SECTION 235413 - ELECTRIC-RESISTANCE FURNACES

TIPS:

To view non-printing **Editor's Notes** that provide guidance for editing, click on Masterworks/Single-File Formatting/Toggle/Editor's Notes.

To read **detailed research, technical information about products and materials, and coordination checklists**, click on Masterworks/Supporting Information.

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. Electric furnaces and accessories complete with controls.
2. Air filters.
3. Air cleaners.
4. UV germicidal lights.
5. Humidifiers.
6. Ventilation heat exchangers.
7. Refrigeration components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. LEED Submittals:

1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.
2. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
3. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
4. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of

Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Shop Drawings:

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

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

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

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Furnace and accessories complete with controls.
b. Air filter.
c. Air cleaner.
d. UV germicidal light.
e. Humidifier.
f. Ventilation heat exchanger.
g. Refrigeration components.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

1. Disposable Air Filters: Furnish [**two**] <**Insert number**> complete sets.
2. Disposable Air-Cleaner Media: Furnish [**one**] <**Insert number**> complete set(s).
3. Fan Belts: Furnish [**one**] <**Insert number**> set(s) for each furnace fan.
4. Disposable Humidifier Media: Furnish [**one**] <**Insert number**> set(s).

1.7 QUALITY ASSURANCE

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

B. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

C. Comply with NFPA 70.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace the following components of furnaces that fail in materials or workmanship within specified warranty period:

1. Warranty Period, Commencing on Date of Substantial Completion:

a. Furnace Heat Exchanger: [**10 years**] [**20 years**] [**Lifetime**] <**Insert value**>.
b. Integrated Ignition and Blower Control Circuit Board: [**Five years**] <**Insert value**>.
c. Draft-Inducer Motor: [**Five years**] <**Insert value**>.
d. Refrigeration Compressors: [**10 years**] [**Lifetime**] <**Insert value**>.
e. Evaporator and Condenser Coils: [**Five years**] <**Insert value**>.
f. <**Insert components requiring extended warranty**>.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.2 ASSEMBLY DESCRIPTION

A. Factory assembled, piped, wired, and tested.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a qualified testing agency, and marked for intended location and application.

2.3 FURNACES

A. Cabinet: Steel, with duct liner[**downstream from cooling coil**].

1. Duct Liner: Fiberglass, minimum [**1/2 inch (13 mm)**] [**3/4 inch (19 mm)**] thick, complying with ASTM C 1071 and having a coated surface exposed to airstream complying with NFPA 90A or NFPA 90B and with NAIMA's "Fibrous Glass Duct Liner Standard."

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

2. Factory paint external cabinets in manufacturer's standard color.

B. Fan: Centrifugal, factory balanced, resilient mounted, direct drive.

1. Fan Motors: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Special Motor Features: Single speed, premium efficiency, as defined in Section 230513 "Common Motor Requirements for HVAC Equipment," and with internal thermal protection and permanent lubrication.
3. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
4. Special Motor Features: Electronically controlled motor (ECM) controlled by integrated furnace/blower control.

C. Electric-Resistant Heating Elements: Helix-wound, nickel-chromium wire-heating elements in ceramic insulators mounted on steel supports.

D. Heating-Element Control: Sequencer relay with relay for each element; switches elements on and off, with delay between each increment; initiates, stops, or changes fan speed.

E. Summer Fan Switch: Connected to permit independent on-off switch of unit fan.

F. Capacities and Characteristics:

1. Airflow Configuration: [**Upflow**] [**Counterflow**] [**Horizontal**].
2. Electric Heating Element:

    a. Capacity: <**Insert MBh (kW)**>.
    b. Number of Steps: <**Insert number**>.
    c. Volts: <**Insert value**>.
    d. Phase: <**Insert value**>.
    e. Hertz: <**Insert value**>.
    f. Full-Load Amperes: <**Insert value**>.
    g. Minimum Circuit Ampacity: <**Insert value**>.
    h. Maximum Overcurrent Protection: <**Insert amperage**>.

3. Fan:

    a. Airflow: <**Insert cfm (L/s)**>.
    b. External Static Pressure: <**Insert inches wg (Pa)**>.
    c. Motor:

        1) Size: <**Insert horsepower**>.
        2) Speed: <**Insert rpm**>.

    d. Volts: <**Insert value**>.
    e. Phase: <**Insert value**>.
    f. Hertz: <**Insert value**>.
    g. Full-Load Amperes: <**Insert value**>.
    h. Minimum Circuit Ampacity: <**Insert value**>.
    i. Maximum Overcurrent Protection: <**Insert amperage**>.

4. Furnace Electrical Connection:

    a. Volts: <**Insert value**>.

b. Phase: <**Insert value**>.
c. Hertz: <**Insert value**>.
d. Full-Load Amperes: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.4 THERMOSTATS[**AND HUMIDISTATS**]

A. Controls shall comply with requirements in ASHRAE/IES 90.1, "Controls."

B. Solid-State Thermostat: [**Wall-mounted**] [**Freestanding**] [**Wireless**], programmable, microprocessor-based unit with [**automatic**] [**manual**] switching from heating to cooling, preferential rate control, seven-day programmability with minimum of four temperature presets per day, [**vacation mode,**]and battery backup protection against power failure for program settings.

C. Single-Stage, Heating-Cooling Thermostat: Adjustable, heating-cooling, wall-mounted unit with fan on-automatic selector.

D. Two-Stage, Heating-Cooling Thermostat: Adjustable, heating-cooling, wall-mounted unit with fan on-automatic selector.

E. [**Single**] [**Two**]-Stage, Heating-Only Thermostat: Wall-mounted unit with fan on-automatic selector.

F. Solid-State, Combination Thermostat and Humidistat: [**Wall-mounted**] [**Freestanding**] [**Wireless**], programmable, microprocessor-based unit with automatic switching from heating to cooling and humidifying to dehumidifying, preferential rate control, seven-day programmability with minimum of four temperature presets per day, [**vacation mode,**]and battery backup protection against power failure for program settings.

G. Humidistat: Adjustable, [**wall**] [**duct**]-mounted unit.

H. Control Wiring: Unshielded twisted-pair cabling.

1. No. 24 AWG, 100 ohm, four pair.
2. Cable Jacket Color: [**Blue**] <**Insert color**>.

2.5 AIR FILTERS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Washable Filters: 1-inch- (25-mm-) thick urethane pad.

C. Disposable Filters: [**1-inch- (25-mm-)**] <**Insert dimension**> thick fiberglass media[**with ASHRAE 52.2 MERV rating of 6 or higher,**] in sheet metal frame.

D. Charged Media Air Filters: Sheet metal housing arranged to be ducted in return-air duct connection to furnace; generates electrostatic charge; MERV 10 rating.

E. HEPA Air-Filter Units: Sheet metal housing with fan arranged to be ducted to return-air duct connection to furnace, with activated carbon prefilter[**, carbon VOC,**] and high-efficiency particulate air (HEPA) disposable filter. HEPA shall be as follows:

1. Standard: UL 586.
2. Rating: ASHRAE 52.2, 99.97 percent efficiency to 0.30-micrometer particle size.

2.6 AIR CLEANERS

A. Electronic Air Cleaners: Packaged system, including sheet metal housing, prefilter, power supply, and automatic control device, arranged for mounting in return-air duct at furnace; equip with on-off and test switches and pilot light.

1. Standard: UL 586.
2. Rating: ASHRAE 52.2, particle size to 0.01 micrometer.
3. Static Pressure Drop: Maximum 0.14-inch wg (35 Pa) at 300-fpm (1.52-m/s) air velocity.

B. Capacities and Characteristics:

1. Volts: <**Insert value**>.
2. Phase: <**Insert value**>.
3. Hertz: <**Insert value**>.
4. Minimum Circuit Ampacity: <**Insert value**>.
5. Maximum Overcurrent Protection: <**Insert amperage**>.

2.7 UV GERMICIDAL LIGHTS

A. Description: Lighting unit in metal housing arranged for installation in supply-air duct and controlled to cycle on and off with furnace fan, with [**one**] [**two**] 75-W UV-light bulb(s).

2.8 HUMIDIFIERS

A. Minimum capacity rating indicated according to AHRI 610.

B. Media-wheel bypass type with bypass damper and motor-driven media wheel in reservoir with float-valve level control; arranged for mounting on return duct or plenum with bypass connection to supply duct.

C. Wetted-pad, continuous-drain, bypass type with bypass damper and water-flow control orifice; arranged for mounting on return duct or plenum with bypass connection to supply duct.

D. Fan-powered, wetted-pad, continuous-drain type with water-flow control orifice and motor; arranged for mounting on duct or plenum.

E. Pumped, fan-powered, wetted-pad type with reservoir-level control and pump and fan motors; arranged for mounting on duct or plenum.

F. Steam type with electric heating element in stainless-steel reservoir with float-valve level control; arranged for attachment to duct or plenum and for control by humidistat.

G. Comply with applicable requirements in ASHRAE 62.1.

H. Capacities and Characteristics:

1. Type: [**Steam**] [**Media wheel**] [**Wetted pad with reservoir**] [**Wetted pad with continuous drain**] [**Wetted-pad bypass**].
2. Steam Capacity: <**Insert lb/h (kg/h)**>.
3. Water Connection Size: <**Insert NPS (DN)**>.
4. Drain Connection Size: <**Insert NPS (DN)**>.
5. Volts: <**Insert value**>.
6. Phase: <**Insert value**>.
7. Hertz: <**Insert value**>.
8. Minimum Circuit Ampacity: <**Insert value**>.
9. Maximum Overcurrent Protection: <**Insert amperage**>.

2.9 VENTILATION AIR HEAT EXCHANGERS

A. Cabinet: Steel, with factory-installed interior insulation and manufacturer's standard factory finish. Fabricate with space for piping and electrical conduits.

B. Heat-Recovery Device: Fixed-plate, polypropylene copolymer (high-density plastic) heat-exchanger plates evenly spaced and sealed and arranged for counter airflow.

C. Supply and Exhaust Fans: Forward curved centrifugal with direct drive. Motors comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

D. Filters: 1-inch- (25-mm-) thick disposable type[**with ASHRAE 52.2 MERV rating of 6 or higher**], in galvanized-steel frame, mounted upstream of unit in both supply and exhaust airstreams.

E. Wiring: Wire motors and controls so only external connections are required during installation.

2.10 REFRIGERATION COMPONENTS

A. General Refrigeration Component Requirements:

1. Refrigeration compressor, coils, and specialties shall be designed to operate with CFC-free refrigerants.
2. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IES 90.1.

B. Refrigerant Coil: Copper tubes mechanically expanded into aluminum fins. Comply with AHRI 210/240. Match size with furnace. Include condensate drain pan with accessible drain outlet[**complying with ASHRAE 62.1**].

1. Refrigerant Coil Enclosure: Steel, matching furnace and evaporator coil, with access panel and flanges for integral mounting at or on furnace cabinet and galvanized sheet metal drain pan coated with black asphaltic base paint.

C. Refrigerant Line Kits: Annealed-copper suction and liquid lines factory cleaned, dried, pressurized with nitrogen, sealed, and with suction line insulated. Provide in standard lengths for installation without joints, except at equipment connections.

1. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534/C 534M, Type I, [**1/2 inch (13 mm)**] [**1 inch (25 mm)**] <**Insert dimension**> thick.

D. Refrigerant Piping: Comply with requirements in Section 232300 "Refrigerant Piping."

E. Air-Cooled Compressor-Condenser Unit:

1. 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.
2. Compressor: Hermetically sealed [**reciprocating**] [**or**] [**scroll**] type.

a. Crankcase heater.
b. [**Restrained vibration**] [**Vibration**] isolation mounts for compressor.
c. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
d. Two-speed compressor motors shall have manual-reset high-pressure switch and automatic-reset low-pressure switch.
e. Refrigerant Charge: [**R-22**] [**R-407C**] [**R-410A**] <**Insert type**>.
f. Refrigerant: R-407C or R-410A.

3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with liquid subcooler.
4. Heat-Pump Components: Reversing valve and low-temperature air cutoff thermostat.
5. Fan: Aluminum-propeller type, directly connected to motor.
6. Motor: Permanently lubricated, with integral thermal-overload protection.
7. Low Ambient Kit: Permits operation down to 45 deg F (7 deg C).
8. Mounting Base: Polyethylene.

F. Capacities and Characteristics:

1. Refrigerant Coil:

a. Total Cooling Capacity: <**Insert Btu/h (kW)**>.
b. Sensible Cooling Capacity: <**Insert Btu/h (kW)**>.
c. Heating Capacity: <**Insert Btu/h (kW)**>.
d. Maximum Air Pressure Drop: <**Insert inches wg (Pa)**>.
e. Condensate Drain Size: <**Insert NPS (DN)**>.

2. Compressor-Condenser Unit:

a. Cooling Energy Efficiency[**(EER)**] [**(SEER)**]: <**Insert value**>.
b. Heating Coefficient of Performance: <**Insert value**>.
c. Volts: <**Insert value**>.
d. Phase: <**Insert value**>.
e. Hertz: <**Insert value**>.

f. Full-Load Amperes: <**Insert value**>.
g. Minimum Circuit Ampacity: <**Insert value**>.
h. Maximum Overcurrent Protection: <**Insert amperage**>.
i. Fan Motor Full-Load Amperes: <**Insert value**>.
j. Compressor Running-Load Amperes: <**Insert value**>.
k. Compressor Motor Full-Load Amperes: <**Insert value**>.

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 factory-installed insulation before furnace installation. Reject units that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.

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

3.2 INSTALLATION

A. Suspended Units: Suspend from structure using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

1. Install seismic restraints to limit movement of furnace by resisting code-required seismic acceleration.

B. Base-Mounted Units: Secure units to substrate. Provide optional bottom closure base if required by installation conditions.

1. Anchor furnace to substrate to resist code-required seismic acceleration.

C. Controls: Install thermostats and humidistats at mounting height of 60 inches (1500 mm) above floor.

D. Wiring Method: Install control wiring in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal control wiring except in unfinished spaces.

E. Install ground-mounted, compressor-condenser components on 4-inch- (100-mm-) thick, reinforced concrete base; 4 inches (100 mm) larger on each side than unit. Concrete, reinforcement, and formwork are specified in [**Section 033000 "Cast-in-Place Concrete."**] [**Section 033053 "Miscellaneous Cast-in-Place Concrete."**] Coordinate anchor installation with concrete base.

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

G. Install roof-mounted compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

3.3 CONNECTIONS

A. Install piping adjacent to equipment to allow service and maintenance.

B. Water piping installation requirements are specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties. Connect water piping with union and ball valve.

C. Connect ducts to furnace with flexible connector. Comply with requirements in Section 233300 "Air Duct Accessories."

D. Connect refrigerant tubing kits to refrigerant coil in furnace and to air-cooled compressor-condenser unit.

1. Flared Joints: Use ASME B16.26 fitting and flared ends, following procedures in CDA's "Copper Tube Handbook."
2. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
3. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

E. Comply with requirements in Section 232300 "Refrigerant Piping" for installation and joint construction of refrigerant piping.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Perform electrical test and visual and mechanical inspection.
2. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
4. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

3.5 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Inspect for physical damage to unit casings.
2. Verify that access doors move freely and are weathertight.
3. Clean units and inspect for construction debris.
4. Verify that all bolts and screws are tight.
5. Adjust vibration isolation and flexible connections.
6. Verify that controls are connected and operational.

B. Adjust fan belts to proper alignment and tension.

C. Start unit according to manufacturer's written instructions and complete manufacturer's operational checklist.

D. Measure and record airflows.

E. Verify proper operation of capacity control device.

F. After startup and performance test, lubricate bearings[**and adjust belt tension**].

3.6 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set controls, burner, and other adjustments for optimum heating performance and efficiency. Adjust heat-distribution features, including shutters, dampers, and relays, to provide optimum heating performance and system efficiency.

3.7 CLEANING

A. After completing installation, clean furnaces internally according to manufacturer's written instructions.

B. Install new filters in each furnace within 14 days after Substantial Completion.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain condensing units. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 235413