SENSITIVE BUT UNCLASSIFIED

US EMBASSY, NEW DELHI

REPLACEMENT OF AIR HANDLING UNITS AND OUTSIDE AIR UNITS

Brief Description:

U.S Embassy, New Delhi has the requirement for supply, installation, and commissioning of 3 each Air handling units, 1 each filtered outside air unit and 2 each Treated Fresh air units. The central station units shall be of modular in construction (capable of being assembled in the field). The unit shall be capable to facilitate upgrades and maintenance of integral parts and to facilitate on site assembly utilizing access routes sized in accordance with the building fire codes. The removal of existing units is exempted from the scope.

Specifications:

CENTRAL-STATION AIR-HANDLING UNITS UNCLASSIFIED SECTION 237315- 1
SECTION 237315 – CENTRAL-STATION AIR HANDLING UNITS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section identifies requirements for air handling units (AHU) in the construction of new and renovation of existing office buildings and on-compound housing.

B. Related Sections:

1. Filters and filter housing requirements for HVAC applications not protected by environmental security protection systems are addressed in Section 234105 “Air Filtration.

2. Section 250593 “Testing, Adjusting, and Balancing for HVAC.”

3. Motor requirements are addressed in Division 23 Section on common motor requirements for HVAC equipment, except where otherwise specifically identified in this Section.

1.2 REFERENCES

A. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):


2. AHRI 640: Performance Rating of Commercial and Industrial Humidifiers.
3. AHRI 850: Commercial and Industrial Air Filter Equipment.


5. AHRI 1350: Mechanical Performance Rating of Central Station Air-Handling Unit Casings.

B. Air Movement and Control Association International, Inc. (AMCA):

4. AMCA 301: Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
5. AMCA 500-D: Laboratory Methods of Testing Dampers for Rating.

C. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):

2. ASHRAE 52.2: Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

D. American Society of Mechanical Engineers (ASME):

1. ASME AG-1: Code on Nuclear Air and Gas Treatment.
2. ASME N509: Nuclear Power Plant Air-Cleaning Units and Components.

E. American Welding Society (AWS):


F. ASTM International:

3. ASTM A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
G. Institute of Electrical and Electronics Engineers (IEEE):


H. Institute of Environmental Sciences and Technology (IEST):

1. IEST-RP-CC001: HEPA and ULPA Filters.

I. International Organization for Standardization (ISO):

1. ISO 5011: Inlet air cleaning equipment for internal combustion engines and compressors - Performance testing.
2. ISO 14694: Specifications for balance quality and vibration levels.

J. National Electrical Manufacturers Association (NEMA):

1. NEMA MG1: Motors and Generators.

K. Underwriters Laboratories (UL):

1. UL 486A-486B: Wire Connectors.
2. UL 586: Standard for High-Efficiency, Particulate, Air Filter Units.
4. UL 900: Standard for Air Filter Units.

1.3 DEFINITIONS AND ABBREVIATIONS

A. AHU: Air Handling Units.


C. High Efficiency Gas Adsorption (HEGA) Filters: Filters with one or more adsorbents (e.g., activated carbon, impregnated carbon, activated alumina, zeolites, and molecular sieves) used to remove airborne toxic chemicals.

D. High Efficiency Particulate Air (HEPA) Filters: Filters typically used in industry in hospital operating rooms and manufacturing clean rooms.

E. Indoor Air Quality (IAQ): Air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupants. IAQ can be affected by gases (e.g., carbon monoxide, volatile organic compounds), particulates (measured in outdoor air and reported as PM10 and PM2.5), and microbial contaminants (e.g., bacteria, mold). Outdoor (and some indoor) pollutants can be created from a variety of sources to include the decay of radioactive elements (e.g., radon), local motor vehicles (e.g., nitrogen oxides, sulfur dioxide, carbon monoxide), manufacturing plants (e.g., toxic industrial chemicals, volatile organic compounds). To provide occupant health and comfort, and to enhance productivity, contaminant levels are controlled utilizing a variety of best practices, including building pressurization and gas/particle filtration.
F. Inertial Separator: Used to extend life of particulate filters by separating heavy airborne particles as air changes direction.

G. Marine Climate: See Appendix R of the OBO Building Code.

H. MERV: Minimum Efficiency Reporting Value as defined by ASHRAE Standard 52.2.

I. Outdoor-Air Pollution Control Filter (OAPCF): Single or combination (e.g., MERV 13, HEGA, adsorption media impregnated bag filters, etc.) of various particulate and/or gas adsorption filters which control contaminants and pollutants to achieve acceptable indoor air quality. Control of humidity, dust, and rain at the pollution control filters is critical to operation and life of the Environmental Security filtration system components.

J. Sub-Arctic/Very Cold/Cold/Mixed: Climate that is sub-arctic, very cold, cold, or mixed as defined by ANSI/ASHRAE/IESNA Standard 90.1.

K. Toxic Industrial Chemicals (TIC): Chemical hazards (e.g., carcinogens, reproductive hazards, corrosives, agents that affect lungs or blood) or physical hazards (e.g., flammable, combustible, explosive, reactive).

L. Volatile Organic Compounds (VOC): Any compound of carbon (apart from carbon monoxide, carbon dioxide, carbonic acid, metallic carbides, and carbonate ammonium carbonate) that participates in atmosphere photochemical reactions, except for those designated by EPA as having negligible reactivity.

1.4 SUBMITTALS

A. Preconstruction Submittals: Copy of Export License (DOS Form DSP-83) for export-controlled ASZM-TEDA carbon, or certification that no license is required. See Article on MARKING, PACKING, SHIPMENT, AND STORAGE.

B. Shop Drawings: Submit AHU room layout drawn to scale with equipment properly configured with conformance to access (e.g., coil pull and filter change).

1. Identify all maintenance space requirements, including space reserved to facilitate coil pull.

2. Identify all ductwork and piping entering and leaving AHU room in plan and elevation.

3. Indicate hose bibb and floor drain locations in each AHU room to facilitate cleaning of coils.

4. Indicate maintenance platform around AHU as required to facilitate maintenance.

C. Product Drawings: Provide dimensioned plan and section views for each air handling unit including the following information:

1. Equipment section breaks, external components (e.g., dampers, intakes with bird/bug screens, security grills, rain/snow entrainment, deicing/icing control system, dust, and sand capture devices, etc.), internal components (e.g., dampers, filter housing, filters, grates,
coils, etc.), equipment pad, chilled/hot water piping connections, drain/condensate drain piping and trap/condensate drain piping and trap/condensate drain piping and trap/condensate drain piping locations and sizes, and inlet and outlet duct connection locations. Indicate location of control dampers, if installed internally, with location of actuator assembly.

2. [Humidifiers: Show minimum length of straight duct downstream of humidifier and associated condensate drip pan.]

3. Filter Housings: Provide dimensional plans and elevations of filter.

4. Cooling and heating coils, including corrosion control systems, as applicable: Clearly show location and “pull space” for coil replacement.

5. Access Doors and Access Panels: Indicate size and location of equipment access doors and panels, latch location, and direction path of door swing.

6. Electrical and Building Automation System (BAS) Control Elements: Indicate location of fan motor power junction box, variable frequency drives, electrical door switch junction box, and Magnehelic®/reporting pressure gauges.

D. Product Data:

1. Motors: Motors and variable frequency drives.
2. Fans.
3. Coils.
5. Insulation: Submit insulation material data sheet. Indicate insulation thickness and R-value. If AHU is to be installed in non-conditioned or outdoor location, submit calculations verifying that unit will not sweat under design conditions.
6. Casing: Submit no-thru-metal design construction sheets and materials that meet corrosive conditions at the intended site.
7. Filter Housings: Submit data which confirms that internal construction components of filter housings are stainless steel or as otherwise specified in this Section.
8. Filters: Submit following data on all filters selected for each AHU:
   a. Filter media.
   b. Framework construction.
   c. Physical dimensions required for clearances and access space.
   d. Weights.
   e. Securing methods.
   f. Fire classification.
   g. Rated flow capacity.
   h. Initial and final pressure drops at scheduled air flow.
   i. Particulate MERV rating.
   j. Gas adsorption residence time.
   k. Expected lifespan and replacement schedule.
   l. Test method.
   m. Operating/storage limits regarding temperature and humidity.

E. Design Data:
1. Derating Equipment: Provide derating corrections for all AHU components as necessary for proper operation at sites with elevation greater than or equal to 500 meters above sea level. Identify necessary derating corrections for heat transfer fluid (baseline: water) and power (e.g., frequency, voltage).

2. Pressure: Static pressure profile for each AHU that shows external static pressure broken down into supply air and return air components, individual AHU component static pressure losses, fan derating for system, and AHU exit loss at design airflow. Provide separate tables for clean and dirty filter operating conditions.

3. Leakage: Leakage compliance data for opposed blade dampers as specified in this Section.

4. Coils and Fins: Identify rated flow and heat transfer data for cooling and heating coils with applicable corrosion control, both waterside and airside, at design and maximum operating points. For cooling coils, separately annotate latent heat transfer data.

5. Filters: Identify quality (at design condition) of ventilation air (temperature and humidity). Submit particulate and gaseous media selection calculations based upon ASHRAE 62.1 or 62.2 (as applicable) IAQ standards for the worst-case local microclimate conditions. Calculations shall support specific recommended filter change schedule provided in O&M manual.

6. Fan Data: Fan performance curves and data table indicating system operating conditions at rated design operating points for clean and dirty filters.

7. Acoustic Summary Data: Provide Sound Power Level table in dBA for inlet openings in mixing plenum and plenum fan discharge. Provide Casing Radiation Sound Level data in dBA for supply fan section. Data shall be based at design airflow rate and maximum total pressure of each AHU.

F. Test Reports:

1. Testing Agency Qualifications: Submit qualifications for independent testing agency.

2. Testing Protocols: Submit testing protocols to Project Director/COR
   a. Factory Testing: Receipt shall be at least seven days in advance of test.
   b. Field Testing: Receipt shall be at least 14 days in advance of test.
   c. Commissioning and Startup Service: Receipt shall be at least 14 days in advance of test. Itemize equipment and materials required on site; list each performance test to be conducted and describe desired outcome of each commissioning test.

3. Factory AHU Casing Pressure Test: Prior to shipping, submit data for test signed by testing official from testing performed in accordance with Article on FACTORY ACCEPTANCE TESTING.

4. Factory Filter Housing Test: Submit data for test signed by testing official from testing
performed in accordance with Article on FACTORY ACCEPTANCE TESTING. Include the following:

a. Filter Housing Test Report from manufacturer of filter frame manifold(s) in housing.

5. Field AHU Casing Pressure Test: For modular AHU assembled in field, submit data for test signed by testing official from testing performed in accordance with Article on FIELD QUALITY CONTROL.

6. Field Filter Bypass Test: Submit data for test signed by testing official from testing performed in accordance with Article on FIELD QUALITY CONTROL. Include the following:

a. Testing Equipment: Provide list of equipment used along with current calibration certificate.
b. Field Quality Test Report: This Report will be forwarded by Project Director/COR for inclusion in Maintenance Database.

7. Field AHU System Leakage Test: Submit data for test signed by testing official from testing performed in accordance with Article on FIELD QUALITY CONTROL.

G. Certificates: For certification as identified in Article on QUALITY ASSURANCE.

H. Operations and Maintenance Manuals.

1.5 QUALITY ASSURANCE

A. Single-Source Responsibility: Obtain all AHU assemblies from a single source, which assumes responsibility for compatibility with each HVAC system.

B. Testing Agency Qualifications: Independent agency with experience and capability to conduct testing included in this Section that is acceptable to Project Director/COR

C. Certification: Certify compliance with the following:

1. Motors: Conventional efficiency testing is performed in accordance with NEMA MG 1. Motors comply with NEMA standards, and are matched to torque and horsepower requirements of load. Motors have electrical insulation in accordance with Article on MOTORS AND VARIABLE FREQUENCY DRIVES.

2. Variable Frequency Drive Controllers: Design and rating of motors for use with variable frequency drive controllers are suitable for use throughout entire speed range without overheating.

3. Electrical Components and Wiring: Testing indicated in the OBO Electrical Code (NFPA 70 as amended by OBO) for items identical to those used in other Sections of this project Construction Specification. Systems shall be listed and labeled for intended use.

4. Welding Certify that manufacturer uses skilled, certified welders for this construction. Welding procedures and personnel certifications shall be in accordance with AWS D1.1 and AWS D9.1 for casing joints, filter housings, and seam welding.
5. Cooling and Heating Coils: Compliance with AHRI 410.

6. Humidifiers: Compliance with AHRI 640 “Standards for Commercial Humidifiers.”

7. Filters:
   a. Compliance with NFPA 90 series for fire classifications, ASHRAE 52.2 for testing and rating air filters, and AHRI 850.
      b. HEPA Filters: Compliance with either IEST-RP-CC001.

D. Corrosion Resistance: Provide corrosion resistance for air handling system in accordance with OBO Building Code Appendix R and OBO Mechanical Code Chapter 3.

1.6 MARKING, PACKAGING, SHIPMENT, AND STORAGE

A. Coordinate shipping to ensure all AHU components, including construction filters and inertial separator for each AHU are delivered at same time for proper field assembly or storage.

B. Packaging, shipping, and storage of filters shall be done in accordance with IEST-RP-CC001 for HEPA filters. To preserve filter integrity and carbon life, ship all occupancy filters and replacement filters to arrive no earlier than 90 days before scheduled filter testing, in individual protective packaging separate from AHU housings. Ship occupancy filters so that they are on jobsite before scheduled filter testing. Carefully handle and store filters in dry location with constantly controlled temperature to protect from inadvertent construction damage. Inspect filters showing damage from shipping/handling or improper packaging to determine filter integrity; and replace damaged filters.

C. Each filter and filter packaging shall be permanently marked in accordance with IEST-RP-CC001 for HEPA filters. Marking shall include HEPA adsorbent data (Manufacturer, type, and grade), adsorbent weight, applicable warnings, and filter filled weight. Cartons or crates shall be clearly marked with “This Side Up” ensure proper orientation is maintained during shipment.

D. AHU Condensate P-Trap: AHU manufacturer shall ship AHU condensate P-traps with each AHU. Provide clear written instructions for proper field installation in shipment package.

1.7 EXTRA MATERIALS

A. Prior to shipping, install one set of construction filters in each AHU, and provide additional three change-out sets of construction filters for each AHU stored in inlet plenum. Occupancy filters shall not be used for initial start-up or during construction. See Article on COMMISSIONING AND START-UP SERVICE for installation of occupancy filters.

B. Provide one complete set of occupancy filters as applicable for each AHU. Each set includes outdoor-air pollution control filters, pre-filters, HEPA, and post filters for that AHU.

C. Provide one replacement set of occupancy filters for largest installed indoor AHU on project (i.e., enough pre-filters, HEPA filters and post-filters to replace all filters in largest
D. Provide one replacement set of occupancy filters for each installed outdoor-air AHU on project (i.e., enough pre-filters, OAPCF, particulate filters, and post-filters to replace all filters in outdoor-air AHU).

E. Provide sufficient length of spare gasket for each size access door used on any AHU installed for project, including filter section.

F. Provide one additional AHU gauge of each type and range used, including filter gauges, as spare set.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AHU: For Dedicated Outdoor Air Supply or Makeup Air Unit, a different manufacturer may be used for this unit than for other AHU.
   a. United Technologies (Carrier).
   b. Daikin Applied (McQuay).
   c. Ingersoll Rand (Trane).
   d. Johnson Controls Incorporated (York).
   e. Haakon (USA).
   f. [Desert Aire (for Dedicated Outdoor Air Supply or Makeup Air Unit only).]

2. Filter and Filter Housing:
   a. Camfil Group (formerly Camfil Farr).
   b. AAF Flanders.
   c. P&G Manufacturing.

3. Activated Carbon:
   b. Molecular Products Group Ltd.

4. Fans (including fan arrays with gravity dampers). Use only direct drive:
   a. AcoustiFLO.
   b. Twin City Fan and Blower (Twin City Fan Companies, Ltd.).
   c. Chicago Blower Corporation.

2.2 MANUFACTURED UNITS

A. Factory design AHU components as modular sections for field assembly on concrete housekeeping pads. Size modular sections to permit installation or removal through fire egress corridors. Modular sections include:
1. Inlet plenum with modulating interconnected dampers for ventilation and return air.
2. Filter sections include pre-filter, HEPA filter and post-filter.
3. Coil section includes finned cooling coils, condensate drain pans, cleaning access, plus heating coils and humidifier as required.
5. Fan sections, including motors and fans.

B. Casings:
1. Wall: AHU Casing shall be double-wall, insulated pressure casing with no-through-wall metal joints or fasteners.
2. Joining: Bolt modular section support frame together and join modular casing sections together with leak-proof mating surfaces.
3. Base: Units shall be supplied with base rails and perimeter lifting lugs for each section. Base rails shall be G90 galvanized steel painted to conform to 1000-hour salt solution (5 percent) spray test without any signs of rust when tested in accordance with ASTM B117. Rust rating shall be 10 with blister rating of 10 in accordance with ASTM D714. Alternatively to painted G90 steel, Type 6061 T6 welded structural aluminum may be used.
4. AHU Installed Outdoors or in Other Unconditioned Areas: Inner and outer walls shall be minimum 1.3 mm 3003 aluminum] [1.6 mm (Gauge 16) 316 stainless steel]. Associated ductwork, dampers, actuators, and other appurtenances exposed to outdoor air or mixed airstream shall be 316 stainless steel or powder-coated epoxy paint. Construct roof panel to provide drainage with 5 percent maximum pitch to side.
5. AHU Installed in Conditioned Mechanical Rooms: Sheet metal wall and roof panels forming outer wall shall be minimum 1.6 mm (Gauge 16) galvanized G90 steel, lock forming quality conforming to ASTM A653. Inner wall shall be minimum 1.6 mm (Gauge 16) [galvanized G90 steel, lock forming quality conforming to ASTM A653.] [316 stainless steel.] Paint outer skin to conform to 1000-hour salt solution (5 percent) spray test without any signs of rust when tested in accordance with ASTM B117. Rust rating shall be 10 with blister rating in accordance with ASTM D714. [Associated ductwork, dampers, actuators, and other appurtenances exposed to outside air or mixed airstream shall be 316 stainless steel or powder-coated epoxy paint.]
6. Deflection: AHU housing shall not deflect more than L/240, where L is major axis across largest unstiffened panel.
7. Flooring: Flooring of sections shall be minimum 3.2 mm (0.125 inches) thick aluminum deck tread (diamond plate), continuously welded. Structural base frame shall be epoxy painted steel C-channels.
8. Insulation: Design unit to prevent condensation on exterior surfaces. Provide calculations showing exterior surface temperatures remain above the design dew point temperature when the air handler is in cooling mode (design dew point temperature varies depending on location, indoor/outdoor, etc.). Core insulation material in walls, floor, and ceiling shall be at least 50 mm (2-in.) thick UL-listed Class-1 medium-density (32 kg/cu-mtr; 2.0 lb/cu-ft) closed-cell polyurethane foam with thermal conductivity not greater than 0.024 W/m·°K (0.014 Btu/hr·ft·°F) (ASTM C518 aged R-value R-6 per inch or greater). Submit material data sheet for the selected insulation product.
9. Penetrations: Do not make penetrations of AHU casing in field; all necessary penetrations (Including for coils, controls, and traps) shall be made at factory.

10. Sealant Material: Joint and Seam sealant shall include tapes, adhesives, masked and open weave fabric. Flange gaskets shall be butyl rubber or EPDM polymer with polysubstance plasticizer. Flange mastics shall be single-component polyurethane-based, non-sag elastomeric joint sealant complying with ASTM C920, Type S, Grade NS, Class 12.5. Water-based joint and seam sealant shall be UL723 listed, complying with NFPA for Class I ducts and be resistant to UV light when cured.

11. Test Ports for Field Installation: Manufacturer shall provide two test ports capable of being installed in field ductwork for sampling of airstream required during filter bypass testing. Test ports shall be cast aluminum or zinc alloy, capable of being attached over neoprene gasket and sealed with removable cap.

12. Control and Electrical Power Connections: All penetrations for control and motor electrical power connections shall be performed at factory such that no additional penetrations are required to be performed in field, and to ensure that installation is leak tight.

C. Filter Gauges: For each AHU, provide factory-mounted 100-mm (4-inch) dial-type Magnehelic® and transmitting differential pressure gauges with brass fittings and copper tubing to indicate pressure drop across each pre-filter, secondary filter/HEPA filter, and HEGA filter. Differential pressure gauge is not required for final filter. Gauges shall be diaphragm type, with dial and pointer in metal case, black figures on white background, and equipped with vent valves and front recalibration adjustment. Calibrate gauges in SI units. Filter gauge markings shall be in Pascals, with pressure range within that scheduled for maximum operating pressure of AHU. Provide placard for each filter; indicate type of filter, and scheduled clean/dirty filter pressure points reflecting points in approved shop drawing submittal.

D. Condensate Pan, Drain, and Trap:

1. Condensate Pan: Install drain pan beneath cooling coils, and extend drain pan the lesser of 800 mm downstream from face of cooling coil or entire length of coil inspection area to collect condensate. Provide removable galvanized steel floor grating over drain pan downstream of cooling coil. Drain pans shall be double sloped to drain, and shall be continuously welded 316 stainless steels with minimum 50 mm (2 inch) depth.

AHU MANUFACTURER IS RESPONSIBLE FOR SIZING AND SUPPLYING AHU CONDENSATE DRAIN LINE. WHILE SECTION 307 OF THE MODEL INTERNATIONAL MECHANICAL CODE (IMC) PROVIDES CRITERIA TO SIZE THIS DRAIN LINE, THE RESULT MAY BE OVERSIZED DRAIN LINES THAT “DRY OUT”; THIS IS BECAUSE THE IMC CRITERIA IS BASED UPON UNCONDITIONED HUMID OUTDOOR AIR RATHER THAN CONDITIONED NON-HUMID INDOOR RECYCULATED AIR.
ALTERNATIVELY, AHU MANUFACTURERS MAY ELECT TO USE THE FOLLOWING RULE OF THUMB FOR CONDENSATE DRAIN LINE SIZE IN LIEU OF CRITERIA IN THE MODEL IMC:

1) 20 MM FOR PRE-CONDITIONED AIR FLOW RATES UP TO 3500 LPS.
2) 25 MM FOR PRE-CONDITIONED AIR FLOW RATES BETWEEN 3500 LPS AND 9440 LPS.
3) 25 MM FOR OUTDOOR-AIR AHU PROVIDING UP TO 70 KW COOLING CAPACITY.
4) 32 MM FOR OUTDOOR-AIR AHU PROVIDING BETWEEN 70 KW AND 140 KW.
5) 40 MM FOR OUTDOOR-AIR AHU PROVIDING GREATER THAN 140 KW COOLING CAPACITY.

2. Condensate Drain: Extend drain connection out through side of casing above structural frame of AHU; see Article on INSTALLATION. Condensate drain size shall be in accordance with AHU manufacturer recommendations.

3. Condensate Trap: AHU manufacturer shall provide each AHU with ASTM B88 Type L copper tube condensate P-trap with inspection caps and screw-on, electronic trap primer. Condensate trap inspection caps shall be removable full-pipe-size located at top of each side of the trap; this is to facilitate inspection of water level in trap and maintenance of condensate trap and condensate drain line. P-trap shall be configured for suction-side operation of sufficient depth to overcome suction pressure of supply fan with fully loaded filters without being sucked dry, plus an additional 50-mm (2-inch) mm depth.

E. Inlet Plenum Wash-down Drain: Install 40 mm floor drain with removable galvanized steel floor grating (capped for normal use) to allow unit wash down in inlet plenum; drain outlet may be located within AHU structural frame.

F. Access Doors: Access doors (not including filter section) and panels shall be of same construction as wall panels. Frames shall be 50 mm extruded aluminum angles with thermal break for no-through metal construction. Doors shall swing 180 degrees and allow easy panel removal. Provide finished assembly with two perimeter sealing surfaces to allow double gaskets. Provide piano or butt hinges, number and size according to SMACNA’s “HVAC Duct Construction Standards – Metal and Flexible.” Provide minimum of two wedge-lever-type, padlock able latches, operable from inside and outside. Doors shall open against air pressure (Swing out on fan suction side and swing in on fan discharge side).

G. Cooling and Heating Coils: [Electro Fin or approved equal coils] [Coils] and fins shall be airside cleanable and conform to AHRI 410 and ASHRAE 33. Thread piping connections on same end.

1. Tubes: 15 mm copper with 0.9 mm wall thickness, complying with ASTM B75M.
2. Fins: Minimum 0.23 mm (.009 inches) thick copper, mechanically bonded to tubes, with minimum fin spacing of 2.3 mm, maximum fin spacing of 3.2 mm.
3. Headers: Seamless copper with brazed joints.
H. Dampers: Motorized control dampers shall be opposed airfoil blade design constructed with 2 mm minimum thickness and 152 mm wide blades constructed of stainless steel, Type 304 or 316, complying with ASTM A312 or ASTM A554 equipped with replaceable seals made of either EPDM or extruded silicone. Dampers frames shall be at least 2 mm thick stainless steel, Type 304 or 316, complying with ASTM A312 or ASTM A554. Secure blades 13 mm diameter zinc plated or cast zinc axles using zinc-plated hardware, with nylon blade bearings and nylon thrust bearings at the end of each axle. Leak test each damper assembly in accordance with AMCA 500-D. Maximum air leakage shall not exceed amount allowed for AMCA Class 1 rating when tested at design static pressure or 1.99 kPa, whichever is greater.

I. AHU Filter Housing:

1. Construct filter housing section for AHU of double-walled interior stainless steel [316 in corrosive environment] [403 in non-corrosive environment] with single side access. Design and construct entire filter housing to withstand negative and positive pressure of 2500 Pa and still maintain filtration leakage/bypass requirements. Continuously weld pressure retaining joints and seams with no pores allowed. Visually inspect welds for workmanship acceptance criteria described in Section 5 and 6 of ANSI/AWS D9.1. Limit filter housing size to maximum of four filters wide and three filters high. Standard filter face dimensions are nominal 609 mm wide by 609 mm high.

2. Filter housings may be designed for combination of inlet air plenum access and side access installation. The exception is that one-high filter housing configuration shall be provided with only side access installation. For filter decks downstream of inlet air plenum, provide at least 0.5 meters between installed filter face and top of AHU where ductwork is installed. If no ductwork is installed through top of AHU, provide at least 0.75 meters between installed filter face and rear wall of plenum or damper (if present) for maintenance accessibility. Locate damper actuator arms (if present) so as to not interfere with filter installation.

3. Filter housing section shall incorporate special securing mechanisms to retain HEPA filters in place. Each mechanism shall exert an equal force on top and bottom edge of filter sufficient for knife edge on filter section housing to penetrate filter's silicone or urethane gel sealant and maintain filter firmly in place. Interlock side access doors for HEPA filter sections with securing mechanism to prevent door closure unless filters are properly sealed in housing.

4. Filter section access doors shall be swing-open type with padlock-type securing latches. Fit with reliable gasket seals to prevent leakage when closed. These side access doors shall enclose HEPA and final filters; label “Warning - Do not install filters, other than construction filters, until all construction work, including drywall and painting, has ceased.”

5. When HEPA filter housings are installed within an AHU casing, all seams between filter housing and inner wall of AHU casing where air could potentially bypass filter section shall be gasketed and sealed.

6. Factory-Installed Filter Housing Test Ports: Filter Housing Manufacturer shall provide factory-installed capped test ports in filter housing upstream of HEPA filter, one in middle
of each filter tier, to facilitate verification of aerosol uniformity during filter bypass testing in field.

7. Factory-Installed Filter Housing Differential Pressure Sensing Points: Male pipe thread ports shall be factory welded into housings for differential pressure sensing across each pre-filter, secondary filter/HEPA filter. AHU manufacturer shall attach and extend pressure tubing from ports to filter gages.

2.3 FILTERS

A. Each filter shall be tested and rated either in accordance with ASHRAE Standard 52.2.

B. Construction Filters: Construction filters shall be used during construction to protect AHU and ductwork until all related project work (e.g., millwork, stone cutting, and painting) is complete in each building. A 102 mm (4 inch) deep MERV 8 filter is minimal acceptable filter for air handling unit. A 51 mm (2 inch) deep MERV 6 filter is minimal acceptable filter rating for fan coil units. Dimensions of filters shall be coordinated with equipment.

C. False Filter Inserts: Provide 609 mm x 609 mm x 305 mm deep metal “filter” frames with adjustable air slots that may be installed with construction filters in air handling units to simulate AHU having “clean” filters, allowing AHU to be operated thru variable speed drives without damage to drives due to high airflow/low total pressure conditions.

D. Roughing Bag-Type Pre-Filter (F-1 for MERV 11) for Single-Pass Outdoor-Air AHU: Each prefilter shall be MERV 11 bag-type filter with microfiber glass media and plastic enclosing frame. Size of pre-filter shall be 609 mm x 609 mm x 305 mm deep. Initial resistance to airflow shall be less than 75 Pascal at airflow of 2.5 m/s (500 fpm).

E. HEPA Filter (F-7):

1. Fabricate and label each HEPA Filter for AHU in accordance with IEST RP-CC001.3 for Type A performance and Grade 2 construction. Filter dimensions shall be 610 mm x 610 mm x 292 mm; careful sizing based on this nominal dimension is important for filter operation. Fabricate filter pack by pleating continuous sheet of filter media per IEST RPCC001 for Type performance and Grade 2 construction. Seal filter pack with fire-retardant solid urethane sealant.

2. Media: UL 586, fibrous glass, constructed of continuous sheets with closely spaced pleats to remove 99.97 percent of all particulate matter 0.3 microns or greater.


4. Face Gasket: Self-healing, non-flowing elastomeric gel sealant.

5. Filter Guard: Provide expanded metal grille over exposed HEPA filter material that does not interfere with filter operation.
6. Mounting Frames: Provide bolted filter-sealing mechanism to mount, and continuously seal each individual filter. Filter frame and housing shall incorporate knife-edge fluid seal design that mate into highly viscous silicone gel fluid-filled perimeter channel on mounting face of filter. Grind all weld seams and joints adjacent to any portion of any gasket-sealing surface smooth and flush with adjacent metal surfaces.

2.4 MOTORS AND VARIABLE FREQUENCY DRIVES

A. Motors shall be totally enclosed fan cooled (TEFC) rated as premium efficiency with Class H insulation and service factor of 1.15. Conventional efficiency tests shall be performed in accordance with NEMA MG 1.

B. Design and rate motors for use with variable frequency drive controllers suitable for use throughout entire speed range without overheating. Comply with NEMA MG 1 for thermal overload protection. Use electronic filters conforming to IEEE 519 for power supply. Provide remote monitor leads compatible with energy management system. Refer to Division 23 Section on motor requirements for HVAC equipment and Division 26 Section on variable frequency motor controllers for additional requirements.

C. All motor wiring shall be factory installed, with leak tight penetration through AHU fan housing section. Install all necessary conduit penetrations at factory for fan, coil, and return/outdoor-air plenum to accommodate field installation of BAS wiring; penetrations shall be capped internally and externally for testing.

D. Provide continuous current, voltage, and power monitoring at each AHU variable frequency drive, together with data logger for historical data retrieval.

2.6 FANS

A. Fan section shall be factory fabricated, assembled, tested. Equip with direct drive centrifugal plenum fan, motor, disconnect switch, drive assembly, and housing.

B. Comply with AMCA 99 for operating limits. Factory tests shall conform to AMCA 210 for fan performance data. Comply with AMCA 300 and AMCA 301 for acoustical data.

C. Fan wheel shall be aluminum, and employ backward inclined blades that are welded or riveted to flange and back plate.

D. Static and dynamic balances shall conform to ISO 14694. Motor vibration shall conform to NEMA MG 1 Part 7 “Motor and Generators.”

E. Fan shaft shall be turned, ground polished, hot rolled steel with keyway, designed to operate at no more than 70 percent of first critical speed when rotating at top of fan speed range.

F. Center fan inlet in fan wall for optimal airflow characteristics and condensation control.

G. Provide piezometer ring with digital display indicating airflow accurate to within plus/minus 5 percent.

H. Provide fan section door electrical interlock that prevents fan operation when door is open.
I. Service disconnect shall be provided by the AHU manufacturer and mounted both within sight and 2 meters reach of motor access door.

J. Labels: On fan door assembly, mount placard with designation of unit, design airflow rate in L/s and M³/hr, and design pressure drop of AHU in Pascals.

K. Fan/Motor Assembly Mounting: Mount assembly structural steel frame such that fan inlet is centered over cooling coil to promote even airflow over coil surface area. Mount fan assembly on steel frame or fan floor casing as applicable, or on seismic or vibration isolators as applicable for site seismicity requirements, and anchored to section floor casing or fan mounting frame as applicable. Refer to Division 23 Section on vibration and seismic controls for HVAC.

2.5 FILTER GAUGES

A. For each filter on air handling unit, except for final filters after HEGA filter, provide factory mounted 100 mm dial-type Magnehelic® and transmitting differential pressure gauges with brass fittings and pneumatic tubing for inside AHU and copper tubing were exposed outside of AHU or Filter Housing. Gauges shall be diaphragm type with dial and pointer in metal case, with black figures on white background, and with vent valves and front recalibration adjustment. Calibrate gauges in Pascals. Gauge range shall be between 0-750 Pascals for pre-filters and 0-500 Pascals for HEPA and HEGA filters. Manufacturer shall provide placard beneath each gauge indicating the type of filter gauged, design “clean” and “dirty” filter pressure drops in Pascals for AHU design airflow (pressure drop for maximum airflow allowed for filters at maximum filter airflow capability allowed is not acceptable).

2.6 ACCESSORIES

A. To facilitate future replacement of HEGA filters, provide filter lift mechanism capable of lifting and lowering heavy filters to/from AHU filter housings. A lifting device is required if AHU contains filter housings that have two- or three-high racked carbon filters.

1. Type:
   a. AHU-mounted gantry or davit.
   b. Alternate lift mechanism may be used when approved in writing by OBO/PDCS/DE Mechanical Engineer through Project Director/COR. Examples of alternate lift mechanisms which may be considered (when clearance above AHU is insufficient for gantry or davit) include duct jack or foot-pedal operated hydraulic scissor lift table on push truck cart equipped with caster wheels and brakes.

2. Performance requirements:
   a. Minimum Lifting Capacity: 350 kg
   b. Minimum Lifting Height: 2.5 meters

2.7 FACTORY ACCEPTANCE TESTING

A. General: Notify Project Director/COR of testing date and location at least 45 days in advance of testing to facilitate representative to witness testing and beginning of start-up service.

B. Filter Housing Test: Housing manufacturer shall test housings for filter alignment, filter fit, and for clamping mechanism operation. Leak test filter sealing surfaces and filter housing assembly pressure boundary in accordance with Section TA of ASME AG-1 before leaving factory.
Record pressure readings once per minute for five minutes. Maximum leak rate shall not exceed 0.008 liter/second per cubic meter of filter housing volume.

C. AHU Casing Pressure Test:

1. Assemble, install, and fill condensate drain trap with potable water prior to conducting AHU Casing Pressure Test.

2. After test preparation is completed, conduct pressure test in accordance with ANSI/AHRI 1350.

3. Leakage Test: Conduct test at design static pressure or 2.48 kPa (positive in normally positive pressure areas, negative in normally negative pressure areas), whichever is greater. Air leakage for AHU, including coil and wiring penetrations, shall not exceed 1.0 percent of total design airflow.

4. Deflection Test: Air handling unit housing shall not deflect more than L/240 during any part of air handling unit and filter section pressurization tests, where L is major axis across largest unstiffened section of air handling unit parallel to direction of airflow between filter housing and fan. If chosen unit fails to meet deflection test requirements, all remaining AHU shall also be tested. If unit fails to meet test requirements, corrections shall be made at Contractor’s expense.

PART 3 – EXECUTION

3.1 FIELD EXAMINATION

A. Examine concrete pads for compliance with requirements for installation tolerances and other conditions affecting installation and performance of HVAC casings. Verify sufficient height exists to allow proper mounting of provided P-trap without contacting the floor.

B. Examine roughing-in of hydronic drainage piping systems and electrical services to verify actual locations of connections before installation.

   A. For renovation and system replacement projects, verify that roof structure can handle load.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Concrete Bases: Install floor mounting units with sufficient height to ensure clearance for condensate trap installation above finished floor, with minimum of 100 mm high concrete bases. See Division 23 Section on common work results for HVAC for concrete base materials and fabrication requirements.

B. Units with Internally Isolated Fans: Secure units to anchor bolts installed in concrete bases. Remove manufacturer’s shipping retainers on the internal isolators supporting fan mounting frame and adjust per manufacturer’s recommendations.
3.3 CONNECTIONS

A. Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems.

B. Piping installation requirements are specified in other Division 23 Sections. Construction Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to AHU to provide coil pull space, and to facilitate service and maintenance.

**B. Drain Piping:**

1. Condensate Drains: Install factory provided condensate trap to drain pan outlet with inlet and outlet connection locations in accordance with manufacturer’s drawings. Connect condensate drain piping using hard copper tube, ASTM B88, Type L [cast-][ or ] [wrought-]copper [solder-joint][ or ][pressure-seal joint] fittings; and [brazed][ or ][soldered][ or ][pressure-seal] joints. Extend to nearest equipment or floor drain. Install cleanouts at each change in direction. Install electronic trap primer system within condensate drain trap inlet above water line to prevent P-trap from drying out. Plastic “P” traps are prohibited.

2. Wash-Down Drain: Connect 40 mm Type L copper drainpipe with ball valve to drain outlet connection and route separate from condensate drainpipe to nearest equipment or floor drain.

D. Connect hot and chilled water piping to supply and return coil taps, with shutoff or balancing valve and union or flange at each connection. Hangers and supports shall support piping so that no piping is supported by air handling unit.

E. Coordinate duct installations and specialty arrangements with schematics on Drawings and with requirements specified in duct and duct accessory Specifications. Make final duct connections with flexible connections.

F. Electrical: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls. Ground equipment according to Division 26 Section on grounding and bonding for electrical systems. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B. Service disconnect, provided by AHU manufacturer, shall be mounted both within sight of, and 2-meters reach of, fan motor access door. [Use NEMA enclosure type 4X panels in locations where exposed to outdoor air or unconditioned outdoor airstream.][Use stainless steel wire connectors in outdoor locations.]

H. Injection and sampling ports: Locate on ductwork so that ports are easily accessible by maintenance personnel on upstream and downstream side of filter housing for commissioning and subsequent testing of HEPA performance in accordance with Section TA of ASME AG-1. Locate injection ports in ductwork upstream of filter section to allow even distribution of test agent (e.g., poly-alpha-olefin (PAO), R-11) across entire filter area. Locate downstream sampling ports after fan discharge in area of ductwork that is accessible. Add warning labels to prevent damage to unit.
I. Verify pressure gauges and air flow monitor pneumatic tubing are connected to the device and gauges. Ensure proper calibration of pressure gauges and airflow monitor. Verify that all equipment labels are installed on the AHU.

3.4 FIELD QUALITY CONTROL

A. After equipment/system installation, perform the following field tests and inspections:

1. Condensate Trap Leakage: Fill condensate trap with potable water. Verify that AHU condensate traps maintain seal with potable water at maximum design static pressure to prevent air from entering AHU through the condensate drain line.

2. AHU Casing Pressure Test: Modular AHU assembled in field shall be tested again in accordance with procedure described in Article on FACTORY ACCEPTANCE TESTING.

3. Filter Bypass Test: Commissioning and subsequent testing of HEPA and adsorption filter performance shall be in accordance with Section TA of ASME AG-1. Independent test agent shall identify appropriate locations in ducts for test ports provided for field installation described in Article on MANUFACTURED UNITS, and shall install identified test ports in those locations. After installation, permanently mark location of these test ports. If halide gas detection instrument is gas chromatograph (GC), test shall include at least four readings taken at least one minute apart within ten-minute interval at rated flow. If halide gas detection instruments are detectors, detectors shall continuously monitor real time of “pulse” charge of halide gas at rated flow, and plot levels using printer provided by testing agent for inclusion with test reports. Reading may not exceed 0.1 percent of upstream value for R-11 (gas) or 0.03 percent of upstream value for particles.

B. Final field assembly shall be tested as complete integral AHU and certified to meet rigid life safety requirements of enhanced filtration.

C. Demonstrate to post Facility Manager and Project Director/COR proper operation of AHU and controls.

3.5 COMMISSIONING AND START-UP SERVICE

A. Factory-trained technician shall inspect field-assembled components and equipment installation, including piping and electrical connections, and perform start-up and performance testing service in accordance with this Article and AHU manufacturer’s recommendations.

B. Prior to AHU startup, perform the following minimum tasks:
1. Verify that shipping, blocking, and bracing are removed.
2. Verify that spring isolators are installed and adjusted.
3. Verify that unit is secure on mountings and supporting devices.
4. Verify that connections to piping, ducts, and electrical systems are complete.
5. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
6. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
7. Lubricate bearings and other moving parts with factory-recommended lubricants.
8. Set connected duct system variable air terminal dampers to fully open position.
9. Set outdoor- and return-air mixing dampers to minimum outdoor-air and maximum return air settings.
10. Clean packaged air-handling units internally upon completion of installation according to manufacturer’s written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum-clean fan wheels, cabinets, and coils entering air face.
12. Coil leak test. Fill water coils with water. Test coils and connections for leaks. Repair leaks and retest until no leaks exist. Drain coils and fill with water or water and propylene glycol solution.

C. Startup: Perform the following minimum tasks:

1. Filters. Verify installation of construction filters.

2. Fans. Verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing operations. After electrical circuitry has been energized, start units to confirm proper motor rotation and drive unit operation. Run fan through entire operational range using VFD controls to verify proper installation. Remove malfunctioning motors, replace with new units, and retest. Adjust fan drive to scheduled RPM for initiation of system balancing. Measure and record motor electrical values for voltage and amperage.

3. Dampers. Adjust damper linkages for proper damper operation. Manually operate dampers from fully closed to fully open position and record fan performance. Refer to Section 250593 “Testing, Adjusting, and Balancing for HVAC” for packaged air-handling system testing, adjusting, and balancing.

4. Separators. Test inertial separators per the general requirements outlined in ISO 5011.

5. Test and adjust controls and safety. Replace damaged and malfunctioning controls and equipment.

D. After Successful Startup: Perform the following minimum tasks after AHU testing, welding, gypsum board installation, sanding, painting, and other dust- and/or VOC-generating activities have been performed and after all spaces are clean of construction dust and fumes, perform the following:

1. Remove construction filters.
2. Clean filter housings.
3. Install occupancy filters.
4. Perform testing, adjusting, and balancing of packaged air-handling and air-distribution system.
5. Commission air-handling and air-distribution system.

3.6 DEMONSTRATION
A. Factory-trained technician (on equipment being installed) shall train post’s maintenance personnel to adjust, operate, and maintain packaged AHU.
# Filtered Outside Air Unit – AF#1 – 1 Each

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Air Quantity (L/s)</td>
<td>6000</td>
</tr>
<tr>
<td>Outside Air Quantity (L/s)</td>
<td>6000</td>
</tr>
<tr>
<td>Initial Resistance</td>
<td>1.13 in wC</td>
</tr>
<tr>
<td>Total Static Pressure (Pa)</td>
<td>2.1-in wC</td>
</tr>
<tr>
<td>Design</td>
<td>Horizontal</td>
</tr>
</tbody>
</table>

## Fan

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan Type</td>
<td>Centrifugal</td>
</tr>
<tr>
<td>Mixing Box</td>
<td>None</td>
</tr>
<tr>
<td>Filter Section</td>
<td>Primary / Activated Carbon / HEPA / Post Filter</td>
</tr>
</tbody>
</table>

# Treated Outside Air Unit #1 Specifications (AH#1) – 1 Each

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Air Quantity (L/s)</td>
<td>3600</td>
</tr>
<tr>
<td>Outside Air Quantity (L/s)</td>
<td>3600</td>
</tr>
<tr>
<td>External Static Pressure (Pa)</td>
<td>125.0</td>
</tr>
<tr>
<td>Total Static Pressure (Pa)</td>
<td>326.0</td>
</tr>
</tbody>
</table>

## Cooling Coil

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tube Material / Fin Material</td>
<td>Cu / Al</td>
</tr>
<tr>
<td>Entering Air Temperature DB/WB (°C)</td>
<td>43.3 / 28.2</td>
</tr>
<tr>
<td>Leaving Air Temperature DB/WB (°C)</td>
<td>15.3 / 14.9</td>
</tr>
<tr>
<td>Total Cooling Capacity (KW)</td>
<td>208.00</td>
</tr>
<tr>
<td>Sensible Cooling Capacity (KW)</td>
<td>121.00</td>
</tr>
<tr>
<td>Water Flow (L/s) @7.2°C EWT</td>
<td>8.70</td>
</tr>
<tr>
<td>Leaving Water Temperature (°C)</td>
<td>12.00</td>
</tr>
<tr>
<td>Water Pressure Drop (kPa)</td>
<td>30.0</td>
</tr>
</tbody>
</table>

## Heating Coil
**TUBE MATERIAL / FIN MATERIAL** | CU / AL
---|---
**ENTERING AIR TEMPERATURE DB (°C)** | 5.0
**LEAVING AIR TEMPERATURE DB (°C)** | 20.2
**TOTAL HEATING CAPACITY (KW)** | 65.00
**WATER FLOW (L/s) @71.1°C EWT** | 1.32
**LEAVING WATER TEMPERATURE (°C)** | 59.30
**WATER PRESSURE DROP (kPa)** | 17.0

**FAN**

| **FAN TYPE** | CENTRIFUGAL
---|---
**MIXING BOX** | NONE
**FILTER SECTION** | NONE

**TREATED OUTSIDE AIR UNIT # 1 SPECIFICAITONS (AH#2) – 1 EACH**

| **TOTAL AIR QUANTITY (L/s)** | 1960
| **OUTSIDE AIR QUANTITY (L/s)** | 1960
| **EXTERNAL STATIC PRESSURE (Pa)** | 125.0
| **TOTAL STATIC PRESSURE (Pa)** | 311.0

**COOLING COIL**

| **TUBE MATERIAL / FIN MATERIAL** | CU / AL
| **ENTERING AIR TEMPERATURE DB/WB (°C)** | 43.3 / 28.2
| **LEAVING AIR TEMPERATURE DB/WB (°C)** | 14.6 / 14.2
| **TOTAL COOLING CAPACITY (KW)** | 118.00
| **SENSIBLE COOLING CAPACITY (KW)** | 67.00
| **WATER FLOW (L/s) @7.2°C EWT** | 5.00
| **LEAVING WATER TEMPERATURE (°C)** | 12.80
| **WATER PRESSURE DROP (kPa)** | 28.0

**HEATING COIL**

| **TUBE MATERIAL / FIN MATERIAL** | CU / AL
| **ENTERING AIR TEMPERATURE DB (°C)** | 5.0
| **LEAVING AIR TEMPERATURE DB (°C)** | 21.5

SENSITIVE BUT UNCLASSIFIED
TOTAL HEATING CAPACITY (KW)   38.00
WATER FLOW (L/s) @71.1°C EWT   0.80
LEAVING WATER TEMPERATURE (°C)   59.70
WATER PRESSURE DROP (kPa)   9.0

FAN
FAN TYPE   CENTRIFUGAL
MIXING BOX   NONE
FILTER SECTION   NONE

AIR HANDLER UNIT - AHU # 4 – 1 EACH

TOTAL AIR QUANTITY (L/s)   1750
OUTSIDE AIR QUANTITY (L/s)   410
EXTERNAL STATIC PRESSURE (Pa)   175.0
TOTAL STATIC PRESSURE (Pa)   842.0

COOLING COIL

TUBE MATERIAL / FIN MATERIAL   CU / AL
ENTERING AIR TEMPERATURE DB/WB (°C)   29.6 / 21.1
LEAVING AIR TEMPERATURE DB/WB (°C)   13.9 / 13.4
TOTAL COOLING-capacity (KW)   49.00
SENSIBLE COOLING-capacity (KW)   33.00
WATER FLOW (L/s) @7.22°C EWT   1.90
LEAVING WATER TEMPERATURE (°C)   13.30
WATER PRESSURE DROP (kPa)   11.0

HEATING COIL

TUBE MATERIAL / FIN MATERIAL   CU / AL
ENTERING AIR TEMPERATURE DB (°C)   16.5
LEAVING AIR TEMPERATURE DB (°C)   23.0
TOTAL HEATING CAPACITY (KW)   14.00
WATER FLOW (L/s) @71.1°C EWT   0.21
LEAVING WATER TEMPERATURE (°C)   55.50
WATER PRESSURE DROP (kPa)   1.0
### FAN
- **FAN TYPE**: CENTRIFUGAL
- **MIXING BOX**: YES
- **FILTER SECTION**: YES
- **FACE AREA FILTER TYPE “A” 51MM 30%TA**: 1.00
- **FACE AREA FILTER TYPE “B” 559MM 84% TA**: 1.00

### AIR HANDLER UNIT (AHU) # 5 – 1 EACH

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL AIR QUANTITY (L/s)</td>
<td>1100</td>
</tr>
<tr>
<td>OUTSIDE AIR QUANTITY (L/s)</td>
<td>378</td>
</tr>
<tr>
<td>EXTERNAL STATIC PRESSURE (Pa)</td>
<td>190.0</td>
</tr>
<tr>
<td>TOTAL STATIC PRESSURE (Pa)</td>
<td>821.0</td>
</tr>
</tbody>
</table>

### COOLING COIL
- **TUBE MATERIAL / FIN MATERIAL**: CU / AL
- **ENTERING AIR TEMPERATURE DB/WB (°C)**: 31.6 / 22.2
- **LEAVING AIR TEMPERATURE DB/WB (°C)**: 13.7 / 13.4
- **TOTAL COOLING CAPACITY (KW)**: 36.00
- **SENSIBLE COOLING CAPACITY (KW)**: 24.00
- **WATER FLOW (L/s) @7.22°C EWT**: 1.50
- **LEAVING WATER TEMPERATURE (°C)**: 13.00
- **WATER PRESSURE DROP (kPa)**: 20.0

### HEATING COIL
- **TUBE MATERIAL / FIN MATERIAL**: CU / AL
- **ENTERING AIR TEMPERATURE DB (°C)**: 17.3
- **LEAVING AIR TEMPERATURE DB (°C)**: 23.9
- **TOTAL HEATING CAPACITY (KW)**: 16.00
- **WATER FLOW (L/s) @71.1°C EWT**: 0.27
- **LEAVING WATER TEMPERATURE (°C)**: 57.10
- **WATER PRESSURE DROP (kPa)**: 1.0
### FAN

- **Fan Type**: Centrifugal
- **Mixing Box**: Yes
- **Filter Section**: Yes
- **Face Area Filter Type “A” 51MM 30% TA**: 1.00
- **Face Area Filter Type “B” 559MM 84% TA**: 1.00

### Air Handler Unit (AHU) # 6 – 1 Each

- **Total Air Quantity (L/s)**: 2040
- **Outside Air Quantity (L/s)**: 60
- **External Static Pressure (Pa)**: 175.0
- **Total Static Pressure (Pa)**: 814.0

### Cooling Coil

- **Tube Material / Fin Material**: CU / AL
- **Entering Air Temperature DB/WB (°C)**: 26.9 / 19.3
- **Leaving Air Temperature DB/WB (°C)**: 14.6 / 13.9
- **Total Cooling Capacity (KW)**: 39.00
- **Sensible Cooling Capacity (KW)**: 30.00
- **Water Flow (L/s) @7.22°C EWT**: 1.50
- **Leaving Water Temperature (°C)**: 13.40
- **Water Pressure Drop (kPa)**: 13.0

### Heating Coil

- **Tube Material / Fin Material**: CU / AL
- **Entering Air Temperature DB (°C)**: 17.3
- **Leaving Air Temperature DB (°C)**: 23.9
- **Total Heating Capacity (KW)**: 16.00
- **Water Flow (L/s) @71.1°C EWT**: 0.27
- **Leaving Water Temperature (°C)**: 57.10
- **Water Pressure Drop (kPa)**: 1.0

---

*Sensitive but unclassified*
**FAN**

- **FAN TYPE**: CENTRIFUGAL
- **MIXING BOX**: YES
- **FILTER SECTION**: YES
- **FACE AREA FILTER TYPE “A” 51MM 30% TA**: 1.00
- **FACE AREA FILTER TYPE “B” 559MM 84% TA**: 1.00