SECTION 237416.12 - PACKAGED, INTERMEDIATE-CAPACITY, ROOFTOP AIR CONDITIONING UNITS

1. GENERAL
	* + 1. SUMMARY
				1. Section Includes:

Packaged rooftop air conditioning unit.

Roof curb.

* + - * 1. Related Sections:

Section 230548 - Vibration and Seismic Controls for HVAC Piping and Equipment: Vibration isolators.

Section 230923 - Direct-Digital Control System for HVAC: Controls remote from unit.

Section 230993 - Sequence of Operations for HVAC Controls: Sequences of operation applying to units in this section.

Section 231123 - Facility Natural-Gas Piping: Natural gas piping connections.

Section 231126 - Facility Liquefied-Petroleum Gas Piping: LP gas piping connections.

Section 232113 - Hydronic Piping: Water and drain piping connections.

Section 232213 - Steam and Condensate Heating Piping: Steam supply and steam condensate piping connections.

Section 233300 - Air Duct Accessories: Flexible connections.

Section **<\_\_\_\_\_\_\_\_>** - **<\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_>**: Roof curbs.

Section **<\_\_\_\_\_\_\_\_>** - **<\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_>**: Roof curb flashing.

* + - 1. REFERENCES

Select appropriate references based on unit capacity.

List reference standards included within text of this section. Edit the following for Project conditions.

* + - * 1. Air-Conditioning and Refrigeration Institute:

ARI 270 - Sound Rating of Outdoor Unitary Equipment.

ARI 340/360 - Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.

* + - * 1. Air Movement and Control Association International, Inc.:

AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

* + - * 1. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

* + - * 1. ASTM International:

ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.

* + - * 1. National Electrical Manufacturers Association:

NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

NEMA MG 1 - Motors and Generators.

* + - * 1. National Fire Protection Association:

NFPA 54 - National Fuel Gas Code.

NFPA 58 - Liquefied Petroleum Gas Code.

NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

* + - 1. DEFINITIONS
				1. Energy Efficiency Ratio (EER) - Ratio of net cooling capacity in Btuh to total rate of electric input in watts under designated operating conditions.
				2. Integrated Part-Load Value (IPLV): Single-number figure of merit based on part-load EER, COP, or kW/ton expressing part-load efficiency for air-conditioning and heat pump equipment on basis of weighted operation at various load capacities for the equipment.
			2. SUBMITTALS
				1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the
				2. General Conditions.
				3. Manufacturer’s installation instructions shall be provided along with product data.
				4. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).

Only request submittals needed to verify compliance with Project requirements.

* + - * 1. Section 013300 - Submittal Procedures: Submittal procedures.
				2. Product Data: Submit data indicating:

Cooling and heating capacities.

Dimensions.

Weights.

Rough-in connections and connection requirements.

Duct connections.

Electrical requirements with electrical characteristics and connection requirements.

Controls.

Accessories.

* + - * 1. Test Reports: Submit results of factory test at **[time of unit shipment] <\_\_\_\_\_\_\_\_>**.
				2. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.
				3. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
				4. Manufacturer's Field Reports: Submit start-up report **[for each unit]**.
			1. CLOSEOUT SUBMITTALS
				1. Section 017716 – Contract Closeout
				2. Project Record Documents: Record actual locations of controls installed remotely from units.
				3. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.
			2. QUALITY ASSURANCE
				1. Cooling Capacity: Rate in accordance with **[ARI 340/360]**.
				2. Sound Rating: Measure in accordance with ARI 270 “Sound Rating of Outdoor Unitary Equipment”.
				3. Insulation and adhesives: Meet requirements of NFPA 90A “Standard for the Installation of Air Conditioning and Ventilating Systems”.
				4. Minimum heating efficiency: **[80] <\_\_\_\_\_\_\_\_>** percent.
				5. Performance Requirements: Conform to minimum **[EER] [IPLV]** prescribed by ASHRAE 90.1 “Energy Standard for Buildings Except Low-Rise Residential Buildings” when tested in accordance with ARI 340/360 “Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment”.
				6. Outside Air Damper Leakage: Test in accordance with AMCA 500 “Test Methods for Louvers, Dampers, and Shutters”.

Include the following paragraph only when cost of acquiring specified standards is justified.

* + - * 1. Maintain **[one copy] [<\_\_\_\_\_\_\_\_> copies]** of **[each]** document on site.
			1. QUALIFICATIONS
				1. Manufacturer: Company specializing in manufacturing products specified in this section with minimum **[three] <\_\_\_\_\_\_\_\_>** years' **[documented]** experience.
				2. Installer: Company specializing in performing Work of this section with minimum **[three] <\_\_\_\_\_\_\_\_>** years' **[documented]** experience **[approved by manufacturer]**.
			2. PRE-INSTALLATION MEETINGS
				1. Section 013000 - Administrative Requirements: Pre-installation meeting.
				2. Convene minimum **[one] <\_\_\_\_\_\_\_\_>** week prior to commencing work of this section.
			3. DELIVERY, STORAGE, AND HANDLING
				1. Section 016500 – Materials and Equipment
				2. Accept units on site. Inspect for damage.
				3. Protect units from damage by storing off roof until roof mounting curbs are in place.
			4. COORDINATION
				1. Section 013000 - Administrative Requirements: Requirements for coordination.
				2. Coordinate installation of roof curbs with roof structure, roof deck and roof membrane installation.
			5. WARRANTY
				1. Section 017716 – Contract Closeout
				2. Furnish **[five] <\_\_\_\_\_\_\_\_>**-year manufacturer's warranty for compressors.

Consider the following for units with gas-fired heating sections.

* + - * 1. Furnish **[five] <\_\_\_\_\_\_\_\_>**-year manufacturer's warranty for heat exchangers.
			1. MAINTENANCE SERVICE
				1. Section 017716 – Contract Closeout

Evaluate need for maintenance and emergency service based Project requirements. If desired, retain the following two paragraphs.

* + - * 1. Furnish service and maintenance of equipment for **[one] <\_\_\_\_\_\_\_\_>** year from Date of Substantial Completion. Include maintenance items as shown in manufacturer's operating and maintenance data, including filter replacements, fan belt replacement, and controls checkout and adjustments.
				2. Furnish 24-hour emergency service on breakdowns and malfunctions for this maintenance period.
			1. EXTRA MATERIALS
				1. Section 017716 – Contract Closeout
				2. Furnish **[one set] <\_\_\_\_\_\_\_\_>** of **[fan belts] <\_\_\_\_\_\_\_\_>** for each unit.
				3. Furnish **[one set] <\_\_\_\_\_\_\_\_>** of **[disposable] [cartridge] [bag]** filters for each unit.
1. PRODUCTS
	* + 1. ROOFTOP AIR CONDITIONING UNITS

In this article, list manufacturers acceptable for this Project.

* + - * 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

AAON.

Addison.

Allied Commercial.

Carrier Global Corporation.

Daikin Applied.

Engineered Air.

Lennox Industries, Inc.; Lennox International.

Rheem Manufacturing Company; Heating and Cooling Products.

Trane.

Valent.

YORK; brand of Johnson Controls International plc, Building Solutions North America.

Approved equivalent.

Edit the following descriptive specifications to identify Project requirements and to eliminate conflicts with manufacturers specified above.

* + - * 1. Product Description: Self-contained, packaged, factory assembled and wired, consisting of **[roof curb,]** cabinet, supply fan, **[inlet guide vanes,] [variable frequency drive,]** evaporator coil, compressor, refrigeration circuit, condenser, **[gas-fired heating section,] [electric heating coil,]** **[hot water heating coil,] [steam heating coil,]** air filters, **[outdoor air section,] [exhaust-return section,] [return fan,]** and controls.
				2. Configuration: **[Downflow air delivery.] [Horizontal air delivery.] [As indicated on Drawings]**.

Choose between the following 2 paragraphs based on whether roof curbs are specified with units or in another section.

When noise considerations are critical, consider including insulated curb. Generally, curbs from unit manufacturers are not insulated.

Vibration type roof curb should be included in Section 230548.

* + - * 1. Roof Mounting Curb: **[14] [24] <\_\_\_\_\_\_\_\_>** inch high, galvanized steel, channel frame with gaskets, nailer strips. **[Full perimeter curb under entire unit.] [Full perimeter curb under unit with separate support curb for condensing section.]**

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - * 1. Roof Mounting Curb: Refer to Section **<\_\_\_\_\_\_\_\_>**.
				2. Cabinet:

Designed for outdoor installation with weatherproof construction.

Panels: **[Steel] [Galvanized steel]** with baked enamel finish meeting **[500] <\_\_\_\_\_\_\_\_>** hour salt spray test in accordance with ASTM B117 “Standard Practice for Operating Salt Spray (Fog) Apparatus”. Furnish **[removable access panels with handles] [hinged access doors with handles and rubber gaskets at edges]**.

Insulation: Factory applied to exposed vertical panels, horizontal panels, and access **[panels] [doors]**. **[1/2] [1] [2]** inch thick, **[0.75] [1.5]** pound per cubic foot density, [neoprene coated] [aluminum foil faced] glass fiber with edges protected from erosion.

Interior lined casing may not available from all manufacturers. When available, generally it will be in 30 ton (105 kW) and larger capacity units. Coordinate availability with selected manufacturer.

Interior Surfaces: Sheet metal lined creating double wall construction.

Verify fan type with selected manufacturer.

* + - * 1. Supply Fan:

Fan: **[Forward curved centrifugal type] [Backward inclined airfoil type]**, statically and dynamically balanced, resiliently mounted.

Fan Drive: V-Belt type, Cast iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed. Furnish solid shaft construction. Select Variable and adjustable pitch motor sheave to obtain required rpm with sheaves set at mid-position as recommended by manufacturer.

Drive Rating: Minimum **[1.5] <\_\_\_\_\_\_\_\_>** times nameplate rating of motor.

Fan Sheave: **[Fixed.] [Adjustable.]**

Motor Sheave: **[Fixed.] [Adjustable.]**

Fan motor: Three phase, NEMA MG1 “Motors and Generators”, Design B, continuously rated at 40 degrees C, **[open drip-proof] [totally enclosed fan cooled] [high efficiency, open drip-proof] [premium open drip-proof efficiency]** NEMA T frame, with permanently lubricated bearings and integral overload protection.

**<\_\_\_\_\_\_\_\_>** hp.

The following is optional item. Coordinate availability with selected manufacturer. When available, generally it will be in 30 ton (105 kW) and larger capacity units.

Fan Assembly Mounting: Furnish spring-type vibration isolators.

Select one of the following for use with variable air volume systems.

* + - * 1. Supply Fan Modulation:

Inlet Guide Vanes: Furnish with factory installed electric actuator, linkage and controller. Entire assembly factory adjusted.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Variable Frequency Drive:

Furnished for supply fan **[and return fan]**.

Factory installed, wired, and tested.

**[With] [Without]** bypass.

Full digital control.

Insulated Gate Bi-Polar Transistors used to produce output pulse width modulation waveform allowing quiet operation.

NEMA 250 “Enclosures for Electrical Equipment (1000 Volts Maximum)” Type 1 enclosure.

Self diagnostics.

Proportional-integral-derivative setpoint control.

Communication port.

Electronic thermal overload protection.

Controlled from duct static pressure by **[unit mounted controller] <\_\_\_\_\_\_\_\_>**. Static pressure sensed by duct mounted sensor.

Furnish field adjustable duct high limit safety control to protect duct work from excessive duct pressure.

* + - * 1. Evaporator Coil:

Constructed of seamless copper tubes mechanically expanded into aluminum fins. Factory leak tested under water.

Galvanized drain pan and piping connection.

Furnish for multiple circuited units **[intertwined] [alternate]** row circuiting.

**[Furnish coil with corrosion resistant coating capable of withstanding salt spray test of [1000] <\_\_\_\_\_\_\_\_> hours in accordance with ASTM B117.]**

Choices in the following paragraphs vary between manufacturers and with unit capacity. Select appropriate items available with unit size.

When project conditions warrant include type of compressor in the following paragraph. This may make specification proprietary as type of compressor differs between manufacturers. Generally, compressor types are scroll or reciprocating.

Compressor type whether hermetic or semi-hermetic varies with manufacturer.

* + - * 1. Compressors:

**[Hermetically sealed] [Semi-hermetic]**, resiliently mounted with positive lubrication, and internal motor overload protection.

Furnish each compressor with independent refrigeration circuit.

Furnish **[internal] [external]** vibration isolators.

Furnish short cycle protection.

* + - * 1. Refrigeration circuit:

Dehydrate and factory charge **[each circuit]** with oil and refrigerant.

Furnish the following for each circuit:

Thermostatic expansion device.

Filter-drier.

Suction, discharge, and liquid line service valves with gauge ports.

Sight glass.

High and low pressure safety controls.

**<\_\_\_\_\_\_\_\_>**.

Select desired method of capacity control. Not all manufacturers offer this option.

Hot gas bypass is usually used with variable air volume systems and other applications to control capacity at minimum cooling loads.

Furnish capacity control by **[hot gas bypass.] [cycling compressors.] [cylinder unloading.] [cycling multi-speed compressors.]**

Furnish control to provide low ambient cooling to **[0] [-20]** degrees F.

* + - * 1. Condenser:

Constructed of copper tubing mechanically bonded to **[aluminum] [copper]** fins **[with sub-cooling rows]**. Factory leak tested under water.

Direct drive propeller fans statically and dynamically balanced. Wired to operate with compressor. Motor permanently lubricated with built-in thermal overload protection. **[Furnish high efficiency fan motors.]**

**[Furnish factory installed coil guard.]**

[Furnish coil with corrosion resistant coating capable of withstanding salt spray test of **[1000] <\_\_\_\_\_\_\_\_> hours in accordance with ASTM B117.]**

* + - * 1. Gas-Fired Heating Section:

Select exchanger material.

Fuel: **[Natural gas.] [Propane.]**

Heat Exchanger: **[Aluminized] [Stainless]** steel, of welded construction.

Gas Burner: **[Induced draft] <\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_>** type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shut-off, intermittent spark or glow coil ignition, flame sensing device, and **[automatic 100 percent shut-off pilot]**.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - * 1. Electric Heating Coil:

Single source power connection is optional and varies with some manufacturers.

**[Finned tube heating elements] [or] [Helical nickel-chrome resistance wire coil heating elements with refractory ceramic support bushings]** easily accessible with automatic reset thermal cut-out, built-in **[magnetic] [mercury]** contactors, galvanized steel frame, **[control circuit transformer and fuse,] [manual reset thermal cut-out,] [airflow proving device,] [toggle switch (pilot duty),]** load fuses. **[Single source power connection.] [Number of stages as indicated on Drawings.]**

Controls: Start supply fan before electric elements are energized and continue operating until air temperature reaches minimum setting, with switch for continuous fan operation.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Not every manufacturer offers hot water coils in this capacity range of rooftop units. Coordinate availability with selected manufacturer.

* + - * 1. Hot Water Heating Coil:

**[Factory mounted] [Field installed]**.

Coil: Constructed of seamless copper tubes mechanically expanded into aluminum fins. Factory leak tested under water.

Furnish factory installed piping package with **[modulating] [two-way] [three-way]** control valve.

Freezestat: Factory mounted on discharge side of coil.

**[Furnish coil with corrosion resistant coating capable of withstanding salt spray test of [1000] <\_\_\_\_\_\_\_\_> hours in accordance with ASTM B117.]**

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Not every manufacturer offers hot water coils in this capacity range of rooftop units. Coordinate availability with selected manufacturer.

* + - * 1. Steam Heating Coil:

Tube-in-tube non-freeze type. Constructed of seamless copper tubes mechanically expanded into aluminum fins. Factory leak tested under water.

Furnish **[modulating] [two-way] [three-way]** control valve.

Freezestat: Factory mounted on discharge side of coil.

**[Furnish coil with corrosion resistant coating capable of withstanding salt spray test of [1000] <\_\_\_\_\_\_\_\_> hours in accordance with ASTM B117.]**

Units with cartridge and bag filters are available in larger capacity units. Coordinate availability with selected manufacturer.

* + - * 1. Air Filters: **[1] [2] [4]** inch **[thick glass fiber disposable media in metal frames.] [25 to 30 percent efficiency based on ASHRAE 52.1.]**

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - * 1. Air Filters: Cartridge type, 12 inch deep, **[60 to 65] [90 to 95]** percent efficient, based on ASHRAE 52.1 “Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter”. Furnish with 2 inch thick pre-filters.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Use the 500 degree F (260 degree C) rated filters with gas heating applications.

* + - * 1. Air Filters: Bag filters with 90 percent average efficiency based on ASHRAE 52.1 “Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter”. **[Rated for 500 degrees F.]** Furnish 2 inch thick pre-filters.
				2. Outdoor Air Section:

International Energy Conservation Code requires outside air dampers to have the following maximum damper leakage. Verify availability with basis for design manufacturer.

Outside Air Damper Leakage: Maximum **[3.0] <\_\_\_\_\_\_\_\_>** cfm per square foot at **[1.0] <\_\_\_\_\_\_\_\_>** inches wg pressure differential.

Outside Air Damper: None. 100 percent return air.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Outside Air Damper: Manual, with 0 to **[25] [30] <\_\_\_\_\_\_\_\_>** percent operating range. **[Outside air damper normally closed and return air damper normally open.]**

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Outside Air Damper: Automatic with 0 to **[25] [30] <\_\_\_\_\_\_\_\_>** percent operating range. **[Outside air damper normally closed and return air damper normally open.]**

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Economizer: Provide economizer components and controls in accordance with ICC IECC. **[Factory installed]** fully modulating from 0 to 100 percent outside air. Motorized outside air and return air dampers controlled by **[dry bulb] [enthalpy] [differential enthalpy]** controller **[with minimum position setting.] [Outside air damper normally closed and return air damper normally open.]**

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Fully integrated economizer runs unit compressors in conjunction with outside air dampers for optimum control.

Economizer: Provide economizer components and controls in accordance with ICC IECC. Furnish **[fully integrated]** factory installed fully modulating from 0 to 100 percent outside air economizer. Economizer operation through microprocessor based primary temperature controls automatically modulate dampers to maintain space temperature conditions.

Furnish economizer with **[dry bulb] [enthalpy] [differential enthalpy]** control.

Furnish adjustable minimum position control located remotely in space.

Furnish spring return motor for outside air damper closure during unit shutdown or power interruption.

* + - * 1. Exhaust and Return Section:

No relief air capability.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Barometric relief gravity type dampers to operate in conjunction with economizer. **[Furnish barometric relief damper capable of closing by gravity.] [Furnish rain hood with screen.]**

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

As unit capacity increases exhaust or relief fan type will change from propeller type fan to centrifugal type fan.

Larger capacity units in this category are available with belt drive exhaust or relief fans.

High efficiency motors are also available in larger sizes.

Coordinate availability with selected manufacturer.

Non-modulating exhaust fans: Forward curved centrifugal type, **[direct drive] [belt drive]**, statically and dynamically balanced, **[high efficiency motor]**. Motor permanently lubricated with built-in thermal overload protection. Furnish barometric dampers at fan outlet to prevent backdraft. Operation of exhaust fans on or off based on economizer outdoor air damper position. **[On-off setpoint selectable through remote potentiometer located in return air section.]**

Modulating exhaust fans: Forward curved centrifugal type, **[direct drive] [belt drive]**, statically and dynamically balanced, **[high efficiency motor]**. Motor permanently lubricated with built-in thermal overload protection. Furnish barometric dampers at fan outlet to prevent backdraft. Fans operated with volume control device based on field adjustable interior space pressure setpoint.

Return fans are available from some manufacturers. Other manufacturers configure units with exhaust fan. Coordinate choice between the above and the following paragraphs.

* + - * 1. Return Fan:

Fan: **[Forward curved centrifugal type] [Backward inclined airfoil type]**, statically and dynamically balanced, resiliently mounted.

Fan Drive: V-Belt type, Cast iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed. Furnish solid shaft construction. Select Variable and adjustable pitch motor sheave to obtain required rpm with sheaves set at mid-position as recommended by manufacturer.

Drive Rating: Minimum **[1.5] <\_\_\_\_\_\_\_\_>** times nameplate rating of motor.

Fan Sheave: **[Fixed.] [Adjustable.]**

Motor Sheave: **[Fixed.] [Adjustable.]**

Fan motor: Three phase, NEMA MG1 “Motors and Generators”, Design B, continuously rated at 40 degrees C, **[open drip-proof] [totally enclosed fan cooled] [high efficiency, open drip-proof] [premium open drip-proof efficiency]** NEMA T frame, with permanently lubricated bearings and integral overload protection.

**<\_\_\_\_\_\_\_\_>** hp.

The following is optional item. Coordinate availability with selected manufacturer.

Fan Assembly Mounting: Furnish spring-type vibration isolators.

* + - * 1. Return Fan Modulation:

Inlet guide vanes: Furnish with factory installed electric actuator, linkage and controller. Entire assembly factory adjusted.

Controlled in conjunction with supply fan.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Supply and return fan can be controlled by either individual or single variable frequency drive. Edit the following.

Variable frequency drive: **[Controlled from same drive as supply fan.] [Individual drive for return fan.]**

The following paragraphs are typical of controls available for rooftop units in this section's capacity range. Control features will vary based on either size of unit or application to system (i.e. constant volume single zone or variable air volume).

Select applicable controls and controls combination.

More sophisticated controls or those for different types of units may be better specified in control sections and described in Sequences of Operation.

* + - * 1. Controls: Furnish space thermostat with **[1] [2] <\_\_\_\_\_\_\_\_>** stage heating and **[1] [2] <\_\_\_\_\_\_\_\_>** stage cooling with [manual] [automatic] changeover. Furnish system selector switch **[heat-off-cool] [off-heat-auto-cool] [and fan control switch, auto-on]**.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - * 1. Controls: Furnish **[7 day] <\_\_\_\_\_\_\_\_>** programmable electronic space thermostat with **[4] <\_\_\_\_\_\_\_\_>** time periods per day, **[1] [2]** stage heating, **[1] [2]** stage cooling, **[manual] [automatic]** changeover, heating setback, cooling setup, override capability, liquid crystal display, memory storage without batteries, security levels feature, and setpoint limiting. Furnish system selector switch **[heat-off-cool] [off-heat-auto-cool] [and fan control switch, auto-on]**.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Use one of the following two paragraphs when controls are specified in other sections.

* + - * 1. Controls: Refer to Section **[230923] [230953]**. **[Refer to Section 230993 for sequence of operation.]**

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - * 1. Controls: Furnish interface to **[Building Automation and Control System] [Direct Digital Control System]** specified in Section **[230923]**.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Microprocessor based controls are available from most rooftop unit manufacturers in this capacity family. Features of controls vary between manufacturers. Edit the paragraphs carefully to avoid specifying proprietary features. Additionally, coordinate factory mounted, manufacturer supplied, controls with overall building control system.

* + - * 1. Controls: Microprocessor based controls, factory mounted with the following features:

Constant Volume Controls: To operate rooftop from space temperature sensor, including economizer control.

Furnish space temperature sensor [with setpoint adjustment] for control of unit equipped with override button for timed override of **[1] [2] [3] [4]** hours.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Furnish space temperature sensor [with setpoint adjustment] for control of unit equipped with override button for timed override of **[1] [2] [3] [4]** hours. Furnish with space temperature offset of plus or minus 5 degrees F.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Variable Air Volume Controls: To operate VAV rooftop from supply air temperature including supply air sensor, and **[inlet guide vanes] [variable frequency drive]**. Microprocessor coordinates economizer control and stages of cooling with supply air temperature reset capability based upon outdoor air temperature.

The following is generic list of control functions. Edit or expand list based on project conditions. Coordinate availability with selected manufacturer.

Control Functions: Furnish the following:

Unit scheduling.

Occupied-unoccupied mode.

Start-up and coast-down modes.

Nighttime free-cool purge mode.

Demand limiting.

Night setback.

Timed override.

Alarm shutdown.

Discharge air set point adjustment.

Static pressure setpoint adjustment.

Smoke control.

Smoke evacuation.

Smoke pressurization.

The following is generic list of setpoints and alarms. Edit or expand list based on project conditions. Coordinate availability with selected manufacturer.

Furnish the following setpoints and diagnostic functions accessible in unit control panel:

Unit operating mode.

Unit failure status.

Supply fan start-stop.

Supply fan status.

Supply fan inlet guide vane position.

Supply fan variable frequency drive percent.

Return fan start-stop.

Return fan status.

Return fan inlet guide vane position.

Return fan variable frequency drive percent.

Exhaust fan start-stop.

Exhaust fan status.

Exhaust fan variable frequency drive percent.

Supply air temperature.

Supply air temperature high-low limit with alarm.

Return air temperature.

Return air temperature high-low limit with alarm.

Mixed air temperature.

Mixed air temperature high-low limit with alarm.

Duct static pressure.

Duct static pressure high-low limit with alarm.

Cooling control.

Cooling status - all stages.

Heating control.

Heating status.

Number of stages activated.

Damper control.

Economizer status.

Requested minimum position.

Damper positions.

Space temperature.

Space temperature high-low limit with alarm.

Filter status.

Smoke detector status.

Outside air temperature.

Outside relative humidity.

The following are specialty control functions furnished by some manufacturers. Coordinate availability with selected manufacturer.

Ventilation Override: Factory installed. Binary input from independent fire or life safety panel causes unit to override standard operation and assumes one of two factory preset ventilation sequences - purge or pressurization.

Indoor Air Quality Control: Furnish demand ventilation control through economizer with carbon dioxide sensor. Sensor adjustable **[duct mounted] [wall mounted] [wall mounted with display of parts per million]**.

* + - * 1. Accessories:

Convenience Outlet: Factory installed, 115 volt, 15 amp, GFI type, internally mounted. **[Factory wired from transformer internal to unit.]**

Roof Curb Adaptor Package: Furnish duct support hardware to adapt unit to existing roof curb.

**[Factory] [Field]** installed ultraviolet C light located downstream of cooling coil.

<\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_>.

* + - * 1. Capacity:

Insert capacity information applicable to project. Use the following for one or identical units. When specifying units of different sizes, use schedule at end of this section.

Supply **[and return]** air: Corrected to **<\_\_\_\_\_\_\_\_>** feet altitude.

Unit Sound Rating: Maximum **<\_\_\_\_\_\_\_\_>** dBA measured 3 feet from casing.

Supply Fan:

Airflow: **<\_\_\_\_\_\_\_\_>** cfm.

Outside airflow: **<\_\_\_\_\_\_\_\_>** cfm.

External static pressure: **<\_\_\_\_\_\_\_\_>** inch wg.

Fan motor: **<\_\_\_\_\_\_\_\_>** hp, **<\_\_\_\_\_\_\_\_>** volts, **[single] [three]** phase, 60 Hz.

Return Fan:

Airflow: **<\_\_\_\_\_\_\_\_>** cfm.

External static pressure: **<\_\_\_\_\_\_\_\_>** inch wg.

Fan motor: **<\_\_\_\_\_\_\_\_>** hp, **<\_\_\_\_\_\_\_\_>** volts, **[single] [three]** phase, 60 Hz.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Exhaust Fan:

Airflow: **<\_\_\_\_\_\_\_\_>** cfm.

External static pressure: **<\_\_\_\_\_\_\_\_>** inch wg.

Fan motor: **<\_\_\_\_\_\_\_\_>** hp, **<\_\_\_\_\_\_\_\_>** volts, **[single] [three]** phase, 60 Hz.

Cooling Capacity:

Total cooling capacity: **<\_\_\_\_\_\_\_\_>** Btuh.

Sensible cooling capacity: **<\_\_\_\_\_\_\_\_>** Btuh.

Entering air temperature:

**<\_\_\_\_\_\_\_\_>** degrees F dry bulb.

**<\_\_\_\_\_\_\_\_>** degrees F wet bulb.

Condenser ambient air temperature: **<\_\_\_\_\_\_\_\_>** degrees F.

Number of **[compressors] [refrigeration circuits]: <\_\_\_\_\_\_\_\_>**.

Capacity steps: **<\_\_\_\_\_\_\_\_>**.

Energy efficiency ratio: Minimum **<\_\_\_\_\_\_\_\_>**.

Gas Heating:

Input: **<\_\_\_\_\_\_\_\_>** Btuh.

Output: **<\_\_\_\_\_\_\_\_>** Btuh.

Stages: **<\_\_\_\_\_\_\_\_>**.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Electric Heating:

Electric resistance heating capacity: **<\_\_\_\_\_\_\_\_>** Btuh.

Capacity steps: **<\_\_\_\_\_\_\_\_>**.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Hot Water Heating:

Capacity: **<\_\_\_\_\_\_\_\_>** Btuh.

Water flow: **<\_\_\_\_\_\_\_\_>** gpm.

Entering air temperature: **<\_\_\_\_\_\_\_\_>** degrees F.

Entering water temperature: **<\_\_\_\_\_\_\_\_>** degrees F.

Leaving water temperature: **<\_\_\_\_\_\_\_\_>** degrees F.

Coil pressure drop: **<\_\_\_\_\_\_\_\_>** feet.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Steam Heating:

Capacity: **<\_\_\_\_\_\_\_\_>** Btuh.

Steam flow: **<\_\_\_\_\_\_\_\_>** lb/hr.

Inlet steam pressure: **<\_\_\_\_\_\_\_\_>** psig.

Entering air temperature: **<\_\_\_\_\_\_\_\_>** degrees F.

Nominal Capacity: **<\_\_\_\_\_\_\_\_>** tons.

* + - 1. ELECTRICAL CHARACTERISTICS AND COMPONENTS

Select one or more of the following subparagraphs appropriate to equipment requirements.

* + - * 1. Electrical Characteristics:

**[<\_\_\_\_\_\_\_\_> hp.] [<\_\_\_\_\_\_\_\_> RLA.]**

**<\_\_\_\_\_\_\_\_>** volts, **[single] [three]** phase, 60 Hz.

**<\_\_\_\_\_\_\_\_>** amperes maximum **[fuse size] [circuit breaker size] [overcurrent protection]**.

**<\_\_\_\_\_\_\_\_>** minimum circuit ampacity.

**<\_\_\_\_\_\_\_\_>** percent minimum power factor at rated load.

* + - * 1. Disconnect Switch: Factory mounted, non-fused type, interlocked with access door, accessible from outside unit, with power lockout capability.
			1. SOURCE QUALITY CONTROL
				1. Perform factory test of **[each] [representative]** unit. Test includes:

Dynamic trim balance of completed fan assembly.

Complete run check of electrical components and safety controls, including proper control sequencing.

Pressure test, at manufacturer's rated pressure, of refrigerant coils and condenser coils prior to unit assembly.

Leak check of completed refrigerant circuits.

Leak check of completed **[water] [steam]** circuit.

Compressor run check.

Use one or both of the following paragraphs to require owner's inspection or witnessing of test at factory.

* + - * 1. Make completed unit available for inspection at manufacturer's factory prior to packaging for shipment. Notify Director’s Representative at least seven days before inspection is allowed.
				2. Allow witnessing of factory inspections and test at manufacturer's test facility. Notify Director’s Representative at least seven days before inspections and tests are scheduled.
1. EXECUTION
	* + 1. EXAMINATION
				1. Section 013000 - Administrative Requirements: Coordination and project conditions.
				2. Verify roof curbs are installed and dimensions are as **[shown on shop drawings] [instructed by manufacturer]**.
			2. PREPARATION
				1. Furnish roof curbs to Section **<\_\_\_\_\_\_\_\_>** for installation.
			3. INSTALLATION

When curbs are specified in another section delete installation requirements.

* + - * 1. Roof Curb:

Assemble roof curb.

Install roof curb level.

Coordinate curb installation and flashing with Section **<\_\_\_\_\_\_\_\_>**.

Install units on roof curb providing watertight enclosure to protect ductwork and utility services.

Install gasket material between unit base and roof curb.

* + - * 1. Install units on vibration isolators. Refer to Section 230548.
				2. Connect units to supply and return ductwork with flexible connections. Refer to Section 233300.
				3. Install condensate piping with trap and route from drain pan to **[splash block on roof] [nearest roof drain.] [condensate drainage system.] <\_\_\_\_\_\_\_\_.>** Refer to Section 232113.
				4. Install components furnished loose for field mounting.
				5. Install electrical devices furnished loose for field mounting.
				6. Install control wiring between unit and field installed accessories.
				7. Remove from roof and dispose off-site panels removed from units during installation of **[economizer] [and] [dampers] <\_\_\_\_\_\_\_\_>**.
				8. Locate remote panels **[as indicated on Drawings.] <\_\_\_\_\_\_\_\_.>**
				9. Provide **[fixed]** sheaves required for final air balance.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - * 1. Install Work in accordance with **[State] [Municipality]** of **<\_\_\_\_\_\_\_\_> [Highways] [Public Works]** standards.
			1. INSTALLATION - NATURAL GAS HEATING SECTION
				1. Connect natural gas piping in accordance with NFPA 54 “National Fuel Gas Code”.
				2. Connect natural gas piping to unit, full size of unit gas train inlet. Arrange piping with clearances for burner service.
				3. Install the following piping accessories on natural gas piping connections. Refer to Section 231123.

Strainer.

Pressure gage.

Shutoff valve.

Pressure reducing valve.

* + - * 1. Install natural gas piping accessories **[above roof] [within unit casing] [below roof]**.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - 1. INSTALLATION - PROPANE HEATING SECTION
				1. Connect propane piping in accordance with NFPA 58 “Liquefied Petroleum Gas Code”.
				2. Connect propane piping to unit, full size of unit gas train inlet. Arrange piping with clearances for burner service.
				3. Install the following piping accessories on propane piping connections. Refer to Section 231126.

Strainer.

Pressure gage.

Shutoff valve.

Pressure reducing valve.

* + - * 1. Install propane piping accessories **[above roof] [within unit casing] [below roof]**.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - 1. INSTALLATION - HOT WATER HEATING COIL

Edit the following based on project conditions or office standards.

* + - * 1. Make connections to coils with unions or flanges.
				2. Connect water supply to leaving airside of coil (counter flow arrangement).
				3. Locate water supply at bottom of supply header and return water connection at top.
				4. Install water coils to allow draining and install drain connection at low points.
				5. Install the following piping accessories on hot water piping connections. Refer to Section 232113.

On supply:

Thermometer well and thermometer.

Well for **[control system]** temperature sensor.

Shutoff valve.

Strainer.

Control valve.

Pressure gage.

On return:

Thermometer well and thermometer.

Well for **[control system]** temperature sensor.

Pressure gage.

Shutoff valve.

**[Balancing valve] [Flow control valve]**.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - * 1. Install valves and piping specialties in accordance with details as indicated on Drawings.
				2. Install **[manual] [automatic]** air vents at high points complete with shutoff valve. Refer to Section 232113.
				3. Install hot water piping accessories **[within unit casing] [below roof]**.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - 1. INSTALLATION - STEAM HEATING COIL
				1. Make connections to coils with unions or flanges.
				2. Install steam traps with outlet minimum 12 inches below coil return connection.
				3. Install the following piping accessories on steam piping connections. Refer to Section 232213.

On supply:

Shutoff valve.

Strainer.

Control valve.

Pressure gage.

Air vent.

On return:

Vacuum breaker.

Steam trap.

Shutoff valve.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - * 1. Install valves and piping specialties in accordance with details as indicated on Drawings.
				2. Install steam piping accessories **[within unit casing] [below roof]**.
			1. MANUFACTURER'S FIELD SERVICES

Include the following based on Project conditions.

* + - * 1. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - * 1. Furnish services of Company Field Advisor per OGS Spec Section 014216 for minimum of **[one] <\_\_\_\_\_\_\_\_>** days to leak test, refrigerant pressure test, evacuate, dehydrate, charge, start-up, calibrate controls, and instruct Director’s Representative on operation and maintenance.
			1. CLEANING
				1. Section 017716 – Contract Closeout
				2. Vacuum clean coils and inside of cabinets.
				3. Install new throwaway filters in units at Substantial Completion.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - * 1. Install temporary filters during construction period. Replace with permanent filters at Substantial Completion.
			1. DEMONSTRATION
				1. Section 017716 – Contract Closeout
				2. Demonstrate unit operation and maintenance.

Include the following based on Project conditions.

* + - * 1. Furnish services of manufacturer's technical representative for **[one] <\_\_\_\_\_\_\_\_> [8] <\_\_\_\_\_\_\_\_>** hour day to instruct Director’s Representative's personnel in operation and maintenance of units. Schedule training with Director’s Representative, provide at least 7 days notice to Director’s Representative **<\_\_\_\_\_\_\_\_>** of training date.
			1. SCHEDULES

Include schedule when more than one size or type unit is required. Coordinate equipment tags and abbreviations with project specific requirements.

Consider the following examples when developing Project schedule.

* + - * 1. Rooftop Units Schedule:

Equipment Tag: **<RT-1>**:

**[Manufacturer: <\_\_\_\_\_\_\_\_>.]**

**[Model: <\_\_\_\_\_\_\_\_>.]**

Location: **<\_\_\_\_\_\_\_\_>**.

Unit Voltage: **<\_\_\_\_\_\_\_\_>**.

Altitude: **<\_\_\_\_\_\_\_\_>**.

Unit Sound Rating: **<\_\_\_\_\_\_\_\_>**.

Supply Fan: **<\_\_\_\_\_\_\_\_>**.

Supply Airflow Rate: **<\_\_\_\_\_\_\_\_>**.

Outside Airflow Rate: **<\_\_\_\_\_\_\_\_>**.

External Static Pressure: **<\_\_\_\_\_\_\_\_>**.

Fan Motor: **<\_\_\_\_\_\_\_\_>**.

Cooling:

Total Cooling Capacity: **<\_\_\_\_\_\_\_\_>**.

Sensible Cooling Capacity: **<\_\_\_\_\_\_\_\_>**.

Entering Air Temperature - Dry Bulb: **<\_\_\_\_\_\_\_\_>**.

Entering Air Temperature - Wet Bulb: **<\_\_\_\_\_\_\_\_>**.

Condenser Ambient Air Temperature: **<\_\_\_\_\_\_\_\_>**.

Energy Efficiency Ratio: **<\_\_\_\_\_\_\_\_>**.

Number of **[Compressors] [Refrigeration Circuits]: <\_\_\_\_\_\_\_\_>**.

Capacity Steps: **<\_\_\_\_\_\_\_\_>**.

Gas Heating:

Input: **<\_\_\_\_\_\_\_\_>**.

Output: **<\_\_\_\_\_\_\_\_>**.

Stages: **<\_\_\_\_\_\_\_\_>**.

Electric Heating:

Electric Resistance Heating Capacity: **<\_\_\_\_\_\_\_\_>**.

Capacity Steps: **<\_\_\_\_\_\_\_\_>**.

Hot Water Heating:

Capacity:

Water Flow Rate: **<\_\_\_\_\_\_\_\_>**.

Entering Air Temperature: **<\_\_\_\_\_\_\_\_>**.

Entering Water Temperature: **<\_\_\_\_\_\_\_\_>**.

Leaving Water Temperature: **<\_\_\_\_\_\_\_\_>**.

Coil Pressure Drop: **<\_\_\_\_\_\_\_\_>**.

Steam Heating:

Capacity: **<\_\_\_\_\_\_\_\_>**.

Steam Flow Rate: **<\_\_\_\_\_\_\_\_>**.

Inlet Steam Pressure: **<\_\_\_\_\_\_\_\_>**.

Entering Air Temperature: **<\_\_\_\_\_\_\_\_>**.

Equipment Tag: **<RT-2>**:

**[Manufacturer: <\_\_\_\_\_\_\_\_>.]**

**[Model: <\_\_\_\_\_\_\_\_>.]**

Location: **<\_\_\_\_\_\_\_\_>**.

Unit Voltage: **<\_\_\_\_\_\_\_\_>**.

Altitude: **<\_\_\_\_\_\_\_\_>**.

Unit Sound Rating: **<\_\_\_\_\_\_\_\_>**.

Supply Fan: **<\_\_\_\_\_\_\_\_>**.

Supply Airflow Rate: **<\_\_\_\_\_\_\_\_>**.

Outside Airflow Rate: **<\_\_\_\_\_\_\_\_>**.

External Static Pressure: **<\_\_\_\_\_\_\_\_>**.

Fan Motor: **<\_\_\_\_\_\_\_\_>**.

Cooling:

Total Cooling Capacity: **<\_\_\_\_\_\_\_\_>**.

Sensible Cooling Capacity: **<\_\_\_\_\_\_\_\_>**.

Entering Air Temperature - Dry Bulb: **<\_\_\_\_\_\_\_\_>**.

Entering Air Temperature - Wet Bulb: **<\_\_\_\_\_\_\_\_>**.

Condenser Ambient Air Temperature: **<\_\_\_\_\_\_\_\_>**.

Energy Efficiency Ratio: **<\_\_\_\_\_\_\_\_>**.

Number of **[Compressors] [Refrigeration Circuits]: <\_\_\_\_\_\_\_\_>**.

Capacity Steps: **<\_\_\_\_\_\_\_\_>**.

Gas Heating:

Input: **<\_\_\_\_\_\_\_\_>**.

Output: **<\_\_\_\_\_\_\_\_>**.

Stages: **<\_\_\_\_\_\_\_\_>**.

Electric Heating:

Electric Resistance Heating Capacity: **<\_\_\_\_\_\_\_\_>**.

Capacity Steps: **<\_\_\_\_\_\_\_\_>**.

Hot Water Heating:

Capacity:

Water Flow Rate: **<\_\_\_\_\_\_\_\_>**.

Entering Air Temperature: **<\_\_\_\_\_\_\_\_>**.

Entering Water Temperature: **<\_\_\_\_\_\_\_\_>**.

Leaving Water Temperature: **<\_\_\_\_\_\_\_\_>**.

Coil Pressure Drop: **<\_\_\_\_\_\_\_\_>**.

Steam Heating:

Capacity: **<\_\_\_\_\_\_\_\_>**.

Steam Flow Rate: **<\_\_\_\_\_\_\_\_>**.

Inlet Steam Pressure: **<\_\_\_\_\_\_\_\_>**.

Entering Air Temperature: **<\_\_\_\_\_\_\_\_>**.

END OF SECTION 237416.12