SECTION 23 72 00
AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

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.

1.2 SUMMARY

A. Section Includes:

1. Heat wheels.
2. Heat-pipe heat exchangers.
3. Fixed-plate sensible heat exchangers.
4. Fixed-plate total heat exchangers.
5. Packaged energy recovery units.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: Air-to-air energy recovery equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For air-to-air energy recovery equipment. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For air-to-air energy recovery equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of air-to-air energy recovery equipment.

2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

3. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Suspended ceiling components.

2. Structural members to which equipment or suspension systems will be attached.

B. Seismic Qualification Certificates: For air-to-air energy recovery equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-to-air energy recovery equipment to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set(s) of each type of filter specified.

2. Fan Belts: One set(s) of belts for each belt-driven fan in energy recovery units.

3. Wheel Belts: One set(s) of belts for each heat wheel.

1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ARI Compliance:

1. Capacity ratings for air-to-air energy recovery equipment shall comply with ARI 1060, "Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment."

2. Capacity ratings for air coils shall comply with ARI 410, "Forced-Circulation Air- Cooling and Air-Heating Coils."

C. ASHRAE Compliance:

1. Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

2. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."

D. NRCA Compliance: Roof curbs for roof-mounted equipment shall be constructed according to recommendations of NRCA.

E. UL Compliance:

1. Packaged heat recovery ventilators shall comply with requirements in UL 1812, "Ducted Heat Recovery Ventilators"; or UL 1815, "Nonducted Heat Recovery Ventilators."

2. Electric coils shall comply with requirements in UL 1995, "Heating and Cooling Equipment."

1.9 COORDINATION

A. Coordinate layout and installation of air-to-air energy recovery equipment and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of air-to-air energy recovery equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Packaged Energy Recovery Units: Two years.

2. Warranty Period for Fixed-Plate Total Heat Exchangers: 10 years.

PART 2 - PRODUCTS

2.1 HEAT WHEELS

A. Casing:

1. Steel with standard factory-painted finish.

2. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg differential pressure.

3. Casing seals on periphery of rotor and on duct divider and purge section.

4. Support vertical rotors on grease-lubricated ball bearings having extended grease fittings or permanently lubricated bearings. Support horizontal rotors on tapered roller bearing.

B. Rotor: Aluminum segmented wheel strengthened with radial spokes, with nontoxic, noncorrosive, silica-gel desiccant coating.

1. Maximum Solid Size for Media to Pass: 800 micrometer.

C. Rotor: Glass-fiber segmented wheel strengthened with radial spokes impregnated with nonmigrating, water-selective, molecular-sieve desiccant coating.

1. Maximum Solid Size for Media to Pass: 800 micrometer.

D. Drive: Fractional horsepower motor and gear reducer, with speed changed by variable frequency controller and self-adjusting multilink belt around outside of rotor.

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 26.

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.

E. Controls:

1. Starting relay, factory mounted and wired, and manual motor starter for field wiring.

2. Variable frequency controller, factory mounted and wired, permitting input of field connected 4-20 mA or 1-10-V control signal.

3. Variable frequency controller, factory mounted and wired, with exhaust-air sensor to vary rotor speed and maintain exhaust temperature above freezing.

4. Variable frequency controller, factory mounted and wired, with exhaust- and outdoor-air sensors, automatic changeover thermostat and set-point adjuster, to vary rotor speed and maintain exhaust temperature above freezing and air differential temperature above set point. Rotor speed shall increase to maximum when exhaust-air temperature is less than outdoor-air temperature.

5. Pilot-Light Indicator: Display rotor rotation and speed.

6. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.

F. Disposable Panel Filters:

1. Comply with NFPA 90A.

2. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.

3. Factory-fabricated, viscous-coated, flat-panel type.

4. Thickness: 2 inches

5. Minimum Arrestance: 80, according to ASHRAE 52.1.

6. MERV: 5, according to ASHRAE 52.2.

7. Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.

8. Frame: Galvanized steel with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.

G. Extended-Surface, Disposable Panel Filters:

1. Comply with NFPA 90A.

2. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.

3. Factory-fabricated, dry, extended-surface type.

4. Thickness: 2 inches.

5. Minimum Arrestance: 90, according to ASHRAE 52.1.

6. MERV: 7, according to ASHRAE 52.2.

7. Media: Fibrous material formed into deep-V-shaped pleats with antimicrobial agent and held by self-supporting wire grid.

8. Media-Grid Frame: Nonflammable cardboard.

9. Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.

H. Extended-Surface, Nonsupported-Media Filters:

1. Comply with NFPA 90A.

2. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.

3. Factory-fabricated, dry, extended-surface, self-supporting type.

4. Minimum Arrestance: 95, according to ASHRAE 52.1.

5. MERV: 13, according to ASHRAE 52.2.

6. Media: Fibrous material constructed so individual pleats are maintained in tapered form by flexible internal supports under rated-airflow conditions and antimicrobial agent.

7. Filter-Media Frame: Galvanized steel.

8. Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks with space for prefilter.

2.2 PACKAGED ENERGY RECOVERY UNITS

A. Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

B. Housing: Manufacturer's standard construction with corrosion-protection coating and exterior finish, hinged access doors with neoprene gaskets for inspection and access to internal parts, minimum 2-inch- thick thermal insulation, knockouts for electrical and piping connections, exterior drain connection, and lifting lugs.

1. Inlet: Weatherproof hood and louver, with damper for exhaust and supply.

a. Exhaust: Spring-return, two-position, motor-operated damper.
b. Supply: Spring-return, two-position, motor-operated damper.

2. Roof Curb: Refer to Section 07 72 00 "Roof Accessories" for roof curbs and equipment supports.

C. Heat Recovery Device: Heat wheel.

D. Supply and Exhaust Fans: Forward-curved, centrifugal, SWSI centrifugal fan with spring isolators and flexible duct connections.

1. Motor and Drive: Drive type indicated on Drawings.

2. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors as scheduled.

3. 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.

4. Spring isolators on each fan having 1-inch static deflection.

E. Disposable Panel Filters:

1. Comply with NFPA 90A.

2. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.

3. Factory-fabricated, viscous-coated, flat-panel type.

4. Thickness: 2 inches.

5. Minimum Arrestance: 80, according to ASHRAE 52.1.

6. MERV: 5, according to ASHRAE 52.2.

7. Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.

8. Frame: Galvanized steel with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.

F. Extended-Surface, Disposable Panel Filters:

1. Comply with NFPA 90A.

2. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.

3. Factory-fabricated, dry, extended-surface type.

4. Thickness: 2 inches.

5. Minimum Arrestance: 90, according to ASHRAE 52.1.

6. MERV: 7, according to ASHRAE 52.2.

7. Media: Fibrous material formed into deep-V-shaped pleats with antimicrobial agent] and held by self-supporting wire grid.

8. Media-Grid Frame: Nonflammable cardboard.

9. Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.

G. Extended-Surface, Nonsupported-Media Filters:

1. Comply with NFPA 90A.

2. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.

3. Factory-fabricated, dry, extended-surface, self-supporting type.

4. Minimum Arrestance: 95, according to ASHRAE 52.1.

5. MERV: 13, according to ASHRAE 52.2.

6. Media: Fibrous material constructed so individual pleats are maintained in tapered form by flexible internal supports under rated-airflow conditions and antimicrobial agent.

7. Filter-Media Frame: Galvanized steel.

8. Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks with space for prefilter.

H. Cooling Coils: Rated according to ARI 410 and ASHRAE 33, and bearing the ARI label.

1. Access: Fabricate coil section to allow removal and replacement of coil and to allow in-place access for service and maintenance of coil(s).

2. Casing: Galvanized steel.

3. Tubes: Copper

4. Tube Headers: Copper.

5. Fins: Aluminum.

6. Fin and Tube Joint: Mechanical bond.

7. Leak Test: Coils shall be leak tested with air under water.

8. Refrigerant Coils:

a. Capacity Reduction: Circuit coils for interleaved control.
b. Suction and Distributor: Seamless copper tube with brazed joints.

9. Coating: Phenolic epoxy corrosion-protection coating after assembly.

I. Cooling-Coil Condensate Drain Pans:

1. Fabricated from stainless-steel sheet and sloped in multiple planes to collect and drain condensate from cooling coils, coil piping connections, coil headers, and return bends.

2. Complying with requirements in ASHRAE 62.1.

3. Drain Connections: At low point of pan with minimum 1-inch threaded nipple.

4. Units with stacked coils shall have an intermediate drain pan to collect and drain condensate from top coil.

J. Electrical Coils, Controls, and Accessories: Comply with UL 1995.

1. Casing Assembly: Flanged type with galvanized-steel frame.

2. Access: Fabricate coil section to allow removal and replacement of coil and to allow in-place access for service.

3. Sheathed Heating Elements: Coiled resistance wire of 80 percent nickel and 20 percent chromium surrounded by compacted magnesium-oxide powder in tubular-steel sheath; with spiral-wound, copper-plated, steel fins continuously brazed to sheath.

4. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.

5. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.

6. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.

7. Control Panel: Unit mounted with disconnecting means and overcurrent protection.

a. Magnetic contactor.
b. Solid-state, stepless pulse controller.
c. Toggle switches, one per step.
d. Step controller.
e. Time-delay relay.
f. Pilot lights, one per step.
g. Airflow proving switch.

K. Indirect-Fired Gas Furnaces:

1. Description: Factory assembled, piped, and wired; complying with NFPA 54, "National Fuel Gas Code," and ANSI Z21.47, "Gas-Fired Central Furnaces."

a. AGA Approval: Furnace shall bear label of AGA.

2. Burners: Aluminized steel with stainless-steel inserts.

a. Ignition: Electronically controlled electric spark with flame sensor.

3. Heat-Exchanger Drain Pan: Stainless steel.

4. Venting: Gravity vented.

5. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.

6. Gas Control Valve: Electronic modulating.

7. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff. Control devices and control sequence shall comply with requirements of IRI.

8. Access: Fabricate section to allow removal and replacement of furnace and to allow in-place access for service.

L. Piping and Wiring: Fabricate units with space within housing for piping and electrical conduits. Wire motors and controls so only external connections are required during installation.

1. Indoor Enclosure: NEMA 250, Type 12 enclosure contains relays, starters, and terminal strip.

2. Outdoor Enclosure: NEMA 250, Type 3R enclosure contains relays, starters, and terminal strip.

3. Include nonfused disconnect switches.

4. Variable-speed controller to vary fan capacity from 100 to approximately 50 percent.

M. Accessories:

1. Roof Curb: Galvanized steel with gasketing, and factory-installed wood nailer; complying with NRCA standards; minimum height of 14 inches.

2. Intake weather hood with 2-inch- (50-mm-) thick filters.

3. Louvered intake weather hood with 2-inch- (50-mm-) thick filters in V-bank configuration.

4. Exhaust weather hood with birdscreen.

5. Low-Leakage, Isolation Dampers: Double-skin, airfoil-blade, extruded-aluminum dampers with compressible jamb seals and extruded-vinyl blade edge seals, in opposed-blade arrangement with cadmium-plated steel operating rods rotating in stainless-steel sleeve and sintered bronze or nylon bearings mounted in a single extruded-aluminum frame, with operating rods connected with a common linkage, and electric damper operator factory wired. Leakage rate shall not exceed 5 cfm/sq. ft. at 1-inch wg and 9 cfm/sq. ft. at 4-inch wg.

6. Isolation Dampers: Opposed-blade, extruded-aluminum] dampers with cadmium-plated] steel operating rods rotating in sintered bronze or nylon bearings mounted in a single extruded-aluminum frame with operating rods connected with a common linkage, and electric damper operator factory wired. Blades shall have gaskets and edge seals, and shall be mechanically fastened to operating rod.

7. Duct flanges.

8. Rubber-in-shear isolators for ceiling-mounted units.

9. Hinged access doors with quarter-turn latches.

10. Drain pans for condensate removal complying with ASHRAE 62.1.

11. Automatic, in-place, spray-wash system.

12. Weatherproofing for tilt-control system.

2.3 CONTROLS

A. Refrigerant-Cooling-Coils Controls:

1. Factory-mounted sensor in unit discharge or Remote-mounted sensor for field installation in supply-air duct with sensor adjustment located in control panel to control remote condensing unit to maintain temperature.

2. Wall-mounted, space-temperature sensor with unit-mounted temperature adjustment controls remote condensing unit to maintain temperature.

3. Cooling Capacity Control: Multiple steps.

B. Electric-Coils Controls:

1. Factory-mounted sensor in unit discharge or Remote-mounted sensor for field installation in supply-air duct with sensor adjustment located in control panel to control electric coil to maintain temperature.

2. Wall-mounted, space-temperature sensor with unit-mounted temperature adjustment to control electric coil to maintain temperature.

3. Coil Controls: Modulating SCR.

C. Indirect-Fired-Gas-Furnaces Controls:

1. Factory-mounted sensor in unit discharge or Remote-mounted sensor for field installation in supply-air duct with sensor adjustment located in control panel to control gas furnace burner to maintain temperature.

2. Wall-mounted, space-temperature sensor with adjustment on remote-control panel to control gas furnace burner to maintain temperature.

3. Burner Controls Modulating.

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 casing insulation materials and filter media before air-to-air energy recovery equipment installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for electrical services to verify actual locations of connections before installation.

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

3.2 INSTALLATION

A. Install heat wheels so supply and exhaust airstreams flow in opposite directions and rotation is away from exhaust side to purge section to supply side.

1. Install access doors in both supply and exhaust ducts, both upstream and downstream, for access to wheel surfaces, drive motor, and seals.

2. Install removable panels or access doors between supply and exhaust ducts on building side for bypass during startup.

3. Access doors and panels are specified in Section 23 33 00 "Air Duct Accessories."

B. Install heat-pipe heat exchangers so supply and exhaust airstreams flow in opposite directions. Install flexible connectors on ducts to enable tilt control; make connections airtight and with slack to compensate for full tilt.

1. Install heat exchanger with clearance space for heat-pipe coil removal.

2. Install duct access doors in both supply and exhaust ducts, both upstream and downstream, for access to both sides of heat-pipe coil. Access doors and panels are specified in Section 23 33 00 "Air Duct Accessories."

3. Install tilt-control components, including electronic controller, electric actuator and linkage, thermostats, and sensors.

C. Install fixed-plate heat exchangers so supply and exhaust airstreams flow in opposite directions.

1. Install duct access doors in both supply and exhaust ducts, both upstream and downstream, for access to heat exchanger. Access doors and panels are specified in Section 23 33 00 "Air Duct Accessories."

D. Install gas-fired furnaces according to NFPA 54, "National Fuel Gas Code."

E. Install floor-mounted units on 4-inch- (100-mm-) high concrete base designed to withstand, without damage to equipment, seismic force required by code.

F. Equipment Mounting:

1. Install air-to-air energy recovery equipment on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."

G. Roof Curb: Install on roof structure or concrete base, level and secure, according to The NRCA "Roofing and Waterproofing Manual - Volume 4: Construction Details - Low-Slope Roofing," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts.". Install air-to-air energy recovery equipment on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 07 72 00 "Roof Accessories." Secure air-to-air energy recovery equipment to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

H. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure air-to-air energy recovery equipment to structural support with anchor bolts.

I. Suspended Units: Suspend and brace units from structural-steel support frame using threaded steel rods and spring hangers. Provide manufacturer's standard elastomeric isolation supports.

J. Install units with clearances for service and maintenance.

K. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

L. Pipe drains from drain pans to nearest floor drain; use ASTM B 88, Type L, drawn-temper copper water tubing with soldered joints, same size as condensate drain connection.

M. Pipe drains from drain pans to nearest floor drain; use ASTM D 1785, Schedule 40 PVC pipe and solvent-welded fittings, same size as condensate drain connection.

1. Requirements for Low-Emitting Materials:

a. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

b. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Requirements for Low-Emitting Materials: Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 23 21 13 "Hydronic Piping" and Section 23 21 16 Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to unit to allow service and maintenance.

C. Connect piping to units mounted on vibration isolators with flexible connectors.

D. Connect cooling condensate drain pans with air seal trap at connection to drain pan and install cleanouts at changes in pipe direction.

E. Refrigerant Piping: Comply with applicable requirements in Section 23 23 00 "Refrigerant Piping."

F. Gas Piping: Comply with requirements in Section 23 11 23 "Facility Natural-Gas Piping." Connect gas piping with shutoff valve and union and with sufficient clearance for burner removal and service. Make connection with AGA-approved flexible connectors.

G. Comply with requirements for ductwork specified in Section 23 31 13 "Metal Ducts."

H. Install electrical devices furnished with units but not factory mounted.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

2. Adjust seals and purge.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

4. Set initial temperature and humidity set points.

5. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

D. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-to-air energy recovery units.

END OF SECTION

SECTION 23 81 13
PACKAGED TERMINAL AIR-CONDITIONERS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide all labor, material, services and appurtenances necessary for the installation of the following equipment:

1. Packaged A/C units (DX, ELEC) in the Raw Water Intake Building

2.01 SUBMITTALS

A. Submit catalog data, shop drawings and installation instructions prior to commencement of work for all materials and equipment incorporated into the drawings and specified herein.

PART 2 - PRODUCTS

A. General: All controls, contactors, and overload protection for fan motors, compressors, heaters, etc., shall be an integral part of the unit.

The unit cabinet shall have 60" width, 94" height, 37.88" depth. Standard unit cabinet shall be constructed of 16-gauge hot-dipped galvanized steel that has been powder coated. Powder coat shall be a TGIC polyester powder coat with a minimum of 4 mils thickness. The unit cabinet shall be internally acoustically insulated with 1.0" closed cell Armaflex and provided with stainless steel access fasteners on removable doors.

Evaporator section of the unit shall be constructed of 16-gauge hot dipped galvanized steel with a cooling coil constructed of aluminum fins mechanically joined to seamless copper tubing. The evaporator coil shall be dual-circuited with two separated refrigerant circuits. Each circuit shall be equipped with service valves, a sight glass, moisture indicator and fully-adjustable expansion valves. A full-area stainless steel drain pan with auxiliary overflow shall be provided.

Compressor/condenser section shall be constructed of hot-dipped galvanized steel with two 7.5 ton compressors and two 7.5 ton condenser circuits complete with service valves on each circuit. The condenser coil is to be constructed of aluminum fins mechanically joined to seamless copper tubing.

Supply air blowers in the unit shall be two DWDI backwardly inclined blower assemblies driven by a common double-shafted motor and packaged in a 16-gauge hot-dipped galvanized assembly.

The unit shall be equipped with a unitized control system with the following features: Unit shall have two-stage cooling and heating control with ± 0.25°F accuracy, 65°F – 95°F set point, three-point system fan switch (fan only, heat/cool cycle operation, and continuous fan cooling) and a control Power-On indicator lamp. System control thermostat shall have a digital readout of the system status, a power on/off switch, and remote/local control status indicating lamps.

The cooling system shall have high and low refrigerant pressure overloads, condenser and evaporator fan overloads with automatic reset on all overload conditions, electric heat, high temperature overload, compressor overloads, compressor short time delays, defrost cycle with control system defrost, and refrigeration system failure lights with Form C alarm contacts. The entire unit shall be designed and constructed with all major system assemblies designed in utilized assemblies that may be easily and quickly repaired by service personnel with minimum down time in the operation of the system.

Accessories shall include the following items:

1. Low ambient controls for operation down to 0 degrees F. Manufacturer shall provide low ambient controls if standard unit is not capable of 0 degrees F operation.
2. Full economizer section.
3. Multiplexer controls for four units.
4. Unit mounted disconnect.
5. Provide 3 spare sets of filters (turn over to owner).
6. Provide compressor anti-short cycle protection.

Provide Specific Systems AirPAK Model 180 units or preapproved equal.

PART 3 - EXECUTION

3.01 GENERAL

A. Install and startup per manufacturer's instructions.

B. Slab mounted packaged air conditioning units shall be set on 6" high concrete base, observe manufacturer's spacing requirements.

END OF SECTION

SECTION 23 81 13.12
PACKAGED TERMINAL AIR-CONDITIONERS, FREESTANDING 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.

1.2 SUMMARY

A. Section includes packaged, terminal, freestanding air conditioners.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For packaged, terminal air conditioners.

1. Include plans, elevations, sections, details for wall penetrations, seismic bracing, and attachments to other work.

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.

C. Color Samples: For unit cabinet, discharge grille, and exterior louver, and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For packaged, terminal air conditioners, for tests performed by manufacturer and witnessed by a qualified testing agency.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged, terminal air conditioners to include in emergency, operation, and maintenance manuals.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of packaged, terminal air conditioners that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Sealed Refrigeration System: Manufacturer's standard, but not less than five years from date of Substantial Completion, including components and labor.

2. Warranty Period for Nonsealed System Parts: Manufacturer's standard, but not less than five years from date of Substantial Completion, including only components and excluding labor.

3. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Description: Factory-assembled and -tested, self-contained, packaged, terminal air conditioner with room cabinet, electric refrigeration system, heating, and temperature controls; fully charged with refrigerant and filled with oil; with hardwired chassis.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

E. ASHRAE Thermal Comfort: Applicable requirements in ASHRAE 55.

F. UL listed and ETL performance certified.

2.2 CHASSIS

A. Cabinet: 0.052-inch- thick powder-coated steel with removable front panel with concealed latches.

1. Discharge Grille: Extruded-aluminum discharge grille, tamperproof, and carrying a flame test rating in accordance with UL standard 494.

2. Louvers: Extruded aluminum with enamel finish color.

3. Finish: Baked enamel.

4. Access Door: Hinged door in top of cabinet for access to controls.

5. Cabinet Extension: Matching cabinet in construction and finish, allowing diversion of airflow to adjoining room; with grille.

6. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

7. Electrical Subbase: Enameled steel with four adjustable leveling feet and adjustable end plates, with factory-installed and -wired, fused disconnect switch and receptacle sized for unit.

8. Wall Sleeves: Galvanized steel with powder coated paint.

B. Refrigeration System: Direct-expansion indoor coil with capillary restrictor and hermetically sealed scroll compressor with vibration isolation and overload protection.

1. Indoor and Outdoor Coils: Seamless copper tubes mechanically expanded into aluminum fins with capillary tube distributor on indoor coil.

2. Accumulator.

3. Constant-pressure expansion valve.

4. Reversing valve.

5. Charge: R-410A.

C. Indoor Fan: Forward curved, centrifugal; with single-speed motor and positive-pressure ventilation damper with electric operator.

D. Filters: Washable polyurethane in molded plastic frame.

E. Condensate Drain: Drain pan and piping to direct condensate to building waste and vent piping.

1. Comply with ASHRAE 62.1 for drain pan construction and connections.

F. Outdoor Fan: Forward curved, centrifugal or propeller type with separate motor.

1. Indoor and Outdoor Fan Motors: Two speed; comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements as scheduled.

a. Fan Motors: Permanently lubricated split capacitor.

b. 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.

c. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

2.3 HEATING

A. Electric-Resistance Heating Coil: Nickel-chromium-wire, electric-resistance heating elements with contactor and high-temperature-limit switch.

B. Gas Heat:

1. General Requirements for Gas-Fired, Noncondensing Furnaces: Factory assembled, piped, wired, and tested; complying with ANSI Z21.86/CSA 2.32, "Vented Gas-Fired Space Heating Appliances," and with NFPA 54.

2. Type of Gas: Natural.

3. Heat Exchanger: Aluminized steel.

4. Burner:

a. Gas Valve: 100 percent safety, modulating main gas valve; main shutoff valve; pressure regulator; safety pilot with electronic flame sensor; limit control; transformer; and combination ignition/fan timer control board.

b. Ignition: Electric pilot ignition with hot-surface igniter or electric spark ignition.

5. Gas-Burner Safety Controls:

a. Electronic Flame Sensor: Prevents gas valve from opening until pilot flame is proven; stops gas flow on ignition failure.

b. Flame Rollout Switch: Installed on burner box; prevents burner operation.

c. Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.

6. Combustion-Air Inducer: Centrifugal fan prepurges heat exchanger and vents combustion products; thermally protected motor includes sleeve bearings; pressure switch prevents operation if combustion-air inlet or flue outlet is blocked.

7. Furnace Controls: Solid-state board for integrating ignition, heat, cooling, and fan speeds; adjustable fan-on and fan-off timing; and terminals for connection to accessories.

2.4 CONTROLS

A. Control Module: Unit-mounted digital panel with touchpad temperature control and with touchpad for heating, cooling, and fan operation. Include the following features:

1. Low-Ambient Lockout Control: Prevents cooling-cycle operation below 40 deg F outdoor air temperature.

2. Heat-Pump Ambient Control: Field-adjustable switch changes to heat-pump heating operation above 40 deg F and to supplemental heating below plus 25 deg F.

3. Temperature-Limit Control: Prevents occupant from exceeding preset setback or setup temperature.

4. Building Automation System Interface: Allows remote on-off control with setback temperature control.

5. Reverse-Cycle Defrost: Solid-state sensor monitors frost buildup on indoor coil and reverses unit to melt frost.

B. Remote Control: Standard unit-mounted controls with remote-mounted, low-voltage, adjustable thermostat with heat anticipator; heat-off-cool-auto switch; and on-auto fan switch.

C. Outdoor Air: Motorized intake damper. Open intake when unit indoor-air fan runs.

D. Outdoor Air: Manual intake damper.

2.5 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Factory test to comply with AHRI 300, "Sound Rating and Sound Transmission Loss of Packaged Terminal Equipment."

B. Unit Performance Ratings: Factory test to comply with AHRI 310/380/CSA C744, "Packaged Terminal Air-Conditioners and Heat Pumps."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb, maintaining manufacturer's recommended clearances and tolerances.

B. Install exterior louver in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Section 07 92 00 "Joint Sealants."

C. Install and anchor exterior louver to withstand, without damage to equipment and structure, seismic forces required by building code.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 23 21 13 "Hydronic Piping" and Section 23 21 16 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements for piping specified in Section 23 11 23 "Facility Natural-Gas Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

C. Install piping adjacent to machine to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.

2. After installing packaged, terminal air conditioners and after electrical circuitry has been energized, test for compliance with requirements.

3. Unit is level on base and is flashed in exterior wall.

4. Unit casing has no visible damage.

5. Compressor, air-cooled condenser coil, and fans have no visible damage.

6. Labels are clearly visible.

7. Controls are connected and operable.

8. Shipping bolts, blocks, and tie-down straps are removed.

9. Filters are installed and clean.

10. Drain pan and drain line are installed correctly.

11. Electrical wiring installation complies with manufacturer's submittal and installation requirements in electrical Sections.

12. Installation: Perform startup checks according to manufacturer's written instructions, including the following:

    a. Lubricate bearings on fan.

    b. Check fan-wheel rotation for correct direction without vibration and binding.

13. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

14. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. After performance test, change filters.

E. Packaged, terminal air conditioners will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged, terminal air conditioners.

END OF SECTION

SECTION 23 81 26
SPLIT-SYSTEM AIR-CONDITIONERS

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.

1.2 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set(s) for each air-handling unit.

2. Gaskets: One set(s) for each access door.

3. Fan Belts: One set(s) for each air-handling unit fan.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 03 30 00 "Cast-in-Place Concrete."

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: One year(s) from date of Substantial Completion.

b. For Parts: One year(s) from date of Substantial Completion.
c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS (NOT USED)

2.2 INDOOR UNITS (5 TONS OR LESS)

A. Concealed Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.

2. Insulation: Faced, glass-fiber duct liner.

3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.

4. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; with a two-position control valve.

5. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.

6. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.

7. Fan Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
c. Wiring Terminations: Connect motor to chassis wiring with plug connection.

8. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

9. Filters: Permanent, cleanable.

10. Condensate Drain Pans:

a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
2) Depth: A minimum of 2 inches deep.

b. Single-wall, stainless-steel sheet.
c. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
d. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

1) Minimum Connection Size: **NPS 1**.

e. Pan-Top Surface Coating: Asphaltic waterproofing compound.
f. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

B. Floor-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect.

a. Discharge Grille: Steel with surface-mounted frame.
b. Insulation: Faced, glass-fiber duct liner.
c. Drain Pans: Galvanized steel, with connection for drain; insulated.

2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.

3. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; with a two-position control valve.

4. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.

5. Fan: Direct drive, centrifugal, with power-induced outside air.

6. Fan Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements scheduled.
b. Multitapped, multispeed with internal thermal protection and permanent lubrication.

7. Air Filtration Section:

a. General Requirements for Air Filtration Section:

1) Comply with NFPA 90A.
2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

b. Disposable Panel Filters:

1) Factory-fabricated, viscous-coated, flat-panel type.
2) Thickness: 1 inch.
3) Arrestance according to ASHRAE 52.1: 80.
4) Merv according to ASHRAE 52.2: 5.
5) Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.
6) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

C. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.

2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.

3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.

4. Fan: Direct drive, centrifugal.

5. Fan Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements scheduled.

b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
c. Enclosure Type: Totally enclosed, fan cooled.
d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
f. Mount unit-mounted disconnect switches on exterior or interior of unit.

6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

7. Condensate Drain Pans:

a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
2) Depth: A minimum of 1 inch deep.

b. Single-wall, stainless-steel sheet.
c. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.

d. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

1) Minimum Connection Size: NPS 1.

e. Pan-Top Surface Coating: Asphaltic waterproofing compound.

8. Air Filtration Section:

a. General Requirements for Air Filtration Section:

1) Comply with NFPA 90A.
2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

2.3 INDOOR UNITS (6 TONS OR MORE)

A. Concealed Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.

2. Insulation: Faced, glass-fiber duct liner.

3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.

4. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; with a two-position control valve.

5. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.

6. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.

7. Fan Motors:

   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements scheduled.
   b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
   c. Three-phase, permanently lubricated, ball-bearing motors with built-in thermal-overload protection.
   d. Wiring Terminations: Connect motor to chassis wiring with plug connection.

8. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

9. Filters: 1 inch thick, in fiberboard frames.

10. Condensate Drain Pans:

    a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
2) Depth: A minimum of 2 inches deep.

b. Single-wall, stainless-steel sheet.
c. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
d. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on [one end of pan.

1) Minimum Connection Size: NPS 1.

e. Pan-Top Surface Coating: Asphaltic waterproofing compound.
f. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

B. Floor-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect.

a. Discharge Grille: Steel with surface-mounted frame.
b. Insulation: Faced, glass-fiber duct liner.

2. Condensate Drain Pans:

a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.

2) Depth: A minimum of 2 inches deep.

b. Single-wall, stainless-steel sheet.
c. Double-wall, stainless]-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
d. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

1) Minimum Connection Size: NPS 1.

e. Pan-Top Surface Coating: Asphaltic waterproofing compound.

f. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.

4. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; with a two-position control valve.

5. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.

6. Fan: Direct drive, centrifugal, with power-induced outside air.

7. Fan Motors:

   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
   c. Enclosure Type: Totally enclosed, fan cooled.
   d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
   e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
   f. Mount unit-mounted disconnect switches on exterior or interior of unit.

8. Air Filtration Section:

   a. General Requirements for Air Filtration Section:

      1) Comply with NFPA 90A.
      2) Minimum Arrestance: According to ASHRAE 52.1 and a MERV according to ASHRAE 52.2.
      3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

C. Variable-Frequency Controllers:

1. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, three-phase induction motor by adjusting output voltage and frequency.

2. Output Rating: Three-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

3. Unit Operating Requirements:

    a. Input-frequency tolerance of 06/11 Hz, plus or minus 6 percent.
    b. Minimum Efficiency: 96 percent at 60 Hz, full load.
    c. Minimum Displacement Primary-Side Power Factor: 96 percent.
    d. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
    e. Starting Torque: 100 percent of rated torque or as indicated.
    f. Speed Regulation: Plus or minus 1 percent.

4. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.

5. Internal Adjustability Capabilities:

    a. Minimum Speed: 5 to 25 percent of maximum rpm.
    b. Maximum Speed: 80 to 100 percent of maximum rpm.
    c. Acceleration: 2 seconds to a minimum of 22 seconds.
    d. Deceleration: 2 seconds to a minimum of 22 seconds.
    e. Current Limit: 50 percent to a minimum of 110 percent of maximum rating.

6. Self-Protection and Reliability Features:

    a. Input transient protection by means of surge suppressors.
    b. Undervoltage and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
    c. Adjustable motor overload relays capable of NEMA ICS 2, Class 30 performance.
    d. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
    e. Instantaneous line-to-line and line-to-ground overcurrent trips.
    f. Loss-of-phase protection.
    g. Reverse-phase protection.
    h. Short-circuit protection.
    i. Motor overtemperature fault.

7. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for

manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads, spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

8. Power-Interruption Protection: Prevents motor from re-energizing after a power interruption until motor has stopped.

9. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

10. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back, based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

11. Door-mounted, digital status lights shall indicate the following conditions:

    a. Power on.
    b. Run.
    c. Overvoltage.
    d. Line fault.
    e. Overcurrent.
    f. External fault.

12. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual-speed-control potentiometer and elapsed-time meter.

13. Meters or digital readout devices and selector switch, mounted flush in controller door and connected, to indicate the following controller parameters:

    a. Output frequency (Hertz).
    b. Motor speed (rpm).
    c. Motor status (running, stop, fault).
    d. Motor current (amperes).
    e. Motor torque (percent).
    f. Fault or alarming status (code).
    g. Proportional-integral-derivative feedback signal (percent).
    h. DC-link voltage (volts dc).
    i. Set-point frequency (Hertz).
    j. Motor output voltage (volts).

14. Control Signal Interface:

a. Electric Input Signal Interface: A minimum of two analog inputs (0 to 10 V or 0/4-20 mA) and six programmable digital inputs.

b. Remote signal inputs capable of accepting any of the following speed-setting input signals from the control system:
   1) 0 to 10-V dc.
   2) 0-20 or 4-20 mA.
   3) Potentiometer using up/down digital inputs.
   4) Fixed frequencies using digital inputs.
   5) RS485.
   6) Keypad display for local hand operation.

c. Output signal interface with a minimum of one analog output signal (0/4-20 mA), which can be programmed to any of the following:

   1) Output frequency (Hertz).
   2) Output current (load).
   3) DC-link voltage (volts dc).
   4) Motor torque (percent).
   5) Motor speed (rpm).
   6) Set-point frequency (Hertz).

d. Remote indication interface with a minimum of two dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

   1) Motor running.
   2) Set-point speed reached.
   3) Fault and warning indication (overtemperature or overcurrent).
   4) High- or low-speed limits reached.

15. Communications: RS485 interface allows VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.

16. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.

17. Accessories:

   a. Devices shall be factory installed in controller enclosure unless otherwise indicated.
   b. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
   c. Standard Displays:

1) Output frequency (Hertz).
2) Set-point frequency (Hertz).
3) Motor current (amperes).
4) DC-link voltage (volts dc).
5) Motor torque (percent).
6) Motor speed (rpm).
7) Motor output voltage (volts).

2.4 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

   a. Compressor Type: Scroll.
   b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
   c. Refrigerant Charge: R-410A.
   d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.

3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.

4. Fan: Aluminum-propeller type, directly connected to motor.

5. Motor: Permanently lubricated, with integral thermal-overload protection.

6. Low Ambient Kit: Permits operation down to 45 deg F

7. Mounting Base: Polyethylene.

2.5 OUTDOOR UNITS (6 TONS (21 kW) OR MORE)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

   a. Compressor Type: Scroll.
   b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
   c. Refrigerant Charge: R-410A.
   d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.

3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.

4. Fan: Aluminum-propeller type, directly connected to motor.

5. Motor: Permanently lubricated, with integral thermal-overload protection.

6. Low Ambient Kit: Permits operation down to 45 deg F

7. Mounting Base: Polyethylene.

2.6 ACCESSORIES

A. Control equipment and sequence of operation are specified in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC."

B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

C. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:

   1. Compressor time delay.

   2. 24-hour time control of system stop and start.

   3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.

   4. Fan-speed selection including auto setting.

D. Automatic-reset timer to prevent rapid cycling of compressor.

E. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

F. Drain Hose: For condensate.

G. Additional Monitoring:

1. Monitor constant and variable motor loads.

2. Monitor variable-frequency-drive operation.

3. Monitor economizer cycle.

4. Monitor cooling load.

5. Monitor air distribution static pressure and ventilation air volumes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 07 72 00 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

D. Equipment Mounting:

1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."

2. Install ground-mounted, compressor-condenser components on polyethylene mounting base.

3. Comply with manufacturer’s requirements for vibration isolation devices.

E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Water Coil Connections: Comply with requirements specified in Section 23 21 13 "Hydronic Piping" and Section 23 21 16 Hydronic Piping Specialties." Connect hydronic piping to supply and return coil

connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

2. Remote, Water-Cooled Condenser Connections: Comply with requirements specified in Section 23 21 13 "Hydronic Piping" and Section 23 21 16 Hydronic Piping Specialties." Connect hydronic piping to supply and return connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Duct Connections: Duct installation requirements are specified in Section 23 31 13 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 23 33 00 "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

SECTION 23 81 27
SPLIT-SYSTEM VRF AIR-CONDITIONERS

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.

1.2 SUMMARY

A. Section includes design, performance criteria, refrigerants, and installation requirements for air cooled split condensing units. Detail specifications are written around products by Daikin. Drawing detailing and equipment calls represent Mitsubishi equipment. Acceptable equipment will be from either manufacturer or other pre-approved equal. All VRF equipment shall be by a single manufacturer and shall incorporate that manufacturer's detail equipment requirements and refrigerant system layout. Equipment shall be provided with system controls by the equipment manufacturer. Controls interfaces shall be provided for monitoring and control interface by the HVAC building control system installed per 23 09 23 Direct Digital Control (DDC) system for HVAC.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set(s) for each air-handling unit.

2. Gaskets: One set(s) for each access door.

3. Fan Belts: One set(s) for each air-handling unit fan.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/ IESNA 90.1.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 03 30 00 "Cast-in-Place Concrete."

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: One year(s) from date of Substantial Completion.
b. For Parts: One year(s) from date of Substantial Completion.
c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 INDOOR UNITS

A. Floor-Mounted, Dedicated Outside Air Evaporator-Fan Components:

1. Fabricate unit with heavy gauge channel posts and panels secured with mechanical fasteners. All panels, access doors, and ship sections shall be sealed with permanently applied bulb-type gasket. Shipped loose gasketing is not allowed.

2. Panels and access doors shall be constructed as a 2-inch nominal thick; thermal broke double wall assembly, injected with foam insulation with an R-value of not less than R-13.

a. The inner liner shall be constructed of G90 galvanized steel.
b. The outer panel shall be constructed of G90 galvanized steel.
c. The floor plate shall be constructed as specified for the inner liner.
d. Unit will be furnished with solid inner liners.

3. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, maximum 5 inches of positive or 6 inches of negative static pressure. Deflection shall be measured at the panel midpoint.

4. The casing leakage rate shall not exceed .5 cfm per square foot of cabinet area at 5 inches of positive static pressure or 6 inches of negative static pressure (0.0025 m3/s per square meter of cabinet area at 1.24 kPa static pressure).

5. Module to module field assembly shall be accomplished with an overlapping, full perimeter internal splice joint that is sealed with bulb type gasketing on both mating modules to minimize on-site labor and meet indoor air quality standards.

6. Access doors shall be flush mounted to cabinetry, with minimum of two six inch long stainless steel piano-type hinges, latch and full size handle assembly. Access doors shall swing outward for unit sections under negative pressure. Access doors on positive pressure sections, shall have a secondary latch to relieve pressure and prevent injury upon access.

7. A 6-inch formed G60 galvanized steel base rail shall be provided by the unit manufacturer for structural rigidity and condensate trapping.. The base rail shall be constructed with 12-gauge nominal for unit sizes 003 - 035 and 10-gauge nominal for unit sizes 040 - 090. The following calculation shall determine the required height of the baserail to allow for adequate drainage. Use the largest pressure to determine base rail height. [(Negative)(Positive) static pressure (in)] (2) + 4" = required baserail height. Should the unit baserail not be factory supplied at this height, the contractor is required to supply a concrete housekeeping pad to make up the difference.

8. Construct drain pans from microbial resistant coated galvanized steel with cross break and double sloping pitch to drain connection. Provide drain pans under cooling coil section. Drain connection centerline shall be a minimum of 3'' above the base rail to aid in proper condensate trapping. Drain connections that protrude from the base rail are not acceptable. There must be a full 2'' thickness of insulation under drain pan.

9. Acceptable fan assembly shall be a single width, single inlet, class II, direct-drive type plenum fan dynamically balanced as an assembly, as shown in schedule. Maximum fan RPM shall be below first critical fan speed. Fan assemblies shall be dynamically balanced by the manufacturer on all three planes. Provide access to motor and fan assembly through hinged access door.

10. Fan and motor shall be mounted internally on a steel base. Factory-mount motor on slide base that can be slid out the side of the unit if removal is required. Provide access to motor, drive, and bearings through hinged access door. Fan and motor assembly shall be mounted on 2" deflection spring vibration type isolators inside cabinetry.

11. Bearings: Basic load rating computed in accordance with AFBMA - ANSI Standards. The bearings shall be provided on the motor with the fan wheel mounted directly on the motor shaft, AMCA arrangement 4.Shafts shall be solid, hot rolled steel, ground and polished, keyed to shaft, and protectively coated with lubricating oil. Hollow shafts are not acceptable.

12. The fan wheel shall be direct coupled to the motor shaft. The wheel width shall be determined by motor speed and fan performance characteristics.

13. ELECTRICAL:

a. Fan motors shall be manufacturer provided and installed, Open Drip Proof, premium efficiency (meets or exceeds EPAct requirements), 3500 RPM, single speed, 460V / 60HZ / 3P. Complete electrical characteristics for each fan motor shall be as shown in schedule.

b. The air handler(s) shall be ETL and ETL-Canada listed by Intertek Testing Services, Inc. Units shall conform to bi-national standard ANSI/UL Standard 1995/CSA Standard C22.2 No. 236.Wiring Termination: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclosed terminal lugs in terminal box sized to NFPA 70.Manufacturer shall provide ASHRAE 90.1 Energy Efficiency equation details for individual equipment to assist Building Engineer for calculating system compliance.

c. Installing contractor shall provide GFI receptacle within 25 feet of unit to satisfy National Electrical Code requirements.

d. Air handler manufacturer shall provide, mount and wire ABB variable speed drive with electrical characteristics such as indicated on project schedule and shown on manufacturer's data sheets."

14. Cooling and Heating Coils

a. Certification: Acceptable water cooling, water heating, steam, and refrigerant coils shall be certified in accordance with AHRI Standard 410 and bear the AHRI label. Coils exceeding the scope of the manufacturer's certification and/or the range of AHRI's standard rating conditions will be considered provided the manufacturer is a current member of the AHRI Forced Circulation Air-Cooling and Air-Heating Coils certification programs and that the coils have been rated in accordance with AHRI Standard 410. Manufacturer must be ISO 9002 certified.

b. Water heating coil shall be provided. Provide access to coil(s) for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with coil connections that extend a minimum of 5" beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections must be factory sealed with grommets on interior and exterior panel liners to minimize air leakage and condensation inside panel assembly. If not factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top

panels of unit without the need to remove and disassemble the entire section from the unit.

c. Headers shall consist of seamless copper tubing to assure compatibility with primary surface. Headers to have intruded tube holes to provide maximum brazing surface for tube to header joint, strength, and inherent flexibility. Header diameter should vary with fluid flow requirements.

d. Fins shall have a minimum thickness of 0.0075 inch aluminum plate construction. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.

e. Coil tubes shall be 5/8 inch OD seamless copper, 0.020 inch nominal tube wall thickness, expanded into fins, brazed at joints.

f. Coil connections shall be carbon steel, threaded connection. Connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain fittings shall be furnished on the connections, exterior to the air handler. Vent connections provided at the highest point to assure proper venting. Drain connections shall be provided at the lowest point to insure complete drainage and prevent freeze-up.

g. Coil shall be furnished as an uncased galvanized steel track to allow for thermal movement and slide into a pitched track for fluid drainage.

h. Direct expansion refrigerant cooling coil shall be provided. Provide access to coil(s) for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with coil connections that extend a minimum of 3" beyond unit casing for ease of installation. Coil connections must be factory sealed with grommets on interior and exterior panel liners to minimize air leakage and condensation inside panel assembly. If not factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.

1) Sweat type copper suction headers shall be provided.

2) Fins shall have a minimum thickness of 0.0075 inch aluminum plate construction. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over

the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.

3) Coil tubes shall be 5/8 inch OD seamless copper, 0.020 inch nominal tube wall thickness, expanded into fins on 1 1/2-inch centers, brazed at joints.

4) Sweat type copper suction connections located at the bottom of the suction headers for gravity oil drainage. Coils shall be uniformly circuited in a counterflow manner for single circuit, row, face, interlaced, or interlaced face split capacity reduction as shown on unit schedule. Pressure type liquid distributors used. Coils shall be tested with 315 pounds air pressure under warm water, and suitable for 250 psig working pressure.

5) Coil casing shall be a formed channel frame of galvanized steel.

15. Air Filtration Section:

a. Furnish combination filter section with 2-inch flat pre-filter and 4-inch final filter. Provide side loading and removal of filters.

b. Furnish flat panel filter section with 2-inch filter. Provide side loading and removal of filters.

c. Filter media shall be UL 900 listed, Class I or Class II.

d. Filter Magnahelic gauge(s) shall be furnished and mounted by others.

16. Additional Sections

a. Access section shall be provided for access between components.

b. Energy recovery wheel shall be constructed of corrugated synthetic fibrous media, with a desiccant intimately bound and uniformly and permanently dispersed throughout the matrix structure of the media. Rotors with desiccants coated bonded, or synthesized onto the media are not acceptable due to delaminating or erosion of the desiccant material. Media shall be synthetic to provide corrosion resistance and resistance against attack from laboratory chemicals present in pharmaceutical, hospital, etc. environments as well as attack from external outdoor air conditions. Coated aluminum is not acceptable. Face flatness of the wheel shall be maximized in order to minimize wear on inner seal surfaces and to minimize cross leakage. Rotor shall be constructed of alternating layers of flat and corrugated media. Wheel layers should be uniform in construction forming uniform aperture sizes for airflow. Wheel construction shall be fluted or formed honeycomb geometry so as to eliminate internal wheel bypass. Wheel layers that can be separated or spread apart by airflow are unacceptable due to the

possibility of channeling and performance degradation. The minimum acceptable performance shall be as specified in the unit schedule.

c. Desiccant Material: The desiccant material shall be a molecular sieve, and specifically a 4A or smaller molecular sieve to minimize cross contamination.

d. Wheel Media Support System: The wheel frames shall consist of evenly spaced steel spokes, galvanized steel outer band and rigid center hub. The wheel construction should allow for post fabrication wheel alignment.

e. Wheel Seals: The wheel seals shall be full contact nylon brush seals or equivalent. Seals should be easily adjustable.

f. Wheel cassette: Cassettes shall be fabricated of heavy duty reinforced galvanized steel or welded structural box tubing. Cassettes shall have a built in adjustable purge section minimizing cross contamination of supply air as shown on unit schedule.

g. Bearings shall be inboard, zero maintenance, permanently sealed roller bearings, or alternatively, external flanged or pillow block bearings.

h. Drive systems shall consist of fractional horsepower AC drive motors with multi-link drive belts.

i. Face and bypass dampers shall be furnished as shown on unit schedule and drawings. Certification:

j. The wheel shall be AHRI certified by the energy recovery wheel supplier to AHRI Standard 1060 and must bear the AHRI certification stamp. Private independent testing performed "in accordance with" various standards is not a substitute for AHRI certification and shall not be accepted. The wheel shall be listed or recognized by UL or equivalent.

B. Wall-Mounted, Single Split Evaporator-Fan Components:

1. Indoor unit shall be a wall mounted fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, for installation onto a wall within a conditioned space. It shall be connected to the corresponding outdoor condensing unit. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while inhibiting changes in room temperature when used with matched programmable controller. A mildew-proof, polyethylene air filter and condensate drain pan shall be included as standard equipment

2. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare

connections, condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an auto-swing louver which ensures efficient air distribution, which closes automatically when the unit stops. The front grille shall be easily removed for washing. The discharge angle shall automatically set at the same angle as the previous operation upon restart. The drain pipe can be fitted to from either left or right sides.

3. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory. Both refrigerant lines shall be insulated from the outdoor unit.

4. Return air shall be through a resin net mold resistant filter. The indoor units shall be equipped with a condensate pan. The indoor units shall be equipped with a return air thermistor.

5. The indoor unit will be separately powered with 208~230V/1-phase/60Hz. The voltage range will be 253 volts maximum and 187 volts minimum.

6. The fan shall be direct-drive cross flow fan type with statically and dynamically balanced impeller with high and low fan speeds available. The fan motor shall operate on 208-230 volts, 1 phase, 60 hertz. The air flow rate shall be available in high and low settings. The fan motor shall be thermally protected.

7. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance. The coil shall be a 2 row cross fin copper evaporator coil with a 17 FPI design completely factory tested. The refrigerant connections shall be flare connections and the condensate will be 11/16 inch outside diameter PVC. A thermistor will be located on the liquid and gas line to facilitate superheat control and PID temperature control logic.

8. The unit shall have controls provided by the manufacturer to perform input functions necessary to operate the system. A full array of fault diagnostics shall be accessible via the wired remote controller. The unit shall be compatible with interfacing with connection to BACnet and LonWorks networks or interfacing with connection to BMS system. Provide hard wired remote sensor kit. The sensor for detecting the temperature can be placed away from the indoor unit (branch wiring is included in the kit).

9. Provide replacement filter.

2.2 INDOOR VARIABLE REFREGERANT VOLUME UNITS

A. Concealed Ceiling Ducted Unit (Med. Static):

1. General: Daikin indoor unit FXMQ_M shall be a built-in ceiling concealed fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, for installation into the ceiling cavity. It is constructed of a galvanized steel casing. It shall be available in capacities from 72,000 Btu/h to 96,000 Btu/h. Model numbers are FXMQ72MVJU and FXMQ96MVJU to be connected to outdoor unit model RXYQ / RWEYQ heat pump and REYQ / RWEYQ heat recovery model. It shall be a horizontal discharge air with horizontal return air configuration. All models feature a low height cabinet making them applicable to ceiling pockets that tend to be shallow. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature when used with Daikin remote control BRC1E72 and BRC2A71. The indoor units sound pressure shall be 48 dB(A) at low speed measured 5 feet below the ducted unit.

2. Indoor Unit:

   a. The Daikin indoor unit FXMQ_M shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an adjustable external static pressure switch.
   b. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory
   c. Both refrigerant lines shall be insulated from the outdoor unit.
   d. The indoor units shall be equipped with a return air thermistor.
   e. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
   f. The voltage range will be 253 volts maximum and 187 volts minimum.

3. Unit Cabinet:

   a. The cabinet shall be located into the ceiling and ducted to the supply and return openings.
   b. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

4. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; with a two-position control valve.

5. Fan:

   a. The fan shall be direct-drive Sirocco type fan, statically and dynamically balanced impeller with high and low fan speeds available.
   b. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz, with a motor output of 0.51 HP.
   c. The airflow rate shall be available in high and low settings. The fan motor shall be thermally protected.
   d. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings.

6. Coil:

   a. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
   b. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
   c. The coil shall be a 3 row cross fin copper evaporator coil with 13 fpi design completely factory tested.
   d. The refrigerant connections shall be flare connections and the condensate will be 1-5/16 inch outside diameter PVC.
   e. A thermistor will be located on the liquid and gas line.

7. Electrical:

   a. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
   b. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet

8. Control:

   a. The unit shall have controls provided by Daikin to perform input functions necessary to operate the system.
   b. The unit shall be compatible with interfacing with a BMS system via optional LonWorks or BACnet gateways.
   c. The unit shall be compatible with a Daikin Intelligent Touch Manager advanced multi-zone controller.

B. Four Way Ceiling Cassette Unit:

1. General: Daikin indoor unit model FXZQ shall be a ceiling cassette fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity equipped with an air panel grill. It shall be available in capacities from 7,500 Btu/h to 18,000 Btu/h. Model numbers are FXZQ07MVJU9, FXZQ09MVJU9, FXZQ12MVJU9, FXZQ15MVJU9, FXZQ18MVJU9 to be connected to outdoor unit model RXYQ / RXYMQ / RWEYQ heat pump and REYQ / RWEYQ heat recovery model. It shall be a four-way air distribution type, white (RAL9010), impact resistant with a washable decoration panel. The supply air is distributed via motorized louvers which can be horizontally and vertically adjusted from 0° to 90°. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature when used with Daikin remote control BRC1E72 and BRC2A71. The indoor units sound pressure shall range from 29 dB(A) to 34 dB(A) at low speed measured at 5 feet below the unit.

2. Indoor Unit:

   a. The Daikin indoor unit FXZQ shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
   b. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
   c. Both refrigerant lines shall be insulated from the outdoor unit.
   d. The 4-way supply air flow can be field modified to 3-way and 2-way airflow to accommodate various installation configurations including corner installations.
   e. Return air shall be through the concentric panel, which includes a resin net mold resistant filter.
   f. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 21" of lift and has a built in safety shutoff and alarm.
   g. The indoor units shall be equipped with a return air thermistor.
   h. All electrical components are reached through the decoration panel, which reduces the required side service access.
   i. The indoor unit will be separately powered with 208~230V/1-phase/60Hz. The voltage range will be 253 volts maximum and 187 volts minimum.

3. Unit Cabinet:

   a. The cabinet shall be space saving and shall be located into the ceiling.
   b. Three auto-swing positions shall be available to choose, which include standard, draft prevention and ceiling stain prevention.
   c. The airflow of the unit shall have the ability to shut down one or two sides allowing for simpler corner installation.
   d. Fresh air intake shall be possible by way of direct duct installation to the side of the indoor unit cabinet.
   e. A branch duct knockout shall exist for branch ducting supply air.
   f. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

4. Fan:

   a. The fan shall be direct-drive turbo fan type with statically and dynamically balanced impeller with high and low fan speeds available.
   b. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range from 0.06 to 0.12 HP. The airflow rate shall be available in high and low settings.
   c. The fan motor shall be thermally protected.

5. Coil:

   a. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
   b. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
   c. The coil shall be a 2-row cross fin copper evaporator coil with 17 FPI design completely factory tested.
   d. The refrigerant connections shall be flare connections and the condensate will be 1 -1/32 inch outside diameter PVC.A condensate pan shall be located under the coil.
   e. A condensate pump with a 21 inch lift shall be located below the coil in the condensate pan with a built in safety alarm.
   f. A thermistor will be located on the liquid and gas line.

C. FXMQ PA – Concealed Ceiling Ducted Unit (Med. Static):

1. General: Daikin indoor unit FXMQ_PA shall be a built-in ceiling concealed fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, direct-drive DC (ECM) type fan with auto CFM adjustment at commissioning, for installation into the ceiling cavity. It is constructed of a galvanized steel casing. It shall be available in

capacities from 7,500 Btu/h to 48,000 Btu/h. Model numbers are FXMQ07PAVJU, FXMQ09PAVJU, FXMQ12PAVJU, FXMQ15PAVJU, FXMQ18PAVJU, FXMQ24PAVJU, FXMQ30PAVJU, FXMQ36PAVJU, FXMQ48PAVJU, and FXMQ54PAVJU to be connected to outdoor unit model RXYQ / RXYMQ / RWEYQ heat pump and REYQ / RWEYQ heat recovery model. It shall be a horizontal discharge air with horizontal return air configuration. All models feature a low height cabinet making them applicable to ceiling pockets that tend to be shallow. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature when used with Daikin remote control BRC1E72 and BRC2A71. Included as standard equipment, a condensate drain pan and drain pump kit that pumps to 18-3/8" from the drain pipe opening. The indoor units sound pressure shall range from 29 dB(A) to 43 dB(A) at low speed measured 5 feet below the ducted unit

2. Indoor Unit.

   a. The Daikin indoor unit FXMQ_PA shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall be equipment with automatically adjusting external static pressure logic that is selectable during commissioning. This adjusts the airflow based on the installed external static pressure.
   b. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
   c. Both refrigerant lines shall be insulated from the outdoor unit.
   d. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 18-3/8" of lift from the center of the drain outlet and has a built in safety shutoff and alarm.
   e. The indoor units shall be equipped with a return air thermistor.
   f. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.The voltage range will be 253 volts maximum and 187 volts minimum.

3. Unit Cabinet:

   a. The cabinet shall be located into the ceiling and ducted to the supply and return openings.

b. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

4. Fan:

a. The fan shall be direct-drive DC (ECM) type fan, statically and dynamically balanced impeller with three fan speeds available.
b. The unit shall be equipment with automatically adjusting external static pressure logic selectable during commissioning.
c. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range of 0.12 to 0.47 HP respectively.
d. The airflow rate shall be available in three settings.
e. The fan motor shall be thermally protected.
f. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings.

5. Coil:

a. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
b. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
c. The coil shall be a 3 row cross fin copper evaporator coil with 13 fpi design completely factory tested.
d. The refrigerant connections shall be flare connections and the condensate will be 1-1/4" outside diameter PVC.A condensate pan shall be located under the coil.
e. A condensate pump with an 18-3/8" lift shall be located below the coil in the condensate pan with a built in safety alarm.
f. A thermistor will be located on the liquid and gas line.

6. Electrical:

a. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
b. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
c. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

7. Internal Adjustability Capabilities:

a. The unit shall have controls provided by Daikin to perform input functions necessary to operate the system

b. The unit shall be compatible with interfacing with a BMS system via optional LonWorks or BACnet gateways.

c. The unit shall be compatible with a Daikin Intelligent Touch Manager advanced multi-zone controller.

2.3 OUTDOOR UNITS SINGLE SPLIT UNITS

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

2. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of a Daikin swing compressor, motors, fan, condenser coil, electronic expansion valves, solenoid valves, 4 way valve, distribution headers, capillaries, filters, shut off valves, service ports and suction accumulator.

3. Both liquid and suction lines must be individually insulated between the outdoor and indoor units.

4. The outdoor unit can be wired and piped with outdoor unit access from the left, right, front or rear.

5. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for re-programming

6. The outdoor unit shall be modular in design, matched to an indoor evaporator unit and should allow for side-by-side installation with minimum spacing.

7. The following safety devices shall be included on the condensing unit; high pressure switch, control circuit fuses, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.

8. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation.

9. The outdoor unit shall be capable of cooling operation at 0°F dry bulb ambient temperature without additional low ambient controls.

10. The outdoor unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

11. The condensing unit shall consist of one propeller type, direct-drive 70 W fan motor that has multiple speed operation via a DC (digitally commutating) inverter. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film type E1. The pipe plates shall be treated with powdered polyester resin for corrosion prevention. The thickness of the coating must be between 2.0 to 3.0 microns.

12. The compressor shall be variable speed (PAM inverter) controlled which is capable of changing the speed to follow the variations in total cooling load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity shall be controlled to eliminate deviation from target value. The inverter driven compressor shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed swing "F-type" type. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.

13. The compressor shall be equipped with a crankcase heater, high pressure safety switch and internal thermal overload protector.

14. The power supply to the outdoor unit shall be 208-230 volts, 1 phase, 60 hertz +/- 10%.

15. The control voltage between the indoor and outdoor unit shall be 16VDC non-shielded, stranded 2 conductor cable. The control wiring shall be a two-wire multiplex transmission system, thus simplifying the wiring operation.

2.4 OUTDOOR UNITS (ACCU)

A. Air-Cooled, Compressor-Condenser Components:

1. Provide and install as shown on the plans factory-assembled, air-cooled scroll compressor, R-410A condensing units in the size and quantity specified. Each unit shall consist of hermetic scroll compressor air-cooled condenser section.

2. Condensing section shall be open on the sides and bottom to provide access and to allow airflow through the coils. Condenser coils shall be constructed with 3/8" copper tubing mechanically bonded to aluminum fins for maximum heat transfer. Each condenser coil shall be factory leak tested with high-pressure air under water.

3. Condenser fans shall be direct drive, propeller type designed for low tip speed, vertical air discharge, and shall include service guFan blades shall be constructed of steel and riveted to a steel center hub. Condenser fan motor shall be direct drive, single phase, permanently lubricated "PSC" motors with inherent thermal overload.

4. Unit shall have standard pressure controls that cycle the condenser fan motors to maintain condensing pressures for operation down to 0°F ambient.

5. Condenser fan motor shall be direct drive, single phase permanently lubricated "PSC" motors with inherent thermal overload.

6. Unit shall be complete with liquid and suction line isolation valves.

7. Scroll Compressors: Unit shall have heavy-duty scroll compressor(s). Compressors shall be isolated with resilient rubber isolators to decrease noise transmission. Capped connections shall be external to the unit providing for field connection of refrigerant piping. Unit shall have a liquid and suction line service valve.

B. Unit shall be equipped with a 24V terminal strip for field supplied and installed controls. Control equipment and sequence of operation are specified in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC."

C. Automatic-reset timer to prevent rapid cycling of compressor.

D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

E. All wiring shall comply with UL requirements. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point terminal block for main power connection. A terminal board shall be provided for low voltage control wiring.

F. The complete unit shall be UL listed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Equipment Mounting:

1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."

2. Comply with manufacturer’s standard requirements for vibration isolation.

D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Duct Connections: Duct installation requirements are specified in Section 23 31 13 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Training shall be on site for a minimum of 16 hours provided for up to 10 maintenance personnel. The training presentation shall be video recorded and two copies presented to the customer for use.

END OF SECTION

SECTION 23 84 16
MECHANICAL DEHUMIDIFICATION 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.

1.2 SUMMARY

A. Section includes packaged, factory-assembled and -tested, refrigerant-type, mechanical dehumidification units designed for outdoor and indoor installation.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Dehumidification units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.4 ACTION SUBMITTALS

A. Product Data: For each dehumidification unit indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each dehumidification unit indicated. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For dehumidification units indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Source quality-control reports.

C. Field quality-control reports.

D. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For dehumidification units to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set(s) of each type of filter specified.

2. Fan Belts: One set(s) for each belt-drive fan.

1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment" and Section 7, "Construction and Startup."

2. Applicable requirements in ASHRAE 15, "Safety Standard for Refrigeration Systems."

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of dehumidification units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than two years from date of Substantial Completion.

2. Warranty Period for Refrigerant Coils: Manufacturer's standard, but not less than five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CASINGS

A. Casing: Double-wall construction with corrosion-protective coating and exterior baked-enamel finish, stainless-steel fasteners, knockouts for electrical and piping connections, condensate drain connection, and lifting lugs.

1. Access: Hinged access doors with neoprene gaskets.

2. Insulation: Minimum 2-inch- thick, glass-fiber-insulation fill with no metal structure through the insulation.

3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

B. Drain Pan and Connection: Stainless steel; insulated and complying with ASHRAE 62.1.

2.2 FANS

A. Supply Fans: Forward curved, centrifugal; galvanized steel with baked-**enamel** finish; belt driven with adjustable sheaves and self-aligning, grease-lubricated ball bearings with extended grease fittings easily accessible inside the casing of dehumidification unit.

B. Exhaust Fans: Forward curved, centrifugal; galvanized steel with baked-enamel finish; belt driven with adjustable sheaves and self-aligning, grease-lubricated ball

bearings with extended grease fittings easily accessible inside the casing of dehumidification unit.

C. Fan Motor: Comply with requirements in Division 26.

1. Enclosure Type: Totally enclosed, fan cooled.

2.3 FILTERS

A. Glass Fiber: Minimum 80 percent arrestance according to ASHRAE 52.1, and MERV 5 according to ASHRAE 52.2.

B. Pleated: Minimum 90 percent arrestance according to ASHRAE 52.1, and MERV 7 according to ASHRAE 52.2.

2.4 REFRIGERATION SYSTEM

A. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1.

B. Refrigerant Coils: Copper tubes with mechanically bonded aluminum fins; factory fabricated and tested to comply with ASHRAE 33 and ARI 410; with multiple refrigerant circuits, seamless-copper headers with brazed connections, and galvanized-steel frame. Coil and fins shall have a polyester coating. Coils shall have a minimum 300-psig working-pressure rating and be factory tested to 450 psig and to 300 psig while underwater.

C. Compressors: Hermetic, scroll compressors with integral vibration isolators and crankcase heaters that de-energize during compressor operation; with thermal-expansion valves, filter-dryers, sight glasses, compressor service valves, and liquid- and suction-line service valves.

1. Number of Refrigerant Circuits: Two for compressor capacities more than 7-1/2 tons.

2. Refrigerant: R-410A.

3. Capacity Control:

a. Hot-gas bypass valve and piping on one compressor.
b. Cycle compressor.

4. Low-Pressure Cutout: Manual reset after three automatic-reset failures.

5. High-Pressure Cutout: Manual reset.

6. Compressor Motor Overload Protection: Manual reset.

7. Antirecycling Timing Device: Prevent compressor restart for five minutes after shutdown.

8. Defrost Cycle: Adjustable timer shuts off supply fan. Compressor cycles until suction line temperature confirms thawed evaporator coil. Timer limits defrost time to 10 minutes.

D. Energy Recovery Heat Exchanger (Pool Heater): Cupronickel, coaxial, vented, double-wall construction for potable-water service.

2.5 REMOTE-MOUNTED, AIR-COOLED CONDENSER UNIT

A. Casing: Steel, finished with baked enamel; with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Refrigerant Coil: ARI 206/110, copper tube with mechanically bonded aluminum fins; with liquid subcooler.

C. Fan: Aluminum-propeller type, directly connected to permanently lubricated motor with integral thermal-overload protection.

D. Adjustable, Low Ambient Head-Pressure Control: Designed to operate at temperatures as low as 0 deg F by cycling condenser fans and controlling speed of last fan of each circuit.

E. Mounting Base: Polyethylene.

2.6 HEATING COILS

A. Electric-Resistance Heating Coil: Comply with UL 1995.

1. Heating Element: Coiled resistance wire of 80 percent nickel and 20 percent chromium; surrounded by compacted magnesium oxide powder in tubular-steel sheath; with spiral-wound, copper-plated steel fins continuously brazed to sheath.

2. Heating Element: Open-coil resistance wire of 80 percent nickel and 20 percent chromium; supported and insulated by floating ceramic bushings recessed into casing openings; fastened to supporting brackets and mounted in galvanized-steel frame.

3. Overtemperature Protection: Disk-type, automatic-reset, thermal-cutout safety device; serviceable through terminal box without removing heater from unit.

4. Thermal Cutouts: Load carrying, manual reset or replaceable, and factory wired in series with each heater stage.

5. Control: Disconnecting means, overcurrent protection, and airflow proving switch.

2.7 DAMPERS

A. Outdoor-Air Dampers: Opposed-blade, extruded-aluminum dampers with cadmium-plated steel operating rod rotating in sintered bronze or nylon bearings. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod. Size for 0 to 25 percent outdoor air, with motorized operator and filter.

B. Face-and-Bypass Dampers: Opposed-blade, extruded-aluminum dampers with cadmium-plated steel operating rods rotating in sintered bronze or nylon bearings with operating rods connected with a common linkage. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod.

C. Outdoor-, Return-, and Exhaust-Air Dampers: Low-leakage, double-skin, airfoil-blade, extruded-aluminum dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed or parallel-blade arrangement with cadmium-plated steel operating rods rotating in stainless-steel sleeve, bronze bearings mounted in a single extruded-aluminum frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 5 cfm/sq. ft. (0.22 L/s per sq. m) at 1-inch wg (250 Pa) and 9 cfm/sq. ft. (0.4 L/s per sq. m) at 4-inch wg (1.0 MPa).

D. Damper Operator: 115-V ac, close coupled, with gear train sealed in oil and with spring return.

2.8 CONTROLS

A. Comply with requirements in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC."

B. Control Panel: Integral service compartment containing fan-motor thermal and overload cutouts, compressor thermal and overload cutouts, 115-V control transformer if required, magnetic contactors for fan and compressor motors, and a nonfused factory-mounted and -wired disconnect switch for single external electrical power connection.

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

D. Operating Control: Space humidistat cycles the compressor. Humidistat shall incorporate fan on-off-auto switch.

E. Operating Controls: Factory-installed microprocessor controller, capable of being remotely mounted.

1. Display the following on the face of controller:

    a. System on.
    b. System dehumidifying mode.
    c. System air-conditioning mode.
    d. System outdoor-air (economizer) mode.
    e. System heating pool water.
    f. Auxiliary space heat is operating.
    g. Unit requires service.
    h. Return-air (space) temperature.
    i. Return-air (space) humidity.
    j. Pool-water temperature.
    k. Outdoor-air temperature.

2. Indicate the following sensor failures on panel:

    a. Airflow: Dirty air filter, blocked airflow, and fan failure.
    b. Refrigerant high and low pressure.
    c. High water temperature.
    d. High and low evaporator temperature.
    e. Low water flow.
    f. Communication fault.
    g. System off.
    h. Antishort cycle delay.
    i. Power failure.

3. Provide access to the following set points on panel:

    a. Space temperature.
    b. Space relative humidity.
    c. Outdoor ventilation/air-conditioning changeover temperature.
    d. Airflow alarm.

4. Provide the following displays on panel:

    a. Space temperature.
    b. Space relative humidity.
    c. Outdoor-air temperature.
    d. Supply-air temperature.
    e. Return-air temperature.
    f. Airflow rating.
    g. Air-off evaporator temperature.
    h. Return-air relative humidity.
    i. Service codes.

5. Provide the following controls on panel:

a. System on-off, fan continues to run.
b. Fan on-off.
c. Service code access.
d. System dehumidifying mode.
e. System air-conditioning mode.
f. System outdoor-air (economizer) mode.
g. Auxiliary space heat is operating.
h. Outdoor-air-temperature, conditioned-space-temperature, and control set-point-temperature digital display.
i. Outdoor enthalpy digital display.
j. Filter pressure drop digital display.
k. Status: Airflow, fans, system, unit operation, and operating mode.
l. Alarm digital display.

F. Operating Controls: Factory-installed microprocessor controller.

1. Factory-installed operator panel with backlit display, capable of being remotely mounted, allows menu-driven display for navigation and control of unit.

2. Integral clock.

3. Personal computer interface.

4. Integral local area network for direct connection to BACnet.

5. Factory programmed.

6. Unit-Mounted Sensors:

a. Airflow switch.
b. Compressor-discharge temperature.
c. Evaporator-air temperature.
d. Pool-water-out temperature.
e. Pool-water-in temperature.
f. Relative humidity.
g. Return-air temperature.
h. Supply-air temperature.

7. Integral diagnostics.

8. Nonvolatile memory.

9. IP or SI display.

10. Provide the following status and alarm functions:

a. System: On-off.

b. Power failure.
c. Fan: Off, overload.
d. Compressor: On, turned off, overload, high pressure, low pressure, overheat, oil failure, and pumpdown.
e. Evaporator damper closed.
f. Pool: Low water flow, heating on.
g. Dehumidification: Call for, on.
h. Air Conditioning: Call for, on.
i. System outdoor-air (economizer) mode.
j. Auxiliary space heat on.
k. Alarms: Firestat, freezestat, and filters.

11. Provide the following controls via operator panel:

a. Compressor auto-off.
b. Fan auto-off.
c. Set-Point Adjustments: Relative humidity, temperatures, deadbands, and differentials.
d. Sensor calibration.

12. Monitor constant and variable motor loads.

13. Monitor cooling load.

14. Monitor economizer cycles.

15. Monitor ventilation air volumes.

2.9 ACCESSORIES

A. Smoke Detectors: Photoelectric detector located in return-air plenum, to de-energize unit per Division 28.

B. Electrical Convenience Outlet: 115-V ac fused, duplex, straight-blade receptacles, separately fused and located inside casing of dehumidification unit or in roof-curb perimeter.

2.10 SOURCE QUALITY CONTROL

A. Verification of Performance: Factory test and rate dehumidification units according to ARI 910.

B. Sound-Power-Level Ratings: Factory test and rate dehumidification units according to ARI 575.

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 refrigerant piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where dehumidification units will be installed.

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

3.2 INSTALLATION

A. Equipment Mounting:

1. Install dehumidification units on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."

2. Comply with manufacturer's requirements for vibration isolation control devices.

3.3 CONNECTIONS

A. Where piping is installed adjacent to dehumidification units, allow space for service and maintenance of dehumidification units.

B. Connect piping to dehumidification units mounted on vibration isolators with flexible connectors.

C. Connect condensate drain pans using minimum NPS 1-1/4 (DN 32) copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan, and install cleanout at changes in direction.

D. Refrigerant Piping: Comply with requirements in Section 23 23 00 "Refrigerant Piping." Connect to supply and return coil tappings with shutoff valve and union or flange at each connection.

E. Hot-Water Piping: Comply with requirements in Section 23 21 13 "Hydronic Piping" and Section 23 21 16 Hydronic Piping Specialties." Connect to supply coil tappings with shutoff valve, return coil tappings with balancing valve, and union or flange at each connection.

F. Duct installation requirements are specified in Section 23 31 13 "Metal Ducts" and Section 23 31 16 "Nonmetal Ducts." Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination in roof-mounted frames. Where indicated, terminate return-air duct through roof structure and insulate the space between roof and bottom of dehumidification unit.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks. Repair leaks and retest until no leaks exist.

2. Charge refrigerant coils with refrigerant and test for leaks. Repair leaks and retest until no leaks exist.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Dehumidification unit will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

B. Perform the following final checks before startup:

1. Verify that shipping, blocking, and bracing are removed.

2. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.

3. Perform cleaning and adjusting specified in this Section.

4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.

5. Check lubrication of bearings, pulleys, belts, and other moving parts.

6. Set outside- and return-air mixing dampers to minimum outside-air setting.

7. Install clean filters.

8. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

C. Starting procedures for dehumidification units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace malfunctioning motors, bearings, and fan wheels.

2. Measure and record motor's electrical values for voltage and amperage.

3. Manually operate dampers from fully closed to fully open position and record fan performance.

D. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing of dehumidification unit.

E. Startup Report: Report findings during startup. Identify startup steps, corrective measures taken, and final results.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust initial temperature and humidity set points.

3.7 CLEANING

A. Clean dehumidification units internally, on 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.

B. After completing system installation, testing, and startup service of dehumidification units, clean filter housings and install new filters.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain dehumidification units.

END OF SECTION