SECTION 235416.16 - OIL-FIRED FURNACES

This Section includes requirements for sustainable design systems. However, equipment specified in this Section may not qualify. Verify with manufacturers that the requirements can be met. To comply with sustainable design systems, HVAC system design alternatives that do not include furnaces may be required.

Revise this Section by deleting and inserting text to meet Project-specific requirements.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

1. GENERAL
   * + 1. RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

* + - * 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
      1. SUMMARY
         1. Section Includes:

Oil-fired furnaces and accessories complete with controls.

Air filters.

Air cleaners.

UV germicidal lights.

Humidifiers.

Ventilation heat exchangers.

Refrigeration components.

* + - 1. SUBMITTALS
         1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
         2. Manufacturer's installation instructions shall be provided along with product data.
         3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
         4. Product Data: For each type of product.

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

* + - * 1. Sustainable Design Submittals:
        2. Shop Drawings:

Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

Include diagrams for power, signal, and control wiring.

* + - * 1. Sample Warranty: For special warranty.
      1. CLOSEOUT SUBMITTALS
         1. Operation and Maintenance Data: For each furnace to include in emergency, operation, and maintenance manuals.

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

Furnace and accessories complete with controls.

Air filter.

Air cleaner.

UV germicidal light.

Humidifier.

Ventilation heat exchanger.

Refrigeration components.

* + - 1. MAINTENANCE MATERIAL SUBMITTALS

Extra materials may not be allowed for publicly funded projects.

* + - * 1. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

Revise subparagraphs below to suit Project.

Disposable Air Filters: Furnish [**two**] <**Insert number**> complete sets.

Disposable Air-Cleaner Media: Furnish [**one**] <**Insert number**> complete set(s).

Fan Belts: Furnish [**one**] <**Insert number**> set(s) for each furnace fan.

Disposable Humidifier Media: Furnish [**one**] <**Insert number**> set(s).

* + - 1. QUALITY ASSURANCE

Retain "ASHRAE Compliance" Paragraph below for sustainable design systems, which require compliance with ASHRAE 62.1, including requirements for controls, surfaces in contact with the airstream, particulate and gaseous filtration, humidification and dehumidification, drain-pan construction and connection, finned-tube coil selection and cleaning, and equipment access. Verify, with manufacturers, availability of units with components and features that comply with these requirements.

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

"ASHRAE/IES 90.1 Compliance" Paragraph may be required to comply with Project requirements or authorities having jurisdiction. Also, sustainable design systems require compliance with ASHRAE/IES 90.1.

* + - * 1. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
        2. Comply with NFPA 70.
      1. WARRANTY

When warranties are required, verify with Director’s Representative's counsel that special warranties stated in this Article are not less than remedies available to Director’s Representative under prevailing local laws.

* + - * 1. Special Warranty: Manufacturer agrees to repair or replace the following components of furnaces that fail in materials or workmanship within specified warranty period:

Warranty Period, Commencing on Date of Substantial Completion:

Verify available warranties for units and components and insert numbers in subparagraphs below.

Furnace Heat Exchanger: [**10 years**] [**20 years**] [**Lifetime**] <**Insert value**>.

Integrated Ignition and Blower Control Circuit Board: [**Five years**] <**Insert value**>.

Draft-Inducer Motor: [**Five years**] <**Insert value**>.

High-Efficiency Oil Furnace Burner: [**Three years**] <**Insert value**>.

Refrigeration Compressors: [**10 years**] [**Lifetime**] <**Insert value**>.

Evaporator and Condenser Coils: [**Five years**] <**Insert value**>.

<**Insert components requiring extended warranty**>.

1. PRODUCTS

See Editing Instruction No. 1 in the Evaluations for cautions about named manufacturers and products. For an explanation of options and Contractor's product selection procedures., see Section 016000 "Product Requirements."

* + - 1. MANUFACTURERS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=9879) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Adams Manufacturing Company](http://www.specagent.com/Lookup?uid=123457139076).

[Bard Manufacturing Company](http://www.specagent.com/Lookup?uid=123457139078).

[Carrier Global Corporation](http://www.specagent.com/Lookup?uid=123457139079).

[Comfort-Aire; a division of Heat Controller, Inc](http://www.specagent.com/Lookup?uid=123457139080).

[Dornback Furnace](http://www.specagent.com/Lookup?uid=123457139082).

[Lennox Industries, Inc.; Lennox International](http://www.specagent.com/Lookup?uid=123457139084).

[Luxaire; brand of Johnson Controls International PLC, Building Solutions North America](http://www.specagent.com/Lookup?uid=123457139085).

[Rheem Manufacturing Company; Heating and Cooling Products](http://www.specagent.com/Lookup?uid=123457139086).

[Ruud Air Conditioning Division](http://www.specagent.com/Lookup?uid=123457139087).

[Thermo Products, Inc](http://www.specagent.com/Lookup?uid=123457139088).

[YORK; brand of Johnson Controls International plc, Building Solutions North America](http://www.specagent.com/Lookup?uid=123457139089).

Approved equivalent.

* + - 1. ASSEMBLY DESCRIPTION
         1. 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. Manufactured Units: Factory assembled, piped, wired, and tested; complying with UL 727 and with NFPA 31.
      2. FURNACES

In "Cabinet" Paragraph below, galvanized steel is offered by some but not all manufacturers.

* + - * 1. Cabinet: [**Steel**] [**Galvanized steel**].

Cabinet interior around heat exchanger shall be factory-installed insulation.

Lift-out panels shall expose burners and all other items requiring access for maintenance.

Factory paint external cabinets in manufacturer's standard color.

"Airstream Surfaces" Subparagraph below may be required to comply with Project requirements or authorities having jurisdiction. Also, sustainable design systems require compliance with ASHRAE 62.1.

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

* + - * 1. Fan: Centrifugal, factory balanced, resilient mounted, [**direct drive**] [**belt drive**] [**direct or belt drive**] [**drive type indicated on Drawings**].

Motor characteristics such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency are specified in Section 230513 "Common Motor Requirements for HVAC Equipment." If different characteristics are required, add subparagraphs below to suit Project.

Fan Motors: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

Retain either or both "Special Motor Features" subparagraphs below, as applicable.

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.

Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.

* + - * 1. Heat Exchanger: Welded steel with [**ceramic-fiber liner**] [**refractory insert**] at the burner in the combustion chamber. Minimum 2-inch- (50-mm-) diameter access ports in heat exchanger to permit access for cleaning.
        2. Burner: High-pressure atomizing type, with rubber-mounted, adjustable, combustion-air blower; integrated fuel pump; hinged, flame-inspection port; cadmium-sulfide flame sensor; electrodes; ignition transformer; and oil nozzle.

Time-Delay Relay: Limits time for establishing main flame.

Flame Sensor: Monitors flame and stops burner on flame failure.

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

* + - * 1. Barometric Draft Regulator: Match furnace; for mounting in flue.
        2. Furnace Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds; and adjustable fan-on and fan-off timing; terminals for connection to accessories.
        3. Vent Materials: Comply with requirements in Section 235123 "Gas Vents" for Type B metal vents.

If Project has more than one type or configuration of oil-fired furnace, delete "Capacities and Characteristics" Paragraph below and schedule furnace and other components on Drawings.

* + - * 1. Capacities and Characteristics:

Airflow Configuration: [**Upflow**] [**Counterflow**] [**Horizontal**].

Retain "Minimum Efficiency AFUE" or "Minimal Thermal Efficiency" Subparagraph below. Specify standing or intermittent pilot with minimum AFUE.

Minimum Efficiency AFUE: <**Insert number**> percent.

Minimum Thermal Efficiency: <**Insert number**> percent.

Oil:

Input: <**Insert gph (L/s)**>.

Heat Output: <**Insert MBh (kW)**>.

Burner Motor:

Size: <**Insert horsepower**>.

Speed: <**Insert rpm**>.

Vent Size: <**Insert inches (mm)**>.

Fan:

Airflow: <**Insert cfm (L/s)**>.

External Static Pressure: <**Insert inches wg (Pa)**>.

Motor:

Size: <**Insert horsepower**>.

Speed: <**Insert rpm**>.

Volts: <**Insert value**>.

Phase: <**Insert value**>.

Hertz: <**Insert value**>.

Full-Load Amperes: <**Insert value**>.

Minimum Circuit Ampacity: <**Insert value**>.

Maximum Overcurrent Protection: <**Insert amperage**>.

Furnace Electrical Connection:

Volts: <**Insert value**>.

Phase: <**Insert value**>.

Hertz: <**Insert value**>.

Full-Load Amperes: <**Insert value**>.

Minimum Circuit Ampacity: <**Insert value**>.

Maximum Overcurrent Protection: <**Insert amperage**>.

* + - 1. THERMOSTATS[**AND HUMIDISTATS**]

Sustainable design systems require compliance with ASHRAE/IES 90.1, in which Section 6.4.3 defines requirements for controls.

* + - * 1. Controls shall comply with requirements in ASHRAE/IES 90.1, "Controls."

Retain one of first five paragraphs below.

* + - * 1. 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.
        2. Single-Stage, Heating-Cooling Thermostat: Adjustable, heating-cooling, wall-mounted unit with fan on-automatic selector.
        3. Two-Stage, Heating-Cooling Thermostat: Adjustable, heating-cooling, wall-mounted unit with fan on-automatic selector.
        4. [**Single**] [**Two**]-Stage, Heating-Only Thermostat: Wall-mounted unit with fan on-automatic selector.
        5. 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.

Retain "Humidistat" Paragraph below if humidifier is specified.

* + - * 1. Humidistat: Adjustable, [**wall**] [**duct**]-mounted unit.
        2. Control Wiring: Unshielded twisted-pair cabling.

No. 24 AWG, 100 ohm, four pair.

Cable Jacket Color: [**Blue**] <**Insert color**>.

* + - 1. AIR FILTERS
         1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=9880) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

Aprilaire; Research Products Corp.

[Filtrete Home Filtration Products; a 3M brand](http://www.specagent.com/Lookup?uid=123457139092).

[General Filters, Inc](http://www.specagent.com/Lookup?uid=123457139094).

[Permatron Corporation](http://www.specagent.com/Lookup?uid=123457139093).

Approved equivalent.

Retain this article for furnaces using air filters. Retain one or more of paragraphs below. If Project has more than one filter type, indicate filter type for each unit on Drawings.

Sustainable design systems require compliance with ASHRAE 62.1, in which a MERV rating of 6 or higher is required. "Washable Filters" Paragraph below does not comply; "Disposable Filters" Paragraph complies.

* + - * 1. Washable Filters: 1-inch- (25-mm-) thick urethane pad.
        2. 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.
        3. Charged Media Air Filters: Sheet metal housing arranged to be ducted in return-air duct connection to furnace; generates electrostatic charge; MERV 10 rating.
        4. 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:

Standard: UL 586.

Rating: ASHRAE 52.2, 99.97 percent efficiency to 0.30-micrometer particle size.

* + - 1. AIR CLEANERS

Retain this article for air filtration using air cleaners. If Project uses both air filters and air cleaners, indicate type for each unit on Drawings.

* + - * 1. 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.

Standard: UL 586.

Rating: ASHRAE 52.2, particle size to 0.01 micrometer.

Static Pressure Drop: Maximum 0.14-inch wg (35 Pa) at 300-fpm (1.52-m/s) air velocity.

If Project has more than one type or configuration of air cleaner, delete "Capacities and Characteristics" Paragraph below and schedule air cleaner and other components on Drawings.

* + - * 1. Capacities and Characteristics:

Volts: <**Insert value**>.

Phase: <**Insert value**>.

Hertz: <**Insert value**>.

Minimum Circuit Ampacity: <**Insert value**>.

Maximum Overcurrent Protection: <**Insert amperage**>.

* + - 1. UV GERMICIDAL LIGHTS
         1. 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. HUMIDIFIERS
         1. Minimum capacity rating indicated according to AHRI 610.

Retain one of first five paragraphs below. Indicate location, mounting arrangement, and piping connections on Drawings.

* + - * 1. 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.
        2. 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.
        3. Fan-powered, wetted-pad, continuous-drain type with water-flow control orifice and motor; arranged for mounting on duct or plenum.
        4. Pumped, fan-powered, wetted-pad type with reservoir-level control and pump and fan motors; arranged for mounting on duct or plenum.
        5. 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.

First paragraph below may be required to comply with Project requirements or authorities having jurisdiction. Also, sustainable design systems require compliance with ASHRAE 62.1, which defines requirements for drain pans, humidifier water quality, obstructions, and accessibility.

* + - * 1. Comply with applicable requirements in ASHRAE 62.1.

If Project has more than one type or configuration of humidifier, delete "Capacities and Characteristics" Paragraph below and schedule humidifier and other components on Drawings.

* + - * 1. Capacities and Characteristics:

Type: [**Steam**] [**Media wheel**] [**Wetted pad with reservoir**] [**Wetted pad with continuous drain**] [**Wetted-pad bypass**].

Retain "Steam Capacity" Subparagraph below for steam humidifiers.

Steam Capacity: <**Insert lb/h (kg/h)**>.

Retain "Water Connection Size" and "Drain Connection Size" subparagraphs below for media wheel and wetted-pad humidifiers.

Water Connection Size: <**Insert NPS (DN)**>.

Drain Connection Size: <**Insert NPS (DN)**>.

Retain subparagraphs below for media-wheel, fan-powered and pumped, fan-powered humidifiers.

Volts: <**Insert value**>.

Phase: <**Insert value**>.

Hertz: <**Insert value**>.

Minimum Circuit Ampacity: <**Insert value**>.

Maximum Overcurrent Protection: <**Insert amperage**>.

* + - 1. VENTILATION AIR HEAT EXCHANGERS
         1. Cabinet: Steel, with factory-installed interior insulation and manufacturer's standard factory finish. Fabricate with space for piping and electrical conduits.
         2. Heat-Recovery Device: Fixed-plate, polypropylene copolymer (high-density plastic) heat-exchanger plates evenly spaced and sealed and arranged for counter airflow.
         3. Supply and Exhaust Fans: Forward curved centrifugal with direct drive. Motors comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

Sustainable design systems require compliance with ASHRAE 62.1, in which a MERV rating of 6 or higher is required.

* + - * 1. 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.
        2. Wiring: Wire motors and controls so only external connections are required during installation.
      1. REFRIGERATION COMPONENTS
         1. General Refrigeration Component Requirements:

Refrigeration compressor, coils, and specialties shall be designed to operate with CFC-free refrigerants.

"Energy Efficiency" Subparagraph below may be required to comply with Project requirements or authorities having jurisdiction. Also, sustainable design systems require minimum efficiency equal to requirements in ASHRAE/IES 90.1.

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

"Refrigerant Coil" Paragraph below may be required to comply with Project requirements or authorities having jurisdiction. Also, sustainable design systems require compliance with ASHRAE 62.1, which defines requirements for drain pans, humidifier water quality, obstructions, and accessibility.

* + - * 1. 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**].

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.

Retain "Refrigerant Line Kits" or "Refrigerant Piping" Paragraph below for refrigerant piping. Retain first paragraph for precharged refrigerant line kits if Project conditions allow standard lengths of tubing without joints; retain second for refrigerant tubing if distance does not allow refrigerant tubing kits.

* + - * 1. 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.

Sustainable design systems require that pipe insulation thickness comply with ASHRAE/IES 90.1, "Minimum Pipe Insulation Thickness." Requirements for minimum insulation thickness vary by pipe size and temperature.

Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I, [**1/2 inch (13 mm)**] [**1 inch (25 mm)**] <**Insert dimension**> thick.

* + - * 1. Refrigerant Piping: Comply with requirements in Section 232300 "Refrigerant Piping."
        2. Air-Cooled Compressor-Condenser Unit:

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.

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

Crankcase heater.

[**Restrained vibration**] [**Vibration**] isolation mounts for compressor.

Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

Two-speed compressor motors shall have manual-reset high-pressure switch and automatic-reset low-pressure switch.

Retain "Refrigerant Charge" or "Refrigerant" Subparagraph below to require a specific refrigerant type; delete both if any refrigerant type is acceptable.

Refrigerant Charge: [**R-407C**] [**R-410A**] <**Insert type**>.

Refrigerant: R-407C or R-410A.

Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with liquid subcooler.

Heat-Pump Components: Reversing valve and low-temperature air cut-off thermostat.

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

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

Low Ambient Kit: Permits operation down to 45 deg F (7 deg C).

Mounting Base: Polyethylene.

If Project has more than one type or configuration of refrigeration component, delete "Capacities and Characteristics" Paragraph below and schedule refrigeration component and other components on Drawings.

* + - * 1. Capacities and Characteristics:

Refrigerant Coil:

Total Cooling Capacity: <**Insert Btu/h (kW)**>.

Sensible Cooling Capacity: <**Insert Btu/h (kW)**>.

Heating Capacity: <**Insert Btu/h (kW)**>.

Maximum Air Pressure Drop: <**Insert inches wg (Pa)**>.

Condensate Drain Size: <**Insert NPS (DN)**>.

Compressor-Condenser Unit:

Cooling Energy Efficiency[**(EER)**] [**(SEER)**]: <**Insert value**>.

Retain "Heating Coefficient of Performance" Subparagraph below for heat pump applications.

Heating Coefficient of Performance: <**Insert value**>.

Volts: <**Insert value**>.

Phase: <**Insert value**>.

Hertz: <**Insert value**>.

Full-Load Amperes: <**Insert value**>.

Minimum Circuit Ampacity: <**Insert value**>.

Maximum Overcurrent Protection: <**Insert amperage**>.

Fan Motor Full-Load Amperes: <**Insert value**>.

Compressor Running-Load Amperes: <**Insert value**>.

Compressor Motor Full-Load Amperes: <**Insert value**>.

1. EXECUTION
   * + 1. EXAMINATION
          1. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
          2. Examine factory-installed insulation before furnace installation. Reject units that are wet, moisture damaged, or mold damaged.
          3. Examine roughing-in for oil[**and refrigerant**] piping systems to verify actual locations of piping connections before equipment installation.
          4. Proceed with installation only after unsatisfactory conditions have been corrected.
       2. INSTALLATION
          1. Install oil-fired furnaces and associated fuel and vent piping according to NFPA 31.
          2. 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.

Delete subparagraph below if Project site is aseismic.

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

* + - * 1. Base-Mounted Units: Secure units to substrate. Provide optional bottom closure base if required by installation conditions.

Delete subparagraph below if Project site is aseismic.

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

* + - * 1. Controls: Install thermostats and humidistats at mounting height of 60 inches (1500 mm) above floor.
        2. 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.

Retain one of first two paragraphs below.

* + - * 1. 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." Coordinate anchor installation with concrete base.
        2. Install ground-mounted compressor-condenser components on polyethylene mounting base.
        3. Install roof-mounted compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
      1. CONNECTIONS

Coordinate piping installations and specialty arrangements with Drawings and requirements specified in piping systems. If Drawings are explicit enough, these requirements may be reduced or omitted.

* + - * 1. Oil piping installation requirements are specified in Section 231113 "Facility Fuel-Oil Piping." Drawings indicate general arrangement of piping, fittings, and specialties. Connect oil piping with union or flange and [**ball**] [**gate**] valve.
        2. Install piping adjacent to equipment to allow service and maintenance.

Retain first paragraph below for furnaces with humidifiers.

* + - * 1. 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.
        2. Vent Connections: Connect Type L vents to furnace vent connection and extend outdoors. Type L vents and their installation requirements are specified in Section 235123 "Gas Vents."
        3. Connect ducts to furnace with flexible connector. Comply with requirements in Section 233300 "Air Duct Accessories."

Retain one of two paragraphs below for refrigerant piping. Retain first paragraph for precharged refrigerant line kits if Project conditions allow standard lengths of tubing without joints; retain second for refrigerant tubing if distance does not allow refrigerant tubing kits.

* + - * 1. Connect refrigerant tubing kits to refrigerant coil in furnace and to air-cooled, compressor-condenser unit.

Retain "Flared Joints," "Soldered Joints," or "Brazed Joints" Subparagraph below. See the Evaluations in Section 232300 "Refrigerant Piping" for a discussion on soldering and brazing refrigerant piping.

Flared Joints: Use ASME B16.26 fitting and flared ends, following procedures in CDA's "Copper Tube Handbook."

Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.

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.

* + - * 1. Comply with requirements in Section 232300 "Refrigerant Piping" for installation and joint construction of refrigerant piping.
      1. FIELD QUALITY CONTROL

Retain "Perform the following tests and inspections" Paragraph below to require Contractor to perform tests and inspections.

* + - * 1. Perform the following tests and inspections:

Perform electrical test and visual and mechanical inspection.

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.

Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.

Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.

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

* + - * 1. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
      1. STARTUP SERVICE
         1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

Inspect for physical damage to unit casings.

Verify that access doors move freely and are weathertight.

Clean units and inspect for construction debris.

Verify that all bolts and screws are tight.

Adjust vibration isolation and flexible connections.

Verify that controls are connected and operational.

Retain first paragraph below for units with belt-driven fans.

* + - * 1. Adjust fan belts to proper alignment and tension.
        2. Start unit according to manufacturer's written instructions and complete manufacturer's operational checklist.
        3. Measure and record airflows.
        4. Verify proper operation of capacity control device.

Retain option in paragraph below for units with belt-driven condenser fans.

* + - * 1. After startup and performance test, lubricate bearings[**and adjust belt tension**].
      1. ADJUSTING
         1. Adjust initial temperature and humidity set points.
         2. 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.
      2. CLEANING
         1. After completing installation, clean furnaces internally according to manufacturer's written instructions.
         2. Install new filters in each furnace within 14 days after Substantial Completion.
      3. DEMONSTRATION
         1. Train Facility’s maintenance personnel to adjust, operate, and maintain condensing units. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 235416.16