

SECTION 23 74 33

DEDICATED OUTDOOR-AIR UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Requirements:
 - 1. Section 28 46 21.11 "Addressable Fire-Alarm Systems."

1.2 SUMMARY

- A. Section includes factory-assembled, dedicated outdoor air-handling units, including multiple components, capable of heating and cooling 100 percent outdoor air.
 - 1. Integrated Energy Recovery Unit
 - a. Casing and Cabinet
 - b. Total Energy Wheel
 - c. Dampers
 - d. Electrical and Controls
 - e. Fans
 - f. Airside Economizer
 - g. Filters
 - 2. Integrated Water Source Heat Pump Condensing Section
 - a. Casing and Cabinet
 - b. Refrigeration Circuit
 - c. Fan
 - d. Electrical and Controls
 - e. Accessories

1.3 DEFINITIONS:

- A. ECM: Electronically commutated motor.
- B. IS COP: Integrated Seasonal Coefficient of Performance.
- C. ISMRE: Integrated Seasonal Moisture Removal Efficiency.
- D. MRC: Moisture Removal Capacity.

1.4 ACTION SUBMITTALS

A. Product Data: For each dedicated outdoor-air unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include unit dimensions and weight.
4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
5. Fans:
 - a. Certified fan-performance curves with system operating conditions indicated.
 - b. Certified fan-sound power ratings.
 - c. Fan construction and accessories.
 - d. Motor ratings, electrical characteristics, and motor accessories.
6. Include certified coil-performance ratings with system operating conditions indicated.
7. Include filters with performance characteristics.
8. Include heat exchangers with performance characteristics.
9. Include dampers, including housings, linkages, and operators.

B. Shop Drawings: For each dedicated outdoor-air unit.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For dedicated outdoor-air units to include in emergency, operation, and maintenance manuals.

1.7 WARRANTY

A. Warranty: Manufacturer agrees to replace components of dedicated outdoor-air units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Dedicated Outdoor-Air-Handling Units: Three years from date of Substantial Completion.
2. Warranty Period for Compressors: Five years from date of Substantial Completion.
3. Warranty Period for Rotary Heat Exchangers: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an "NRTL" (nationally recognized testing laboratory), and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of units and components.
- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE 15 and ASHRAE 34 Compliance: For refrigeration system safety.
- E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. ASHRAE 84 Compliance: Comply with capacity ratings for heat-wheel energy-recovery equipment.
- G. UL Compliance:
 - 1. Electric Coils: Comply with requirements in UL 1995.

2.2 MANUFACTURERS

- A. Source Limitations: Obtain dedicated outdoor-air units from single manufacturer.

2.3 UNIT CASING

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Wall, Base, and Top Panels
 - 1. Air Leakage: The casing and cabinet leakage of the unit shall not exceed 1% of the design airflow of the unit when tested at 1.5 times the scheduled operating pressure.
 - 2. Construction: 1-inch thick, double wall box construction, with formed edges of exterior wall overlapping formed edges of interior wall
 - a. Exterior Wall: 24-gauge
 - b. Interior Wall: 20-gauge, Galvanized G90 sheet metal
 - 3. Insulation
 - a. Pressure injected with 2.2 pounds of polyurethane foam per cubic foot to achieve an R-6.5 value
 - b. Foam shall have an ODP value of zero, negligible GWP and VOC exempt

- c. Flame Spread Index (FSI): 25 or less, when tested in accordance with UL 723
 - d. Smoke Developed Index (SDI): 50, maximum, when tested in accordance with UL 723
- 4. Flanged duct connections, minimum 1" deep
- C. Frame: Constructed from EN AW 6060 T6 aluminum tube extrusion with a thickness of 0.07" and a tensile strength of 1,000 psi
 - 1. Cabinet Seams: Factory supplied 1/8" thick foam gasketing to be field installed between the two ERW sections
- D. Access Panels:
 - 1. Provide access to components through large and easily removable panels.
 - 2. Isolation and Seal: Form continuous, thermally isolated, weather tight seal between inner wall of panels and structural framing with P-shaped extruded neoprene

2.4 FANS, DRIVES, AND MOTORS

- A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
- B. Supply-Air Fans and Exhaust-Air Fans: Centrifugal; galvanized or painted steel; mounted on solid-steel shaft.
 - 1. Shafts: With field-adjustable alignment.
 - a. Turned, ground, and polished hot-rolled steel with keyway.
 - 2. Shaft Bearings:
 - a. Heavy-duty, self-aligning, pillow-block type with an L-50 rated life of minimum 100,000 hours in accordance with ABMA 9.
 - 3. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
 - a. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 - 4. Housings, Plenum Fans: Steel frame and panel; fabricated without fan scroll and volute housing. Provide inlet screens for Type SWSI fans.
 - 5. Backward incline, Centrifugal Fan Wheels (Plenum Fan Wheels): Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; steel hub riveted to backplate and fastened to shaft with setscrews.
 - 6. Mounting: For internal vibration isolation. Factory mount fans with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch .
 - 7. Shaft Lubrication Lines: Extended to a location outside the casing.
 - 8. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches wide, attached to two strips of minimum 2-3/4-inch- wide by 0.028-inch- thick, galvanized-steel sheet.
 - a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.
- C. Drive, Direct: Factory-mounted direct drive.

D. Motors:

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
3. Motor Type: Totally enclosed, electronically communicated (EC) .
4. Efficiency: High efficiency as defined in NEMA MG 1.
5. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
6. Mount unit-mounted disconnect switches on exterior of unit.

2.5 COILS

A. General Requirements for Coils:

1. Comply with AHRI 410.
2. Fabricate coils section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. Coils are not to act as structural component of unit.

B. Supply-Air Refrigerant Coils:

1. Tubes: Copper .
2. Fins:
 - a. Material: Aluminum .
 - b. Fin Spacing: Maximum 12 fins per inch.
3. Fin and Tube Joints: Mechanical bond.
4. Headers: Seamless-copper headers with brazed connections .
5. Frames: Galvanized steel .
6. Ratings: Designed, tested, and rated in accordance with ASHRAE 33 and AHRI 410.
 - a. Working Pressure: Minimum 300 psig.

C. Hot-Gas Reheat Refrigerant Coils:

1. Tubes: Copper .
2. Fins:
 - a. Material: Aluminum .
 - b. Fin Spacing: Maximum 12 fins per inch.
3. Fin and Tube Joints: Mechanical bond.
4. Headers: Seamless-copper headers with brazed connections .
5. Frames: Galvanized steel .
6. Ratings: Designed, tested, and rated in accordance with ASHRAE 33 and AHRI 410.
 - a. Working Pressure: Minimum 300 psig.
7. Coating: Corrosion-resistant coating.
8. Suction-discharge bypass valve.

2.6 REFRIGERATION CIRCUIT COMPONENTS

- A. Compressors: Hermetic, variable-speed scroll compressors, mounted on integral vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief.
- B. Refrigerant: R-410A .
- C. Refrigeration Specialties:
 - 1. Refrigerant filter/dryer.
 - 2. Manual-reset high-pressure safety switch.
 - 3. Automatic-reset low-pressure safety switch.
 - 4. Minimum off-time relay.
 - 5. Automatic-reset compressor motor thermal overload.
 - 6. Thermostat for coil freeze-up protection during low-ambient-temperature operation or loss of air.
 - 7. Modulating hot-gas reheat solenoid valve with a replaceable magnetic coil.

2.7 AIR FILTRATION

- A. Panel Filters:
 - 1. Description: Pleated factory-fabricated, self-supported disposable air filters with holding frames.
 - 2. Filter Unit Class: UL 900.
 - 3. Media: Interlaced glass, synthetic, or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
 - 4. Filter-Media Frame: High wet-strength beverage board with perforated metal retainer, or metal grid, on outlet side.
- B. Mounting Frames:
 - 1. Panel filters arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or from access plenum.
 - 2. Cartridge filters arranged for flat orientation, removable from access plenum.
 - 3. Galvanized or stainless steel with gaskets and fasteners, suitable for bolting together into built-up filter banks with space for prefilter.
 - 4. Provide with standard 2" MERV8, and 2" MERV13 final on outdoor air.
 - 5. Provide with 4" MERV8 on exhaust air.

2.8 ROTARY HEAT EXCHANGER

- A. Wheel: Transfer heat and humidity from one air stream to the other with minimum carryover of the exhaust air into the supply air stream. The overall energy recovery system shall meet ASHARE 90.1-2016 – Section 6.6.6.1 requirements for both the enthalpy recovery ratio and provisions to bypass or control the energy recovery system to permit airside economizer operation as required by Section 6.5.1.1. The system controls shall also provide high-limit shutoff settings for airside economizers set forth in Table 6.5.1.3 without relying upon controls external to the system and communicated over the BAS.

1. Cassette frame and structural components shall be constructed of G90 galvanized steel for corrosion resistance.
 2. Wheel structure shall consist of a welded hub, spoke and continuous rolled rim assembly of stainless steel and shall be self-supporting without energy transfer segments present.
 3. Wheel bearings shall be permanently sealed and selected for a minimum 30 Year L-10 life of 400,000 hours. Bearings requiring external grease fittings or periodic maintenance are not acceptable.
- B. Energy Wheel Media:
1. Energy transfer media shall be constructed of a durable synthetic lightweight polymer with a thickness of 3”.
- C. Wheel Effectiveness: Performance shall be AHRI 1060 certified and bear the AHRI certified label.
- D. The energy recovery cassette shall comply with NFPA 90A by virtue of UL standard 1812 and UL 900 fire test for determination of flammability and smoke density.
- E. Desiccant:
1. Desiccant shall be either silica gel or molecular sieve and permanently bonded to the energy transfer media without the use of binders or adhesives, which may degrade desiccant performance. Desiccants not permanently bonded are not acceptable due to potential delamination or erosion of the desiccant from the energy transfer media.
 2. Desiccant shall be non-migrating nor shall it dissolve or deliquesce in the presence of water or high humidity
 3. Energy transfer media shall be capable of repeated washings without significant degradation of the desiccant bond as documented by an independent third party
- F. Removeable Energy Transfer Segments:
1. Wheels shall be provided with removable energy transfer segments.
 2. Segments shall be removable without the use of tools to facilitate maintenance and cleaning.
- G. Seals:
1. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set
 2. Seals shall be non-contact nylon pile brush seal orientated in a labyrinth style configuration
 3. Diameter Seals shall be fully adjustable and easily accessible
 4. Perimeter seals shall be permanently mounted to the wheel rim and not require adjustment.
- H. Drive System:
1. The wheel drive motor shall be an UL recognized component and shall be mounted in the cassette frame and supplied with a service connector or junction box
 2. Drive motors shall be suitable for use in inverter rated applications

3. Wheels shall use a urethane stretch belt for wheel rim drive without the need for external tensioners
4. Wheel drive system shall not require periodic adjustment

2.9 DAMPERS

- A. Damper Operators: Comply with requirements in Section 23 09 50, "Building Automation System (BAS) General."
- B. Type:
 1. Motorized, 24 VAC powered, Modbus modulating, horizontal, two position parallel blade damper with blade seals.
 2. Ultra-low leakage control dampers tested in accordance with AMCA 500-D capable of withstanding system operating pressures of 13 inches w.g. while closed and a maximum leakage rate of 5 cfm at 4 inches w.g. in conformance with ASHRAE 90.1-2016 – Section 6.4.3.4.3 for low leakage requirement.
 3. Rated air velocities up to 6,000 fpm with a maximum pressure drop of 0.03 inches w.g.
 4. Frame: 6063-T5 extruded aluminum hat channel with hat mounting flanges on both sides of the frame and reinforced at corners.
 5. Blades: Airfoil-shaped, single-piece constructed of 6063-T5 extruded aluminum.
 6. Blade Edge Seals: Extruded neoprene mechanically attached and rated to between -22 to 122 degrees F.
 7. Jamb Seals: Flexible metal, compression type to prevent leakage between end of the blade and the damper frame.
- C. Cleanable with water and detergent or alkaline coil cleaner ($\leq 170^{\circ}\text{F}$) without degrading performance outside of the AHRI certified performance limits.
- D. Dampers to Include: Outdoor Air Damper (Factory Installed), Energy Wheel Bypass Damper (Factory Installed)

2.10 ELECTRICAL POWER CONNECTIONS

- A. Single-Point Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a single-point field power connection to unit .
- B. Enclosure: NEMA 250, Type 3R , mounted in unit with hinged access door in unit cabinet having a lock and key or padlock and key.
- C. Wiring: Numbered and color-coded to match wiring diagram.
- D. Wiring Location: Install factory wiring outside an enclosure in a raceway.
- E. Factory Wiring: Branch power circuit to each motor and to controls with one of the following disconnecting means:

1. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection in accordance with IEC 60947-4-1.
 2. NEMA KS 1, heavy-duty, nonfusible switch.
 3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- F. Factory-Mounted, Overcurrent-Protection Service: For each motor.
- G. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
- H. Controls: Factory wire unit-mounted controls where indicated.
- I. Control Relays: Auxiliary and adjustable time-delay relays.

2.11 CONTROLS

- A. Comply with the requirements in Section 23 09 50, "Building Automation System (BAS) General" for control equipment.
- B. A control box shall be located within the ERW module and shall contain a 75VA controls transformer, 24 VAC activated, 3 pole energy wheel drive motor contactor, 3 pole exhaust fan motor contactor, Aurora Energy Control solid-state controller and Aurora System for complete DOAS system operation. Manual electrical disconnect switches isolate the power to the motors for service. Units shall be name-plated for use with time delay fuses or HACR circuit breakers.
- C. Control Wiring: Factory wire connection for controls' power supply.
- D. Control Devices: Sensors, transmitters, relays, switches, detectors, operators, actuators, and valves shall be manufacturer's standard items to accomplish indicated control functions.
- E. Unit-Mounted Status Panel:
1. Cooling/Off/Heating Controls: Control operational mode.
 2. Damper Position: Indicate position of outdoor-air dampers in terms of percentage of outdoor air.
 3. Status Lights:
 - a. Filter dirty.
 - b. Fan operating.
 - c. Cooling operating.
 - d. Heating operating.
 - e. Smoke alarm.
 - f. General alarm.
 4. Digital Numeric Display:
 - a. Outdoor airflow.
 - b. Supply airflow.
 - c. Outdoor dry-bulb temperature.
 - d. Outdoor dew point temperature.
 - e. Space temperature.
 - f. Supply temperature.

- g. Space relative humidity.
- h. Space carbon dioxide level.

F. Refrigeration System Controls:

- 1. Unit-mounted enthalpy controller shall lock out refrigerant system when outdoor-air enthalpy is less than 28 Btu/lb of dry air or outdoor-air temperature is less than 60 deg F .
- 2. Outdoor-air sensor de-energizes dehumidifier operation when outdoor-air temperature is less than 60 deg F .
- 3. Relative-humidity sensor energizes dehumidifier operation when relative humidity is more than 50 percent.

G. Rotary Heat-Exchanger Control:

- 1. Sequence with refrigeration system controls and heating controls.
- 2. For operation of rotary heat exchanger itself, see "Rotary Heat Exchanger" Article.

H. Damper Controls: Space-pressure sensor modulates outdoor- and relief-air dampers to maintain a positive pressure in space at a minimum of 0.05 inch wg with respect to outdoor reference.

I. DDC Temperature Control: Standalone control module for link between unit controls and DDC temperature-control system. Control module shall be compatible with control system specified in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC." Links shall include the following:

- 1. Start/stop interface relay and relay to notify DDC temperature-control system alarm condition.
- 2. Hardware interface or additional sensors for the following:
 - a. Room temperature.
 - b. Discharge-air temperature.
 - c. Refrigeration system operation.

J. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display unit status and alarms.

- 1. Hardwired Points:
 - a. Monitoring: On-off status, common trouble alarm .
 - b. Control: On-off operation, supply temperature set-point adjustment .
- 2. ASHRAE 135 (BACnet) communication interface with the DDC system for HVAC shall enable the DDC system for HVAC operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel shall be available through the DDC system for HVAC.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.
- C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Unit Support: Install unit level on structural steel supports. Coordinate roof penetrations and flashing with roof construction. Secure units to structural support with anchor bolts. Coordinate sizes and locations of steel supports with actual equipment provided.
 - 1. Comply with requirements for vibration isolation and seismic-control devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."
 - 2. Comply with requirements for vibration isolation devices specified in Section 23 05 48.13 "Vibration Controls for HVAC."
- B. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.
- C. Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.
- D. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 23 33 00 "Air Duct Accessories."
- E. Install wall- and duct-mounted sensors furnished by manufacturer for field installation. Install control wiring and make final connections to control devices and unit control panel.
- F. Install separate devices furnished by manufacturer and not factory installed.
- G. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

3.3 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to units, allow space for service and maintenance.
- C. Connect piping to units mounted on vibration isolators with flexible connectors.
- D. Hydronic Piping Connections:

1. Comply with requirements in Section 23 21 13 "Hydronic Piping" and Section 23 21 16 "Hydronic Piping Specialties."
2. Install shutoff valve and union or flange on each supply connection, and install balancing valve and union or flange on each return connection.

E. Duct Connections:

1. Comply with requirements in Section 23 31 13 "Metal Ducts."
2. Drawings indicate the general arrangement of ducts.
3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section 23 33 00 "Air Duct Accessories."

3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."
 2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Section 26 05 23 "Control-Voltage Electrical Power Cables."

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
 2. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
 3. Start refrigeration system when outdoor-air temperature is within normal operating limits. and measure and record the following:

- a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
 - b. Cooling coil entering-air, dry- and wet-bulb temperatures.
 - c. Condenser coil entering-air dry-bulb temperature.
 - d. Condenser coil leaving-air dry-bulb temperature.
 4. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.
 5. Inspect casing insulation for integrity, moisture content, and adhesion.
 6. Verify that clearances have been provided for servicing.
 7. Verify that controls are connected and operable.
 8. Verify that filters are installed.
 9. Clean coils and inspect for construction debris.
 10. Inspect and adjust vibration isolators and seismic restraints.
 11. Verify bearing lubrication.
 12. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
 13. Adjust fan belts to proper alignment and tension.
 14. Start unit.
 15. Inspect and record performance of interlocks and protective devices, including response to smoke detectors by fan controls and fire alarm.
 16. Operate unit for run-in period.
 17. Calibrate controls.
 18. Adjust and inspect high-temperature limits.
 19. Inspect outdoor-air dampers for proper stroke.
 20. Verify operational sequence of controls.
 21. Measure and record the following airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Relief-air flow.
 - c. Outdoor-air flow.
 - B. After startup, change filters, verify bearing lubrication, and adjust belt tension.
 - C. Remove and replace components that do not properly operate, and repeat startup procedures as specified above.
 - D. Prepare written report of the results of startup services.
- 3.7 ADJUSTING
- A. Adjust initial temperature and humidity set points.
 - B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
 - C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.8 CLEANING

- A. After completing system installation; testing, adjusting, and balancing dedicated outdoor-air unit and air-distribution systems; and completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, casings, dampers, coils, and filter housings, and install new, clean filters.

3.9 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 74 33