. m)<br>Air temperature:<br>Entering, D.B. (°C)<br>Entering, W.B. (°C)<br>Leaving, D.B. (°C)<br>Leaving, W.B. (°C) | :<br>:<br>:<br>:<br>:<br>:<br>: |
| 6.            | Fresh air intakes   | Face area (sq. m)<br>Air quantity (CMH)  | :<br>:                          |
| 7.            | Room condition at the working place (Number of reading shall be taken and avg. out) | Temperature (°C)<br>D.B.<br>W.B.   | :<br>:<br>:                     |
| 8.            | Vibration level at following location   | Foundation<br>Motor foundation bolt<br>Bearings  | :<br>:<br>:                     |
| 9.            | Sound level   | At 1.5 m from the AHU (dB)<br>At 1.5 m from the ODU (dB)   | :<br>:                          |
| 10.           | Controls  | Function of each control shall be tested and report furnished  |                                 |



**SCHEDULE –A**

Following free issue material (FIM) will be provided by BARC for this work:

1. MS Filter hood (Quantity 2 set)

**SCHEDULE – B**

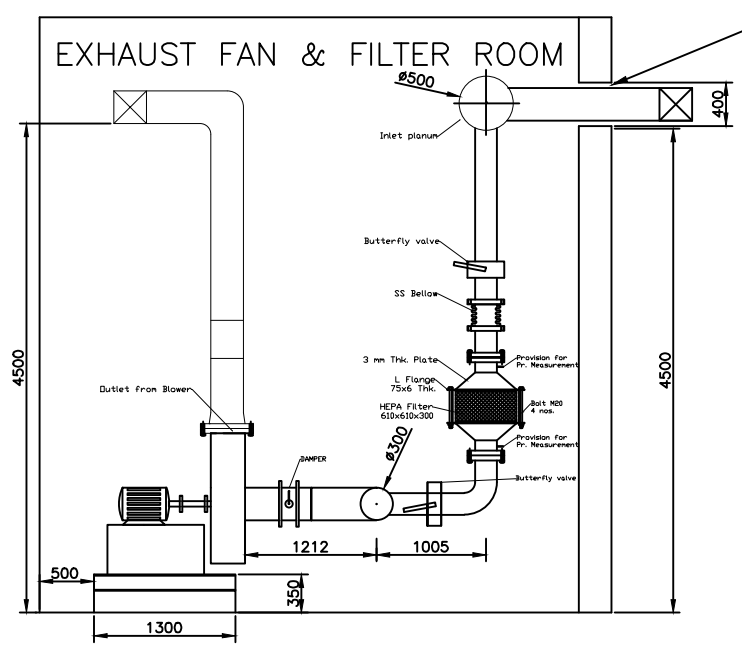
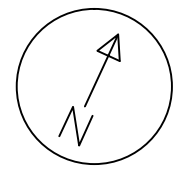
**Bill of Quantity (BOQ):** The bill of quantity is shown below. The minor quantity or scope may change at any stage. However the supplier/ vendor have to complete the revised/ change work without any extra cost.

**BILL OF QUANTITY**

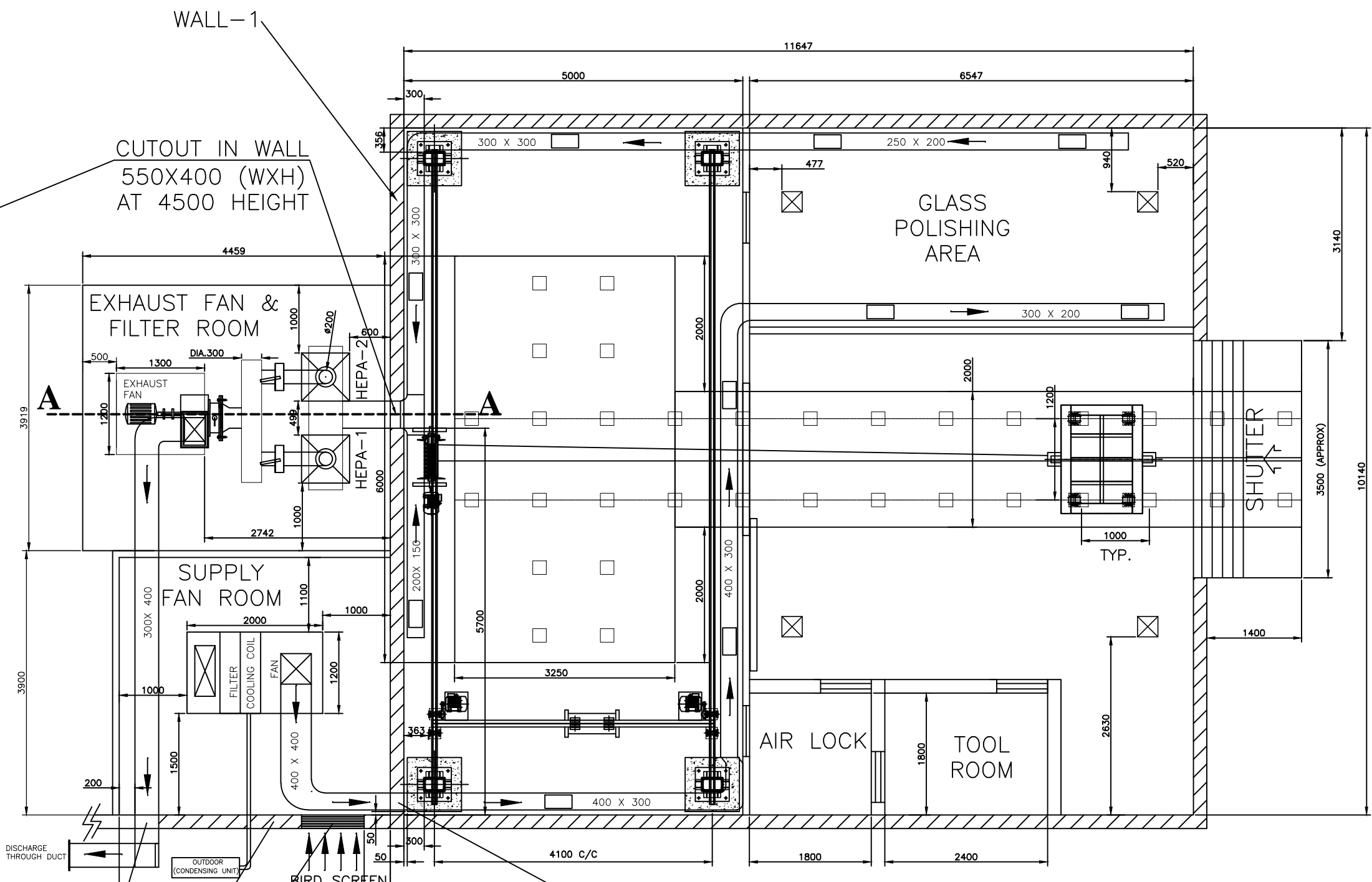
| <b>Ventilation system for RSWRF, RSMS</b> |  |                 |               |             |                   |
|---|--|-----------------|---------------|-------------|-------------------|
| <b>Sr. No.</b>                            | <b>Item description</b>  | <b>Quantity</b> | <b>Unit</b>   | <b>Rate</b> | <b>Total cost</b> |
| 1   | <b>Air supply system (Package unit):-</b> Design, manufacturing, assembly, inspection, factory testing, painting, packaging, supply, installation, commissioning and performance testing at site of eco-friendly refrigerant based Double skin type Air Handling Unit (consist of pre and HEPA filter, cooling coil, mist eliminator, supply fan), outdoor air cooled condensing unit (approved make: BLUE STAR / VOLTAS / HITACHI / CARRIER or equivalent) along with all accessories and control system (built-in controls like HP/LP/OL/UL /Temperature, SPP, Phase Sequence Relay AND DISPLAY OF SAME) as per technical specification. Fan Capacity: 2500 CMH & static 140 mm WCg, Cooling capacity 12 TR. | <b>1</b>        | <b>Number</b> |             |                   |
| 2   | <b>Exhaust fan:</b> Design, manufacturing, assembly, inspection, factory testing, painting, packaging, supply, installation, commissioning and performance testing at site of exhaust fan along with motor and all accessory as per technical specification. Fan capacity: 3000 CMH, Static: 150 mm WCg.   | <b>1</b>        | <b>Number</b> |             |                   |
| 3   | <b>SS supply and exhaust duct:</b> Procurement of complete raw material, fabrication, welding, inspection, testing and erection of 1.6 mm thick SS304L ducts with DPT as requirement for root and final weld layers.   | <b>1200</b>     | <b>kg</b>     |             |                   |
| 4   | <b>Insulation of supply duct:-</b> supply and installation of insulation to the duct. Material of construction (MOC) for the insulation will be 19 mm thickness. Nitrile rubber.   | <b>30</b>       | <b>sq. m</b>  |             |                   |
| 5   | <b>M.S. Supports structure:</b> Supply of materials, fabrication, epoxy painting and installation of supporting structures for duct, filter hood (will be provided as FIM), equipment, duct reinforcements etc.  | <b>2200</b>     | <b>kg</b>     |             |                   |
| 6   | <b>Manual dampers for supply duct:</b> - Supply, installation and testing of flow balancing manual dampers as per specification. (MOC: 3 mm thickness aluminium blades of powder coated) along with Stainless Steel counter flange of thickness 6 mm. size:  | <b>1</b>        | <b>Number</b> |             |                   |

| Ventilation system for RSWRF, RSMS |  |          |        |      |            |
|------------------------------------|--|----------|--------|------|------------|
| Sr. No.                            | Item description   | Quantity | Unit   | Rate | Total cost |
|                                    | 200x150mm, 1 no.,  |          |        |      |            |
| 7                                  | <b>Isolation dampers electrically operated:-</b> Supply, installation and testing of isolation dampers electric motor operated with sealing efficiency better than 99.8 % as per specification. (MOC: MS with epoxy painted, 3 mm thickness blades and 6 mm thickness body,) along with Stainless Steel counter flanges of thickness 6 mm. Sizes:<br>400x400mm, 1 no.,<br>300x400mm, 1 no. | 2        | Number |      |            |
| 8                                  | <b>Air supply grill:-</b> Supply, installation and testing of air supply grills with volume control dampers (VCD), rectangular, double deflection type, MOC: Aluminium with powder coating (18G thickness). Size:<br>150mm X 800mm, 5 no.  | 5        | Number |      |            |
| 9                                  | <b>Air return grill:-</b> Supply, installation and testing of air return grills with volume control dampers (VCD), rectangular, MOC: Aluminium with powder coating (18G thickness). Size: 125mm X 900mm, 5 no.   | 5        | Number |      |            |
| 10                                 | Supply and installation of manual Stainless Steel butterfly valve wafer type of 200 mm NB, class 150   | 4        | Number |      |            |
| 11                                 | Supply and installation of SS Flange, 200 mm NB, Class 150   | 8        | Number |      |            |
| 12                                 | Supply and installation of SS bellow 200 mm NB with minimum axial deflection 10 mm.  | 2        | Number |      |            |
| 13                                 | Fabrication supply and installation of metallic window louvers for air inlet of size 1.2mx1.2m   | 1        | Number |      |            |
| 14                                 | SS304L threaded Nipple 8mm NB 200mm long with cap  | 20       | Number |      |            |
| 15                                 | SS304L stud M12 x 380mm long with double nuts at both ends   | 20       | Number |      |            |
| 16                                 | Basic cost   |          |        |      |            |
| 17                                 | Taxes  |          |        |      |            |
| 18                                 | Total Cost   |          |        |      |            |

| REV.NO. | DESCRIPTION | DATE | DRAWN | CHKD. BY | APPROVED |
|---------|-------------|------|-------|----------|----------|
|         |             |      |       |          |          |

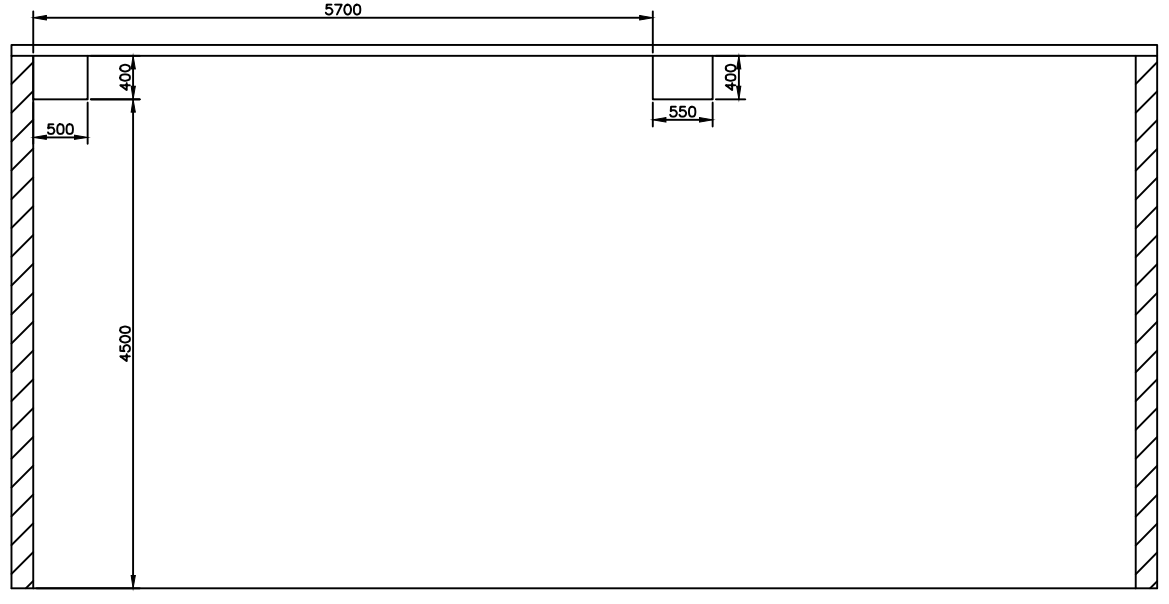


**SECTION A-A**

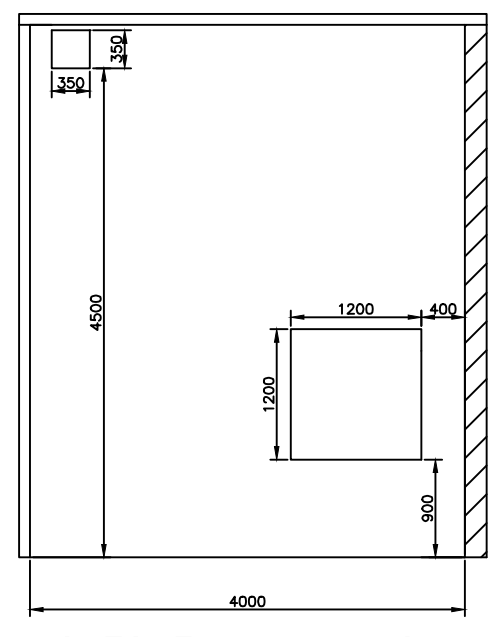


**PLAN VIEW**

**NOTES:**  
1. ALL DIMENSIONS ARE IN MILLIMETERS. NO DIMENSION SHALL BE SCALED OFF FROM THIS DRAWING.



CUTOUT IN WALL-1



CUTOUT IN WALL-2

|                                      |  |                           |            |
|--------------------------------------|--|---------------------------|------------|
| <b>G.A. OF VENTILATION SYSTEM</b>    |  | PROJECT                   |            |
| <b>RSW REFURBISHMENT FACILITY</b>    |  | RSWRF<br>RSMS             |            |
| GOVERNMENT OF INDIA                  |  |                           |            |
| <b>BHABHA ATOMIC RESEARCH CENTRE</b> |  |                           |            |
| TECHNOLOGY DEVELOPMENT DIVISION      |  |                           |            |
| DRAWN                                |  | PROJ'N                    | SCALE      |
| DRG. CHD.                            |  | NTS                       | DATE       |
| DESIGNED                             |  | 09/05/2018                |            |
| DESIGN                               |  | FILE NAME --              |            |
| CHD.                                 |  | DRG. NO.                  |            |
| APP'D                                |  | <b>A2-TDD-RSWRF-18-01</b> | RO<br>REV. |

THIS DRAWING IS THE PROPERTY OF BARC AND IT SHOULD NOT BE COPIED, LOANED OR USED WITHOUT WRITTEN PERMISSION.