

**SECTION 23 81 00
DECENTRALIZED UNITARY HVAC EQUIPMENT**

SPEC WRITER NOTE:

1. Delete between //---// if not applicable to project. Also delete any other item or paragraph not applicable in the section and renumber the paragraphs.
2. Provide the year of latest edition to each publication listed in Article 1.5 APPLICABLE PUBLICATIONS.

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies // self-contained, // split-systems, // rooftop, // room-type, // and // through-the-wall packaged terminal // air conditioners//and gas-fired furnaces//.
- B. Definitions:
 1. Energy Efficiency Ratio (EER): The ratio of net cooling capacity is Btu/h to total rate of electricity input in watts under designated operating conditions (Btu hour/Watt).
 2. Seasonal Energy Efficiency Ratio (EER): The ratio of the total cooling output of an air conditioner during its normal annual usage period for cooling in Btu/h divided by total electric energy input in watts during the same period (Btu hour/Watt).
 3. Unitary: A Unitary Air Conditioner consists of one or more factory-made assemblies which normally include an evaporator or cooling coil, a compressor and condenser combination, and may include a heating function as well.
 4. Where such equipment is provided in more than one assembly the separated assemblies are to be designed to be used together and the requirements of rating are based upon use of matched assemblies.

1.2 RELATED WORK

- //A. Section 01 00 00, GENERAL REQUIREMENTS. //
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES
- C. Section 03 30 00, CAST-IN-PLACE CONCRETE.
- D. Section 07 72 00, ROOF ACCESSORIES.
- E. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

- F. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT
- G. Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- //H. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.//
- //I. Section 23 07 11, HVAC and BOILER PLANT INSULATION.//
- J. Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS.
- K. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- L. Section 23 11 23, FACILITY NATURAL-GAS PIPING.
- //M. Section 23 23 00, REFRIGERANT PIPING.//
- N. Section 23 31 00, HVAC DUCTS and CASINGS.
- //O. Section 23 36 00, AIR TERMINAL UNITS.//.//
- Q. Section 23 72 00, AIR-TO-AIR ENERGY RECOVERY EQUIPMENT.
- //R. Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS.//
- //S. Section 23 74 13, PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS.//
- //T. Section 23 81 23, COMPUTER-ROOM AIR-CONDITIONERS. //
- U. Section 23 82 16, AIR COILS
- V. Section 28 31 00, FIRE DETECTION and ALARM.

1.3 QUALITY ASSURANCE

- A. Refer to specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Safety Standards: ASHRAE Standard 15, Safety Code for Mechanical Refrigeration.

1.4 SUBMITTALS

- A. Submit in accordance with specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES
- B. Manufacturer's literature and data:
 1. Sufficient information, including capacities, pressure drops, and piping connections clearly presented, shall be included to determine compliance with drawings and specifications for units noted below:
 - a. Unitary air conditioners:
 - 1) Self-contained units
 - 2) Split systems
 - 3) Rooftop units
 - b. Window air conditioners
 - c. Through-the-wall packaged terminal air conditioning units
 - d. Gas-Fired Furnaces

2. Unit Dimensions required clearances, operating weights accessories and start-up instructions.
 3. Electrical requirements, wiring diagrams, interlocking and control wiring showing factory installed and portions to be field installed.
 4. Mounting and flashing of the roof curb to the roofing structure with coordinating requirements for the roof membrane system.
- C. Certification: Submit proof of specified ARI Certification.
- D. Performance Rating: Submit catalog selection data showing equipment ratings and compliance with required sensible-to-heat-ratio, energy efficiency ratio (EER), and coefficient of performance (COP).
- E. Operating and Maintenance Manual: Submit three copies of Operating and Maintenance manual to Resident Engineer three weeks prior to final inspection.
- F. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

SPEC WRITER NOTE: Insert the year of approved latest edition of the publications between the brackets //----// and delete the brackets if applicable to this project.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):
- 210/240-//2017//.....Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment
- 270-//2015//.....Sound Rating of Outdoor Unitary Equipment
- 310/380-//2017//.....Standard for Packaged Terminal Air-Conditioners and Heat Pumps (CSA-C744-04)
- 340/360-//2015//.....Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment
- 520-//2004//.....Performance Rating of Positive Displacement Condensing Units
- C. Air Movement and Control Association (AMCA):

- 210-//2016//.....Laboratory Methods of Testing Fans for
Aerodynamic Performance Rating (ANSI)
- 410-//1996//.....Recommended Safety Practices for Users and
Installers of Industrial and Commercial Fans
- D. American National Standards Institute (ANSI):
- S12.51-//2017//.....Acoustics - Determination of Sound Power Levels
of Noise Sources Using Sound Pressure -
Precision Method for Reverberation Rooms (same
as ISO 3741:1999)
- E. American Society of Civil Engineers (ASCE)
- ASCE 7-//2017//.....Minimum Design Loads for Buildings and Other
Structures
- F. American Society of Heating, Refrigerating, and Air-Conditioning
Engineers (ASHRAE):
- Handbook //2016//.....HVAC Systems and Equipment
- 15-//2019//.....Safety Standard for Refrigeration Systems
(ANSI)
- 62.1-//2016//.....Ventilation for Acceptable Indoor Air Quality
(ANSI)
- G. American Society of Testing and Materials (ASTM):
- B117-//2018//.....Standard Practice for Operating Salt Spray
(Fog) Apparatus
- H. Federal Specifications (Fed. Spec.):
- A-A-50502-//2009//..... Air conditioner (Unitary Heat Pump) Air to Air
(3000-300,000 Btu)
- I. Military Specifications (Mil. Specs.):
- MIL-PRF-26915D-//---//.Primer Coating, for Steel Surfaces
- J. National Electrical Manufacturer's Association (NEMA):
- ICS 1-//2005//.....Industrial Controls and Systems: General
Requirements
- MG 1-//2019//.....Motors and Generators (ANSI)
- K. National Fire Protection Association (NFPA) Publications:
- 90A-//2018//.....Standard for the Installation of Air-
Conditioning and Ventilating Systems

PART 2 - PRODUCTS

2.1 UNITARY AIR CONDITIONERS - GENERAL

- A. Applicable ARI Standards:
1. Cooling Capacity 39.6 kW (135,000 Btu/h) and More: AHRI 340/ 360.

2. Cooling Capacity Less Than 39.6 kW (135,000 Btu/h): AHRI 210/240.

Units shall be listed in the ARI Directory of Certified Unitary Air-Conditioners.

- B. Performance Rating: Cooling capacity of units shall meet the sensible heat and total heat requirements shown in the contract documents. In selecting unit size, make true allowance for "sensible to total heat ratio" to satisfy required sensible cooling capacity.
- C. Machinery Guards: Provide guards as shown in AMCA 410 for belts, chains, couplings, pulleys, sheaves, shafts, gears and other moving parts regardless of height above the floor. Drive guards may be excluded where motors and drives are inside factory fabricated casings.

DESIGNER'S NOTE: See HVAC Design Manual for high humidity areas.

- D. Corrosion Prevention: Unless specified otherwise, equipment fabricated from ferrous metals that do not have a zinc coating or a duplex coating of zinc and paint shall be treated for prevention of rust with a factory coating or paint system that will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall be tested for 500 hours. The salt-spray fog test shall be in accordance with ASTM B117 using a 20 percent sodium chloride solution. Immediately after completion of the test, the coating shall show no signs of blistering, wrinkling or cracking, no loss of adhesion, and the specimen shall show no signs of rust beyond 3 mm (1/8-inch) on both sides from the scratch mark. //For units located in high humidity areas, provide factory-coated coils for protection from corrosion by using multiple stage electro-deposition coating process. Refer to Drawings and Section 23 82 16, AIR COILS, for additional coil requirements. //

2.2 SELF-CONTAINED AIR CONDITIONERS

- A. Description: Factory assembled and wired consisting of the following:
1. Cabinet.
 2. Compressor.
 3. Evaporator fan.
 4. Evaporator coil,
 5. Integral // air-cooled // water-cooled // condenser.
 6. // Steam // Hot-water // Electric-resistance // heating coil.
 7. Air filters.
 8. Controls.

9. Full charge of refrigerant and oil.
- B. Cabinet Frame and Panels: Structural-steel frame with galvanized-steel panels with baked-enamel finish in color selected by Architect, and with access doors or panels.
1. Insulation: Minimum 25-mm (1-inch) thick, // neoprene coated// aluminum foil faced// glass fiber duct liner on cabinet interior and control panel.
 2. Drain Pan: // Galvanized steel with corrosion-resistant coating // Molded corrosion-resistant material// Stainless steel // insulated// complying with ASHRAE 62.1-2007.
 3. Isolation: Spring isolators for mounting under base of unit, with minimum static deflection of 25 mm (1 inch).
 4. Discharge Plenum: // Cabinet extension with directional louvers. // Cabinet extension with duct openings for supply air and lined with a minimum of 50-mm (2-inch) thick duct liner //.
 5. Corrosion-Resistant Treatment: Phenolic coating on unit interior and exterior.
 6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Evaporator Fan: Galvanized steel, double-width, double-inlet, // forward-curved // airfoil // centrifugal fan; statically and dynamically balanced. // Direct // Belt // drive, with fan mounted on permanently lubricated bearings and having cast-iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed. Motor sheaves shall be variable and adjustable pitch selected so required rpm are obtained when set at middle position. Fan and motor shall be resiliently mounted with ratings as recommended by the manufacturer with a minimum of one and one-half times nameplate rating of motor. Bearings shall be grease lubricated with grease lines extended to exterior of unit. Variable-air volume units shall have variable frequency drives with adjustable, static-pressure controller responding to a static-pressure sensor and variable-frequency motor controller.
- D. Fan Motors: Comply with requirements in Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT and shall be // multi-speed, PSC type // open dripproof // totally enclosed fan cooled //, premium efficiency. //

- E. Isolation: Mount fan and motor on common sub-base and mount assembly on spring isolators with minimum static deflection of 25 mm (1 inch) unless otherwise indicated.
- F. Compressor hermetically sealed, scroll, 3600 rpm maximum, and resiliently mounted with positive lubrication and internal motor protection. //Furnish each compressor with independent refrigeration circuits. //
- G. Evaporator Coil: Direct-Expansion Coil: Seamless copper tubes expanded into aluminum fins// with interlaced circuiting//:
1. Corrosion-Resistant Treatment: Phenolic coating applied with multiple dips and baked. //For units located in high humidity areas, provide factory-coated coils for protection from corrosion by using multiple stage electro-deposition coating process. Refer to Drawings and Section 23 82 16, AIR COILS, for additional coil requirements. //
- H. Refrigerant Circuits: A separate circuit for each compressor, with externally equalized thermal-expansion valve with // adjustable superheat //, filter-dryer, sight glass, high-pressure relief valve, and charging valves.
- I. Water-Cooled Condenser: Copper tubes in steel shell with removable heads, for 2760-kPa (400-psig) waterside working pressure.
1. ASME Compliance: For units larger than 15 tons fabricate and label water-cooled condensers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.
 2. Water-Flow Switch.
- J. Remote Air-Cooled Condenser: Factory assembled and tested; consisting of condenser coil, fans and motors, and operating controls; and suitable for roof mounting.
1. Condenser Coil: Aluminum-fin copper tube with integral subcooler; leak tested to 3110 kPa (450 psig). //For units located in high humidity areas, provide factory-coated coils for protection from corrosion by using multiple stage electro-deposition coating process. Refer to Drawings and Section 23 82 16, AIR COILS, for additional coil requirements. //
 2. Condenser Fans: Direct-drive propeller type.
 3. Fan Motors: Three-phase//or single phase//, permanently lubricated, ball-bearing motors with built-in thermal-overload protection.

Comply with requirements in Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.

- //4. Furnish low ambient controls to allow stable operation down to minus 18 degrees C (0 degrees F). //
- K. Refrigerant Line Kits: Annealed-copper suction and liquid lines that are factory cleaned, dried, pressurized, and sealed; insulated suction line; flared fittings at evaporator end, no fitting at condenser end; and service valves for both suction and liquid lines.
- L. Integral Air-Cooled Condenser for Units 52.8 kW (15 tons) and Smaller. Factory assembled and tested; consisting of condenser coil, fans and motors, and cabinet:
1. Condenser Coil: Aluminum-fin copper tube with integral sub cooler; leak tested to 2930 kPa (425 psig). //For units located in high humidity areas, provide factory-coated coils for protection from corrosion by using multiple stage electro-deposition coating process. Refer to Drawings and Section 23 82 16, AIR COILS, for additional coil requirements. //
 2. Condenser Fans: Direct-drive propeller type with permanently lubricated motor with built-in thermal-overload protection.
 3. Low Ambient Control: Cycles fans to permit operation down to minus 18 deg C (0 deg F).
- M. Refrigeration System: Factory assembled and tested, and charged with refrigerant; and consisting of piping and accessories connecting compressor, evaporator coil, and condenser coil, and including the following:
1. For heat pump units, a four-way reversing valve and suction-line accumulator.
 2. Expansion valve with replaceable thermostatic element.
 3. Refrigerant dryer.
 4. High-pressure switch.
 5. Low-pressure switch.
 6. Thermostat for coil freeze-up protection during low-ambient temperature operation or loss of air.
 7. Low-ambient switch.
 8. Brass service valves installed in discharge and liquid lines.
 9. //R-407C // R-410A // refrigerant unless otherwise indicated.
- N. Terminate suction and liquid refrigerant piping with service valves within unit.

- O. Low Ambient Control: //Cycle fans to permit operation down to 7 deg C (45 deg F). // For units larger than 52.8 kW (15 tons), cycle fans and modulate condenser fan damper assembly to permit operation down to minus 18 deg C (0 deg F) //.
- P. Coil Guard: Painted galvanized steel with louvered grilles.
- Q. Corrosion-Resistant Treatment: Phenolic coating applied in multiple dips and baked. See paragraph 2.1.D above.
- R. Heating Coil:
1. // Water // Steam // Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 10 fins per 25 mm (1 inch); leak tested to 2070 kPa (300 psig) underwater; and having a modulating control valve.
 2. Electric-Resistance Heating 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.
- S. Air Filters:
- SPEC WRITER NOTE: Retain one of first two paragraphs below. If Project has more than one filter type, indicate filter type for each unit on Drawings. Pleated filters in second paragraph are not available in 1-inch (25-mm) thickness. One-inch-thick option may be all that is available on units 15 tons (50 kW) and smaller.
1. Disposable Filters: // 25 mm (1 inch)// 50 mm (2 inch) // thick, glass-fiber, //flat // pleated // MERV 7 panel filters.
 2. Extended-Surface, Disposable Panel Filters: // 50 mm (2 inch) // 100 mm (4 inch) // thick, MERV 8, dry, filters with fibrous media material formed into deep-V-shaped pleats and held by self-supporting wire grid holding frames, with nonflammable cardboard media and media-grid frame.
 3. Filter Efficiency: MERV rating as specified above according to ASHRAE 52.2.
 4. Air-Pressure Switch: Indicates dirty filters.
- T. Controls:

1. Control Package: Factory wired, including contactor, high- and low-pressure cutouts, internal-winding thermostat for compressor, control-circuit transformer, and noncycling reset relay.
 2. Time-Delay Relay: Five-minute delay to prevent compressor cycling.
 3. Adjustable Thermostat: // Unit mounted // // Remote // to control the supply fan, compressor, condenser; and hot-water or steam coil valve or electric-resistance heating coil.
 4. System Selector Switch: // Heat-off-cool // // Off-heat-auto-cool //.
 5. Fan Control Switch: Auto-on.
 6. Time Clock: Cycle unit on and off.
 7. Microprocessor Control Panel: Control unit functions, including refrigeration and safety controls, supply-fan motor speed, compressors, air-cooled condenser, cooling tower pump, modulating hot-water coil valve, modulating, steam coil valve and multi-step, electric-resistant heating coil. Time-of-day control shall cycle unit on and off Night-heat and morning warm-up cycle.
 8. DDC Interface: Controls shall interface with the BMS system.
//Provide open protocol BACnet interface. //
 9. Panel-mounted control switch shall operate unit in remote or local control mode, or to stop or reset.
 10. Panel-mounted indication of the operating status system diagnostics and safety alarms, supply-air temperature set point, zone heating-temperature set point, supply-air pressure set point, economizer minimum position set point, supply-air pressure, and high-limit set point. Time-of-day control shall cycle unit on and off and night-heat and morning warm-up cycle.
- U. Ventilation Options for Units 52.8 kW (15 tons) and Smaller:
1. //Barometric Outside-Air Damper: Adjustable-blade damper allowing induction of up to 25 percent outside air when evaporator fan is running. //Motorized Outside-Air Damper: Motorized, two-position blade damper allowing induction of up to 25 percent outside air; with spring-return, low-voltage damper motor.//
 2. Economizer: Damper assembly allowing induction of up to 100 percent outside air to maintain a selected mixed-air temperature; and exhaust damper and spring-return, low-voltage, modulating damper motor with minimum position adjustment.

SPEC WRITER NOTE: In general, an economizer (paragraph above) should be eliminated if an energy recovery ventilator is provided (these components do not operate properly together).

//3. Energy-Recovery Ventilator: Assembly of desiccant-coated, heat-recovery wheels and centrifugal exhaust fans to transfer approximately 67 percent of the difference between the sensible and latent heat of outside and exhaust air. Refer to Section 23 72 00, AIR-TO-AIR ENERGY RECOVERY EQUIPMENT. //

V. Economizer options for Units Larger than 52.8 kW (15 tons):

1. Air-Side Economizer: Damper assembly allowing induction of up to 100 percent outside air to maintain a selected mixed-air temperature. Damper assembly with exhaust damper and spring-return, and low-voltage, modulating damper motor with minimum position adjustment.
2. Water-Side Economizer: Mechanically cleanable, aluminum-fin, copper-tube coil assembly, // two // four // rows deep, allowing precooling of inlet air using condenser water; with piping and bypass control valves.

2.3 SPLIT-SYSTEM AIR CONDITIONERS

- A. Description: Factory assembled and tested, // floor-mounted // wall-mounted // ceiling mounted // unit, with // an air- // water- // cooled remote condensing unit, and field-installed refrigeration piping. Unit shall include a //hot-water // steam // electric-resistance // heating coil.
- B. Concealed Evaporator Components:
 1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
 2. Insulation: Factory-applied duct liner.
 3. Drain Pans: Galvanized steel, with connection for drain; insulated and complying with ASHRAE 62.1.
 4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
 5. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with thermal-expansion valve.
 6. // Water // Steam // Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 10 fins per 25 mm (1 inch); leak

tested to 2070 kPa (300 psig) underwater; and having a modulating control valve.

SPEC WRITER'S NOTE: Provide staged or SCR control of electric coils as required.

7. Electric-Resistance Heating 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. Provide //minimum two-stage//SCR// control of electric heating coils as indicated.
 8. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
 9. Fan Motors: Comply with requirements in Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT for multi-tapped, multi-speed motors with internal thermal protection and permanent lubrication.
 10. Disposable Filters: 25 mm (1 inch) thick, in fiberboard frames // with MERV rating of 7 or higher according to ASHRAE 52.2 //.
 11. Wiring Terminations: Connect motor to chassis wiring with plug connection.
- C. Floor-Mounting, Evaporator-Fan Components:
1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect.
 2. Discharge Grille: // Steel with surface-mounted frame // welded steel bars forming a linear grille and welded into supporting panel //.
 3. Insulation: Factory-installed duct liner.
 4. Drain Pans: Galvanized steel, with connection for drain; insulated and complying with ASHRAE 62.1.
 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
 6. Coils:
 - a. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with thermal-expansion valve.
 - b. // Water // Steam // Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 10 fins per 25 mm (1 inch);

leak tested to 2070 kPa (300 psig) underwater; and having a modulating control valve.

SPC WRITER'S NOTE: Provide staged or SCR control of electric coils as required.

- c. Electric-Resistance Heating 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. Provide //minimum two-stage//SCR// control of electric heating coils as indicated.
- 7. Fan: Direct drive, centrifugal.
- 8. Fan Motors: Comply with requirements in Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT for // multi-tapped, multi-speed motors with internal thermal protection and permanent lubrication.
- 9. Filters: Disposable, with MERV rating of 7 or higher according to ASHRAE 52.2.
- D. Wall-Mounting, 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. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1. Drain Pan and Drain Connection: Comply with ASHRAE 62.1-2007.
 - 4. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with thermal-expansion valve.
 - 5. Electric-Resistance Heating 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 fan.
 - 7. Fan Motors: Comply with requirements in Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT for multi-tapped, multi-speed motors with internal thermal protection and permanent lubrication.

8. Filters: Disposable, with MERV rating of 7 or higher according to ASHRAE 52.2.

E. Ceiling-Mounting, 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. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
3. Drain Pan and Drain Connection: Comply with ASHRAE 62.1.
4. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with thermal-expansion valve.
5. Electric-Resistance Heating 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 fan, and integral condensate pump.
7. Fan Motors: Comply with requirements in Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT for multi-tapped, multi-speed motors with internal thermal protection and permanent lubrication.
8. Filters: Disposable, with MERV rating of 7 or higher according to ASHRAE 52.2.

F. 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. Service valves, fittings, and gage ports shall be brass and located outside of the casing.
2. Compressor: Hermetically sealed // reciprocating // scroll // with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
3. Compressor motor with manual-reset, high-pressure switch and automatic-reset, low-pressure switch.
4. Refrigerant: // R-407C // R-410A // unless otherwise indicated.
5. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with liquid subcooler.

6. Fan: Aluminum, propeller type, directly connected to motor.
 7. Motor: Permanently lubricated, with integral thermal-overload protection.
 8. Low Ambient Kit: Permit operation down to minus 18 deg C (0 deg F).
 9. Mounting Base: Polyethylene.
 10. Minimum Energy Efficiency: Comply with ASHRAE/IESNA 90.1 "Energy Standard for Buildings except Low-Rise Residential Buildings."
- G. Water-Cooled, Compressor-Condenser Components:
1. Casing: Steel, with baked-enamel finish in color selected by Architect, removable panels for access to controls, and mounting holes in base. Service valves, fittings, and gage ports shall be brass and located on outside of casing.
 2. Compressor: Hermetically sealed // reciprocating // scroll // with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 3. Compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 4. Refrigerant: //R-407C // R-410A // unless otherwise indicated.
 5. Heat Exchanger: Copper tubes in copper tube or in steel shell, with water-temperature-actuated, water-regulating valve.
 6. Minimum Energy Efficiency: Comply with ASHRAE/IESNA 90.1, "Energy Standard for Buildings except Low-Rise Residential Buildings."

2.4 ROOFTOP AIR CONDITIONERS

- A. Casing: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed. Exterior casing of // 1.3 mm (0.052 inch) // 1.6 mm (0.0626 inch) // 2.0 mm (0.079 inch) // thick galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs. Galvanized inner casing of // 0.86 mm (0.034 inch) // 0.7 mm (0.028 inch) // thick, // perforated 40 percent free area //. Casing insulation and adhesive shall comply with NFPA 90A or NFPA 90B and comply with ASTM C 1071, Type I and shall be // 13 mm (1/2 inch) // 25 mm (1 inch) // thick. Space between double wall panels filled with foam insulation and sealed moisture tight. Removable cam latched access panel to allow access to internal parts.

DESIGNER'S NOTE: See HVAC Design Manual for high humidity areas.

- B. Corrosion Prevention: Paint shall be treated for prevention of rust with a factory coating or paint system that will withstand 500 hours in a salt-spray fog test. The salt-spray fog test shall be in accordance with ASTM B117 using a 20 percent sodium chloride solution. //For units located in high humidity areas, provide factory-coated coils for protection from corrosion by using multiple stage electro-deposition coating process. Refer to Drawings and Section 23 82 16, AIR COILS, for additional coil requirements. //
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- //D. Supply-Air Fan: Direct driven, double width, // forward curved // backward inclined //, centrifugal; with permanently lubricated, // multi-speed // EC // motor resiliently mounted in the fan inlet. Fan wheel shall be aluminum or painted-steel, and fan scroll shall be galvanized- or painted-steel. //
- //E. Supply-Air Fan: Belt-driven, double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Fan wheel shall be aluminum or painted-steel and fan scroll shall be galvanized- or painted-steel. //
- F. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.
- G. Relief-Air Fan: // Propeller // Forward curved // Backward inclined //, shaft mounted on permanently lubricated motor.
- //H. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT when fan-mounted frame and RTU-mounted frame are anchored to building structure. //

SPEC WRITE NOTE: Motor characteristics such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency are specified in Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT. If different characteristics are required, add subparagraphs to paragraph below to suit Project.

- I. Fan Motor: Comply with requirements in Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.
- J. Supply-Air Refrigerant Coil: // Aluminum // Copper // -plate fins and seamless // internally grooved // copper tube in steel casing with equalizing-type vertical distributor. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan. Coil split shall be interlaced. Coil shall have // baked phenolic // cathodic epoxy // coating.
- K. Condensate Drain Pan: Formed sections of stainless-steel sheet, a minimum of 50 mm (2 inches) deep and complying with ASHRAE 62.1. Drain connections shall be threaded nipple // both sides of drain pan //.
- L. Outdoor-Air Refrigerant Coil: // Aluminum // Copper // -plate fins and seamless // internally grooved // copper tube in steel casing with equalizing-type vertical distributor. Polymer strip shall prevent copper coil from contacting steel coil frame or condensate pan. Coil shall have // baked phenolic // cathodic epoxy // coating.
- M. Hot-Gas Reheat Refrigerant Coil: // Aluminum // Copper // -plate fins and seamless // internally grooved // copper tube in steel casing with equalizing-type vertical distributor. Polymer strip shall prevent copper coil from contacting steel coil frame or condensate pan. Coil shall have // baked phenolic // cathodic epoxy // coating.
- N. Electric-Resistance Heating 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.
1. Terminals: Stainless-steel machine-staked terminals secured with stainless-steel hardware.
 2. Overtemperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box.
 3. Overcurrent Protection: Manual-reset thermal cutouts, factory wired in each heater stage.
 4. Control Panel: Unit mounted with disconnecting means and overcurrent protection and shall include // magnetic // mercury // contactors.
 5. Step Controller: Have pilot lights and override toggle switch for each step.
 6. SCR Controller: Have pilot lights operate on load ratio, a minimum of five steps.

- 7. Time-delay relay.
 - 8. Airflow proving switch.
- O. Refrigerant Circuit Components:
- 1. Number of Independent Refrigerant Circuits: // One // Two //.
 - 2. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief //, and crankcase heater //.
- P. Refrigerant: //R-407C // R-410A // unless otherwise indicated.
- Q. Refrigeration Specialties:
- 1. Expansion valve with replaceable thermostatic element.
 - 2. Refrigerant filter/dryer.
 - 3. Manual-reset high-pressure safety switch.
 - 4. Automatic-reset low-pressure safety switch.
 - 5. Minimum off-time relay.
 - 6. Automatic-reset compressor motor thermal overload.
 - 7. Brass service valves installed in compressor suction and liquid lines.
 - 8. Low-ambient kit high-pressure sensor.
 - 9. Hot-gas reheat solenoid valve with a replaceable magnetic coil.
 - 10. Hot-gas bypass solenoid valve with a replaceable magnetic coil.
 - 11. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.
- R. Air Filtration: Minimum arrestance according to ASHRAE 52.1, and MERV rating according to ASHRAE 52.2.
- //1. Glass Fiber: Minimum 80 percent arrestance, and MERV 5. //
 - //2. Pleated: Minimum 90 percent arrestee, and MERV 7.//
- S. Gas Furnace: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54. Furnace shall be designed and certified by and bearing label of CSA.
- 1. Burners: Stainless steel.
 - 2. Fuel: // Natural // Propane //gas.
 - 3. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
 - 4. High-Altitude // Model // Kit //: For Project elevations more than 610 m (2000 feet) above sea level.
 - 5. Heat-Exchanger and Drain Pan: Stainless steel.
 - 6. Venting: Gravity vented // with vertical extension //.

7. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve // with vertical extension //.
8. Safety Controls:
 - a. Gas Control Valve: // Single stage // Two stage // Modulating //.
 - b. 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.
- T. Outdoor-Air Damper: Linked damper blades, for 0 to 25 percent outdoor air, with // manual // motorized // damper filter.
- U. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
- V. Damper Motor: Modulating with adjustable minimum position.
- W. Relief-Air Damper: Gravity actuated or motorized, complying with ASHRAE/IESNA 90.1, and having bird screen and hood.
- X. Electrical Power Connection: A single connection of power to unit with // unit-mounted disconnect switch accessible from outside unit and // control-circuit transformer with built-in overcurrent protection.
- Y. Controls:
 1. Basic Unit Controls:
 - a. Control-voltage transformer.
 - b. Wall-mounted thermostat or sensor with heat-cool-off switch.
 - c. Fan on-auto switch.
 - d. Fan-speed switch.
 - e. // Manual // Automatic // changeover.
 - f. Adjustable deadband.
 - g. // Concealed // Exposed // set point.
 - h. // Concealed // Exposed // indication.
 - i. // Degree C // Degree F // indication.
 - j. Unoccupied-period-override push button.
 - k. Data entry and access port to input temperature set points, occupied and unoccupied periods, and output room temperature, supply-air temperature, operating mode, and status.

1. // Remote wall // Unit-mounted annunciator panel with lights to indicate power on, cooling, heating, fan running, filter dirty, and unit alarm or failure.
- m. DDC controller or programmable timer and interface with HVAC instrumentation and control system and to digital display outdoor-air temperature, supply-air temperature, return-air temperature, economizer damper position, indoor-air quality, and control parameters. Interface with BMS/DDC system via BACnet open protocol.
2. //Electronic //DDC// controller shall have volatile-memory backup.
3. Safety Control Operation:
 - a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected and with additional contacts for alarm interface to fire alarm control panel.
 - b. Fire Stats: Stop fan and close outdoor-air damper if air greater than 54 deg C (130 deg F)] enters unit and with additional contacts for alarm interface to fire alarm control panel.
 - c. Fire Alarm Control Panel Interface: Control interface to coordinate with operating sequence described in Section 28 31 00, FIRE DETECTION and ALARM.
 - d. Low-Discharge Temperature: Stop fan and close outdoor-air damper if supply air temperature is less than 4 deg C (40 deg F)].
 - e. Defrost Control for Condenser Coil: Pressure differential switch to initiate defrost sequence.
4. Scheduled Operation: Occupied and unoccupied periods on // 7 // 365 // -day clock with a minimum of // 2 // 4 // programmable periods per day.
5. Unoccupied Period: Heating Setback: 5.6 deg C (10 deg F)].
6. Cooling Setback: System off.
7. Override Operation: Two hours unless otherwise indicated.
8. Supply Fan Operation:
 - a. Occupied Periods: Run fan continuously.
 - b. Unoccupied Periods: Cycle fan to maintain setback temperature.
9. Refrigerant Circuit Operation:
 - a. Occupied Periods: Cycle or stage compressors // and operate hot-gas bypass // to match compressor output to cooling load to maintain // room // discharge // temperature //. Cycle condenser

- fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.
- b. Unoccupied Periods: Compressors off
10. Gas Furnace Operation:
- a. Occupied Periods: // Cycle // Stage // Modulate // burner to maintain // room // discharge // temperature.
 - b. Unoccupied Periods: Cycle burner to maintain setback temperature.
11. Electric-Resistance Heating-Coil Operation:
- a. Occupied Periods: // Cycle // Stage / Modulate // coil to maintain // room // discharge // temperature.
 - b. Unoccupied Periods: Energize coil to maintain setback temperature.
 - c. Supplemental Electric Heat Operation: Electric-resistance heating coil with compressor for heating with outdoor temperature below minus 4 deg C (25 deg F).
12. Fixed Minimum Outdoor-Air Damper Operation:
- a. Occupied Periods: Open to 25 percent.
 - b. Unoccupied Periods: Close the outdoor-air damper.
13. Economizer Outdoor-Air Damper Operation:
- a. Occupied Periods: Open to // 10 // 25 // percent fixed minimum intake, and maximum 100 percent of the fan capacity to comply with ASHRAE Cycle II. Controller shall permit air-side economizer operation when outdoor air is less than 15 deg C (60 deg F). Use // outdoor-air temperature // mixed-air and outdoor-air temperature // outdoor-air enthalpy // mixed-air temperature and select between outdoor-air and return-air enthalpy // to adjust mixing dampers. // Start relief-air fan with end switch on outdoor-air damper. // During economizer cycle operation, lock out cooling.
 - b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
14. Outdoor-Airflow Monitor: Accuracy maximum plus or minus 5 percent within 15 and 100 percent of total outdoor air. Monitor microprocessor shall adjust for temperature, and output shall range from // 2- to 10-V dc // 4 to 20 mA //.
- //15. Carbon Dioxide Sensor Operation:

- a. Occupied Periods: Reset minimum outdoor-air ratio down to minimum 10 percent to maintain maximum 1000-ppm concentration.
 - b. Unoccupied Periods: Close outdoor-air damper and open return-air damper. //
16. Interface Requirements for HVAC Instrumentation and Control System:
- a. Interface relay for scheduled operation.
 - b. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
 - c. Compatible with BACnet for central HVAC control workstation for adjusting set points, monitoring supply fan start, stop, and operation, inquiring data to include // outdoor-air damper position, // supply- and room-air temperature // and humidity //, monitoring occupied and unoccupied operations, monitoring constant and variable motor loads, monitoring variable-frequency drive operation, monitoring cooling load, monitoring economizer cycles and monitoring air-distribution static pressure and ventilation air volume.
- Z. Accessories:
- 1. Electric heater with integral thermostat maintains minimum 10 deg C (50 deg F) temperature in gas burner compartment.
 - 2. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. // Outlet shall be energized even if the unit main disconnect is open. //
 - 3. Low-ambient kit using // staged // damper on // variable-speed // condenser fans for operation down to 1.7 deg C (35 deg F).
 - 4. Filter differential pressure switch with sensor tubing on both sides of filter. Set for final filter pressure loss.
 - 5. Coil guards of painted, galvanized-steel wire.
 - 6. Hail guards of galvanized steel painted to match casing.
 - 7. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.
- AA. Roof curbs: Vibration isolators and wind or seismic restraints shall be as specified in Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT. Manufacturer's standard curbs constructed of galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

1. Curb Insulation and Adhesive: Factory applied and complying with NFPA 90A or NFPA 90B and ASTM C 1071, Type I or II. Thickness shall be 25 mm (1 inch) // 38 mm (1-1/2 inches) // (50 mm (2 inches) //. Insulation shall be applied with adhesive and mechanical fasteners to the internal surface of curb. Liner adhesive shall comply with ASTM C 916, Type I. Liner shall be fastened with mechanical fasteners of galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied without causing leakage in cabinet. Liner materials shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity. Liner adhesive shall comply with ASTM C 916, Type I.
2. Curb Height: // 355 mm (14 inches) // 610 mm (24 inches) //.
3. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT for wind-load requirements.

2.5 ROOM-TYPE AIR CONDITIONERS

- A. Units shall comply with NFPA 70, ASHRAE 15, and UL 484 except as modified herein, and shall be // window // through-the-wall // or floor-mounted // type as indicated. Capacity and electrical characteristics shall be as shown on drawings.

SPEC WRITERS NOTE: Specify DOE's
recommended EER value of 9.7 or more for
Room Type Air Conditioners.
- B. Energy Efficiency Ratio (EER): Energy Efficiency Ratio shall be not less than 10.7 for unit smaller than 6 kW (20,000 Btu/h), and not less than 9.7 for unit 6 kW (20,000 Btu/h) and larger.
- C. Outside Air: Provisions shall be made in the unit for exhaust and fresh air required for the room.
- D. Unit Supports: Comply with Fed. Spec. 00-A-372, unless otherwise shown with mounting sleeves for through-the-wall units to suit the sill height, wall construction, and wall thickness, as shown.
- E. Fan Motor and Air Impeller: Permanent split-capacitor type with run capacitor. Air impellers shall be // forward-curved blower wheel // axial or radial-flow fan blade // type.

- F. Electronics: Microprocessors shall monitor and control numerous functions for the unit such as digital display and touch panels for programming desired temperature, on-off timing, modulating fan speeds, bypass capabilities, and sensing for humidity, temperature and airflow control.

SPEC WRITERS NOTE: Specify DOE's recommended EER value of 9.0 or more for packaged terminal Air-Conditioner.

2.6 PACKAGED TERMINAL AIR CONDITIONERS

- A. Description: Factory-assembled and tested, self-contained, air-cooled packaged terminal air conditioner with room cabinet, electric refrigeration // and electric-resistance heating // system and temperature controls; fully charged with refrigerant and filled with oil; with // cord connected // hardwired // chassis. The unit shall comply with ASHRAE 15 and should comply with the safety requirements of UL 484.
- B. Chassis/Cabinet 1.3-mm- (18 gauge) minimum steel phosphatized and finished with two coats of baked enamel. Front panel shall be removable with the use of tools to provide full access to filters and cooling unit. Unit shall be tested according to ASTM E 331 which assures no water infiltration when tested with eight of rain per hour at 63 mph wind for 15 minutes.
- C. Mounting: // Wall with wall sleeve // Floor with subbase //
- D. Cabinet Extension: Matching cabinet in construction and finish, allowing diversion of airflow to adjoining room; with grille.
- E. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- F. Subbase: Enameled steel with adjustable leveling feet and adjustable end plates // include an electrical power cord // with factory-installed and -wired, fused disconnect switch and receptacle sized for unit //.
- G. Wall Sleeves: // Galvanized steel with polyester finish // Molded polymer // Molded fiberglass-reinforced polyester // not less than 1.3 mm (18 gauge) zinc-coated steel, phosphatized //, with manufacturer's standard finish and completely insulated. Design of sleeve for field installation and fasten to outside air louver.
- H. Refrigeration System: Direct expansion indoor coil with capillary restrictor; and hermetically sealed scroll compressor with vibration isolation and overload protection.

- I. Indoor and Outdoor Coils: Seamless copper tubes mechanically expanded into aluminum fins // with capillary tube distributor on indoor coil //.
- J. For Heat Pump Unit:
 - 1. Accumulator.
 - 2. Constant-pressure expansion valve.
 - 3. Reversing valve.
- K. Charge: // R407C // R410A // unless otherwise indicated.
- L. Condenser/Evaporator Fans: One direct drive with permanent split capacitor two-speed motor. The condenser fan shall be propeller type and the evaporator fan shall be centrifugal blower type.
- M. Filters: Washable // polyurethane // polypropylene // in molded plastic frame.
- N. Condensate Drain: Drain pan //to direct condensate to outdoor coil for re-evaporation // and piping to direct condensate to building waste and vent piping //. Drain pan shall comply with ASHREA 62.1 for construction and connections.
- O. Electric-Resistance Heating Coil: Nickel-chromium-wire, electric-resistance heating elements with contactor and high-temperature-limit switch.
- P. Hot-Water Heating Coil: Seamless copper tubes mechanically expanded into aluminum fins with two-way modulating control valve and air vent.
- Q. 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: Prevent cooling-cycle operation below 5 deg C (40 deg F) outdoor air temperature.
 - 2. Heat-Pump Ambient Control: Field-adjustable switch changes to heat-pump heating operation above 5 deg C (40 deg F) and to supplemental heating below minus 4 deg C (plus 25 deg F).
 - 3. Temperature-Limit Control: Prevent occupant from exceeding preset//setback or// setup temperature.
 - 4. Building Automation System Interface: Allow remote on-off control with setback temperature control. Coordinate with Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
 - 5. Reverse-Cycle Defrost: Solid-state sensor monitors frost buildup on // indoor // outdoor // coil and reverses unit to melt frost.

- 6. Remote Control: Standard unit-mounted controls with remote-mounted, low-voltage adjustable thermostat with heat anticipator, // heat-off-cool-auto // heat-off-cool // switch, and // on-auto // fan switch.
- R. Outdoor Air: // Manual // Motorized // intake damper. Open intake when unit indoor air fan runs.
- S. Sound-Power Level Ratings: Factory test to comply with ARI 300, "Sound Rating and Sound Transmission Loss of Packaged Terminal Equipment."
- T. Unit Performance Ratings: Factory test according to ARI 310/380/CSA C744, "Packaged Terminal Air-Conditioners and Heat Pumps."

2.7 GAS-FIRED //NON-CONDENSING// CONDENSING // FURNACES

- A. General Requirements for Gas-Fired, Non-Condensing 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.
 - 1. Type of Gas: // Natural // Propane //.
 - 2. Heat Exchanger: // Aluminized // Stainless // steel.
 - 3. Burner Gas Valve: 100 percent safety // two-stage // 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.
 - 4. Ignition: Electric pilot ignition with hot-surface igniter or electric spark ignition.
 - 5. Gas-Burner Safety Controls: Electronic flame sensor prevents gas valve from opening until pilot flame is proven; stops gas flow on ignition failure.
 - 6. Flame Rollout Switch: Installed on burner box; prevents burner operation.
 - 7. Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.
 - 8. Combustion-Air Inducer: Centrifugal fan pre-purges heat exchanger and vents combustion products; thermally protected motor with sleeve bearings; pressure switch prevents operation if combustion-air inlet or flue outlet is blocked.
 - 9. Furnace Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds; adjustable fan-on and fan-off timing; and terminals for connection to accessories.

SPEC WRITERS NOTE: Provide B vent for non-condensing type furnaces. For condensing furnaces provide vent per manufacturer's instructions.

10. Provide refrigerant type cooling coil by furnace manufacturer with matched condensing unit where shown on the drawings.
- //11. Type B Gas Vents: Inner pipe of sheet aluminum, and outer pipe of galvanized sheet steel, tested in compliance with UL 441. //
- //12. Condensing Furnace Vent/Combustion Air Piping:
- a. The boiler vent shall be //an approved AL29-4C stainless steel venting system and components for cold-start condensate//positive pressure Category IV stack and breeching of the double wall construction with a 25mm (1 inch) annular insulating air space, outer wall constructed of 304 stainless steel and inner wall constructed of type AL29-4C stainless steel. Vent components exposed to the atmosphere shall be type 304 stainless steel.
 - b. The combustion air conduit shall be PVC or CPVC utilizing a vacuum relief damper sized equal in diameter to the intake pipe.
 - c. All supports, ventilated thimble, barometric dampers, vent caps, adapters, flashing, drain fittings and expansion joints shall be included by and as recommended by the manufacturer. //

PART 3 EXECUTION

3.1 INSTALLATION

- A. Roof Curb: Install on roof structure or concrete base, level and secure, according to // NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." // ARI Guideline B. // Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 0772 00, ROOF ACCESSORIES. Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.
- B. Rooftop Unit Support: Install unit level on structural // curbs // pilings //. Coordinate wall penetrations and flashing with wall construction. Secure rooftop units to structural support with anchor bolts.
- C. Install wind //and seismic// restraints according to manufacturer's written instructions. Wind //and seismically// restrained vibration isolation roof-curb rails are specified in Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.

- D. Install units level and plumb maintaining manufacturer's recommended clearances and tolerances.
- E. Install water-cooled units with thermometer and pressure gage at the water supply and return connection.
- F. Install vibration spring isolators under base of self-contained unit, with minimum static deflection of 25 mm (1 inch) unless otherwise indicated. Refer to Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT
- G. Install ground-mounting, compressor-condenser components on 100 mm (4-inch) thick, reinforced concrete base; 100 mm (4 inches) larger on each side than unit. Concrete, reinforcement, and formwork are specified in Section 03 30 00, CAST-IN-PLACE CONCRETE. Coordinate anchor installation with concrete base.
- H. Install ground-mounting, compressor-condenser components on polyethylene mounting base.
- I. Install roof-mounting compressor-condenser components on equipment supports specified in Section 07 72 00, ROOF ACCESSORIES. Anchor units to supports with removable, cadmium-plated fasteners.
- J. //Install seismic restraints. //
- K. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 25 mm (1 inch) unless otherwise indicated. Refer to Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- L. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.
- M. Install wall sleeves in finished wall assembly and weatherproof. Install and anchor wall sleeves to withstand, without damage seismic forces as required by code.

3.2 CONNECTIONS

- A. Verify condensate drainage requirements.
- B. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
- C. Install piping adjacent to units to allow service and maintenance.
- D. Gas Piping: Comply with applicable requirements in Section 23 11 23, FACILITY NATURAL-GAS PIPING. Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

- E. Install ducts to termination at top of roof curb. Cut roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
- F. Connect supply ducts to units with flexible duct connectors specified in Section 23 31 00, HVAC DUCTS and CASINGS.
- G. Install return-air duct continuously through roof structure.
- H. Install normal-weight, 20.7-MPa (3000-psi), compressive strength (28-day) concrete mix inside roof curb, 100 mm (4 inches) thick.
- I. Ground equipment and install power wiring, switches, and controls for self contained and split systems.
- J. Connect refrigerant piping to coils with shutoff valves on the suction and liquid lines at the coil and a union or flange at each connection at the coil and condenser.
- K. Install ducts to the units with flexible duct connections.
- L. Connect piping with shutoff duty valves on the supply and return side of the coil and unions at all connections and with a throttling valve on the return piping near the coil.
- M. Connect piping with shutoff duty valves on the supply and return side of the water-cooled condenser and unions at all connections and with a throttling valve on the return piping near the condenser
- N. Connect piping with shutoff duty valves and unions on the steam supply and condensate side of the steam coil. On the condensate line near the coil provide a strainer, trap and shutoff valve.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections: After installing units and after electrical circuitry has been energized, test units for compliance with requirements. Inspect for and remove shipping bolts, blocks, and tie-down straps. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment. Remove and replace malfunctioning units and retest as specified above.

3.4 STARTUP AND TESTING

- A. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior notice.

- B. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of units.

3.5 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

3.6 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS.

---END---