SECTION 238143 - AIR-SOURCE UNITARY HEAT PUMPS

This Section includes roof-mounted self-contained heat pumps heating, and related controls. It also includes packaged heat pump units with refrigerant compressors and controls, intended for indoor installation, with connections for water-source condenser/evaporator units or air-source condenser/evaporators.

Manufacturers found in SpecAgent for this Section were identified as representative and not as an endorsement for meeting the requirements of this specification.

This Section includes performance, proprietary, and descriptive type specifications. Edit to avoid conflicting requirements.

This Section includes the term Architect/Engineer. "Architect" is used in AIA contract documents; "Engineer" is used in EJCDC contract documents. Retain appropriate term.

See the Drawing Coordination Considerations for information needed to coordinate this specification Section with the Drawings.

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

Packaged rooftop heat pumps.

Unitary heat pumps.

* + - * 1. Related Sections:

Section 230513 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors for placement by this section.

Section 230548 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for vibration isolators for placement by this section.

Section 230923 - Direct-Digital Control System for HVAC: Execution requirements for connecting units to controls remote from unit specified in this section.

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

Section 230953 - Pneumatic and Electric Control System for HVAC: Execution requirements for connecting units to controls remote from unit specified in this section.

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

Section 232113 - Hydronic Piping: Execution requirements for condenser water and drain piping specified by this section.

Section 232300 - Refrigerant Piping: Execution requirements for refrigerant piping specified by this section.

Section 233300 - Air Duct Accessories: Product requirements for flexible connections for placement by this section.

Section 234000 - HVAC Air Cleaning Devices: Product requirements for Air Filters for placement by this section.

Section 236313 - Air-Cooled Refrigerant Condensers: Product requirements for condensing units used with air cooled units included in this section.

Execution requirements for electrical connection to units specified by this section.

* + - 1. REFERENCES

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

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

ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.

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

* + - * 1. International Organization for Standardization:

ISO 13256-1 - Water-Source Heat Pumps - Testing and Rating for Performance - Part 1: Water-to-Air and Brine-to-Air Heat Pumps.

* + - * 1. Underwriters Laboratories, Inc.:

UL 1995 - Heating and Cooling Equipment.

* + - 1. DEFINITIONS
				1. Coefficient of Performance (COP), heat pump, heating - Ratio of rate of heat delivered to rate of energy input, in consistent units, for complete heat pump system, including compressor and, if applicable, auxiliary heat, under designated operating conditions.
				2. Energy Efficiency Ratio (EER) - Ratio of net cooling capacity in Btu/h to total rate of electric input in watts under designated operating conditions.
				3. Heating Seasonal Performance Factor (HSPF) - Total heating output of heat pump during its normal annual usage period for heating (in Btu) divided by total electric energy input during the same period.
				4. Seasonal Energy Efficiency Ratio (SEER) - Total cooling output of an air conditioner during its normal annual usage period for cooling (in Btu) divided by total electric energy input during the same period (in Wh).
			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. Shop Drawings: Indicate dimensions, rough-in connections, and duct connections of manufactured products and assemblies. Indicate electrical service with connection requirements.
				3. Product Data: Submit drawings indicating capacity, weights, electrical characteristics and connection requirements. Indicate electrical characteristics.
				4. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.
				5. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
			1. CLOSEOUT SUBMITTALS
				1. Section 017716 - Contract Closeout : Closeout procedures.
				2. Project Record Documents: Record actual locations of controls separate 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. Air Cooled Equipment:

Cooling Performance Requirements: Conform to minimum **[SEER] [EER]** prescribed by ASHRAE 90.1 “Energy Standard for Buildings Except Low-Rise Residential Buildings” when tested in accordance with **[ARI 210/240] [ARI 340/360] [and UL 1995]**.

Heating Performance Requirements: Conform to minimum **[HSPF] [COP]** prescribed by ASHRAE 90.1 “Energy Standard for Buildings Except Low-Rise Residential Buildings” when tested in accordance with **[ARI 210/240] [ARI 340/360] [and UL 1995]**.

* + - * 1. Water Cooled Equipment:

Cooling Performance Requirements: Conform to minimum EER prescribed by ASHRAE 90.1 “Energy Standard for Buildings Except Low-Rise Residential Buildings” when tested in accordance with ISO 13256-1 “Water-Source Heat Pumps - Testing and Rating for Performance - Part 1: Water-to-Air and Brine-to-Air Heat Pumps” **[and UL 1995]**.

Heating Performance Requirements: Conform to minimum COP prescribed by ASHRAE 90.1 “Energy Standard for Buildings Except Low-Rise Residential Buildings” when tested in accordance with ISO 13256-1 “Water-Source Heat Pumps - Testing and Rating for Performance - Part 1: Water-to-Air and Brine-to-Air Heat Pumps” **[and UL 1995]**.

* + - * 1. Sound Rating: Measure in accordance with ARI 270 “Sound Rating of Outdoor Unitary Equipment”.
				2. 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 **[, and with service facilities within [100] <\_\_\_\_\_\_\_\_> miles of Project].**
				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: Product storage and handling requirements.
				2. Accept heat pump units on site in factory packaging. Inspect for damage.
				3. Protect heat pump units from damage by providing temporary covers until construction is complete in adjacent space. Protect rooftop heat pump units from damage by storing off roof until roof mounting curbs are in place.
			4. FIELD MEASUREMENTS
				1. Verify field measurements prior to fabrication.
			5. WARRANTY

This article extends warranty period beyond one year. Extended warranties increase construction costs and Owner enforcement responsibilities. Specify warranties with caution.

* + - * 1. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.
				2. Furnish **[five] <\_\_\_\_\_\_\_\_>**-year manufacturer's warranty for Compressors.
			1. MAINTENANCE SERVICE
				1. Section 017716 - Contract Closeouts: Maintenance service.
				2. Furnish service and maintenance of packaged heat pump roof top units 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. Furnish 24-hour emergency service on breakdowns and malfunctions.
			2. EXTRA MATERIALS
				1. Section 017716 - Contract Closeout: Spare parts and maintenance products.
				2. Furnish **[one set] <\_\_\_\_\_\_\_\_>** of **[filters] [fan belts]** for each unit.
1. PRODUCTS
	* + 1. ROOFTOP HEAT PUMPS

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:

Carrier Global Corporation.

ClimateMaster, Inc.

Daikin-McQuay.

Trane Inc.

York.

Approved equivalent.

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

* + - * 1. Product Description: **[Roof mounted units having supplementary electric heating elements and electric refrigeration.]** **[Self-contained, packaged, factory assembled and pre-wired, consisting of cabinet and frame, supply fan, [return fan,] electric heating elements, reversing valve, controls, air filters, compressor, refrigerant coils and fans.]**
				2. Fabrication:

Omit or select access fastener type.

Cabinet: Constructed of **[steel] [galvanized steel]** with baked enamel finish, access doors or removable access panels with **[quick fasteners] [screwdriver operated flush cam type.]** **[hex-head sheet metal screws.] [locking door handle type with piano hinges.]** Minimum 18 gage structural members, with access doors or removable panels of minimum 20 gage.

Insulation: **[1/2] [one] [2]** inch thick **[neoprene coated] [aluminum foil]** glass fiber with edges protected from erosion.

Include return air fan when applicable. Some manufacturers do not furnish variable pitch pulleys as standard. Use complete isolation only in very large units.

* + - * 1. Supply **[and Return] [and Exhaust]** Fan: Forward curved centrifugal type, resiliently mounted with V-belt drive, **[adjustable variable pitch motor pulley,]** and **[rubber isolated hinge mounted] [high efficiency]** motor **[or direct drive as indicated on Drawings]**. **[Isolate complete fan assembly.]** Refer to Section 230548.
				2. Air Filters: **[1 inch thick permanent washable.] [1 inch thick glass fiber disposable media in metal frames.] [2 inch thick glass fiber disposable media in metal frames.] [Automatic renewable media with extended surface media filters.] [Refer to Section 234000.]**
				3. Roof Mounting Curb: **[14] [24] <\_\_\_\_\_\_\_\_>** inches high, galvanized steel, channel frame with gaskets, nailer strips.
				4. Electric Heating Coil:

**[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.

Controls: Confirm supply fan is operating before electric elements are energized. Operate electric heater in **[2] [3] <\_\_\_\_\_\_\_\_>** stages when outdoor ambient is too low to maintain space thermostat setting with compressor operation.

* + - * 1. Space Supply Air Coil:

Copper tube aluminum fin coil assembly with galvanized drain pan and connection.

Capillary tubes or thermostatic expansion valves for units of 10 tons capacity and less, and thermostatic expansion valves and alternate row circuiting for units 12 tons cooling capacity and larger.

* + - * 1. Compressor:

**[Hermetic] [or] [semi-hermetic]** compressors, 3600 rpm maximum, resiliently mounted with positive lubrication, high and low pressure safety controls, motor overload protection, and gage ports.

Five-minute timed off circuit to delay compressor start.

Outdoor thermostat to energize compressor above **[35] <\_\_\_\_\_\_\_\_>** degrees F ambient.

Select desired method of capacity control.

Step capacity control accomplished by **[hot gas by-pass.] [cycling compressors.] [cylinder unloading.] [cycling multi-speed compressors.]**

Furnish reversing valve, suction line accumulator, **[discharge muffler,]** flow control check valve, and solid-state defrost control.

* + - * 1. Outdoor Coil:

Copper tube **[aluminum] [copper]** fin coil assembly **[with subcooling rows] [and coil guard]**.

Direct drive propeller fans, motor overload protection, wired to operate with compressor. **[Furnish high efficiency fan motors.]**

Include pressure switch for operation with low ambient temperatures on larger capacity units.

Furnish **[refrigerant pressure switches] [outdoor thermostat]** to cycle fans.

* + - * 1. Mixed Air Casing:

International Energy Conservation Code requires outside air dampers to have the following maximum damper leakage rate. 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.

Select applicable ventilation method. Third option, complete economizer, includes paragraphs 1 through 4.

Dampers: Manual outside **[and return]** air dampers for fixed outside air quantity.

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

Dampers: Remote controlled outside **[and return]** air dampers with damper operator and remote rheostat for adjusting outside air quantity.

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

Dampers: Outside, return, and relief dampers with damper operator and control package to automatically vary outside air quantity. Outside air damper to fail to closed position. **[Furnish relief dampers gravity balanced.]**

Select one of the following two paragraphs for appropriate damper operator.

Damper Operator: 24 volt with gear train sealed in oil **[with spring return on units 7.5 ton cooling capacity and larger]**.

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

Damper Operator: Pneumatic piston or gear driven type with spring return **[and pilot positioner]**.

Select control parameter. Select ambient switch over to match particular unit and control sequence.

Mixed Air Controls: Maintain selected supply air temperature and return dampers to minimum position **[on call for heating and] [above 57 degrees F ambient.] [above 75 degrees F ambient.] [when ambient air temperature exceeds return air temperature.] [when ambient air enthalpy exceeds return air enthalpy.]**

The following article is typical of controls provided as standard on smaller capacity and single zone units. Some of these features may be provided with other control options.

* + - * 1. Operating Controls - Single Zone Units:

Electric solid state microcomputer based room thermostat, located **[as indicated on Drawings] [in service area with remote sensor]**.

Room thermostat incorporating:

Automatic switching from cooling to heat pump heating to supplemental electric heating.

Instant override of set point for continuous or timed period from one hour to 31 days.

Short cycle protection.

Programming based on weekdays, Saturday and Sunday.

Switch selection features including imperial or metric display, 12 or 24-hour clock, keyboard disable, remote sensor and fan-on-auto.

Room thermostat display including:

Time of day.

Actual room temperature.

Programmed temperature.

Programmed time.

Duration of timed override.

Day of week.

System model indication: cooling, heating, supplemental heating, auto, off, fan auto, fan on.

Stage (heating or cooling) operation.

Furnish low limit thermostat in supply air to close outside air dampers and stop supply fan.

* + - * 1. Operating Controls:

Select applicable controls and controls combination. This article deals with standard, factory available, operating controls for smaller capacity, single zone units. More sophisticated controls or those for different types of units are contained in paragraphs following.

Low voltage, adjustable **[room]** thermostat to control heater stages in sequence with delay between stages, compressor and outdoor coil fan supply fan to maintain temperature setting.

Include system selector switch **[(heat-off-cool)] [(off-heat-auto-cool)] [and fan control switch (auto-on)]**.

Double acting thermostat with minimum **<\_\_\_\_\_\_\_\_>** stage heating and **<\_\_\_\_\_\_\_\_>** stage cooling.

Single acting thermostat with minimum **<\_\_\_\_\_\_\_\_>** stage cooling.

Locate thermostat in **[room as indicated on Drawings.] [supply air.] [return air.]**

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

Terminal strip on unit for connection of operating controls to remote panel. Control for **[two] <\_\_\_\_\_\_\_\_>** stages of heating and **[two] <\_\_\_\_\_\_\_\_>** stages of cooling.

Remote mounted fan control switch (on-auto).

Low limit thermostat in supply air to close outside air damper and stop supply fan.

Night control energized by central time clock to **[lock out refrigeration,] [close outside air damper and open return air damper,] [stop supply air fan,] [set fan control switch to auto position,]** for night and unoccupied operation. **[Furnish time delay to maintain outside air damper closed and return air damper to open position after switching to day and occupied operation.]**

Select applicable panel options. Generally options are not standard but available.

Remote readout panels containing signal lights indicating system status, system failure and dirty filters; check switches proving signal light operations; system on-off switch.

Select panel options to match operating controls.

Furnish in panel **[manual 12 hour timer to override night control,] [7 day time clock for energizing night control,] [remote damper control,] [low limit manual reset,] [and] [remote thermostat temperature set point]**.

* + - * 1. Operating Controls - Variable Volume Units:

Temperature transmitter located in supply air to signal electronic logic panel to control mixing dampers and cooling in sequence. Operate mixing section as first stage of cooling and revert to minimum outside air above approximately 75 degrees F as determined by [enthalpy] [temperature] of return and outdoor air.

Control cooling by cycling compressors, cylinder unloading, and hot gas bypass.

Control logic to allow supply air reset under low load or airflow conditions.

Seven-day time clock with spring carry over (or electronic clock with battery backup) to control unit on occupied/un-occupied schedule. At night, unit is to be off. Locate clock in remote control panel with status lights.

Two-stage morning warm-up thermostat to hold outdoor dampers closed and energize heat until return air temperature reaches set point.

By-pass dampers, **[located within roof curb,]** bypassing air from supply fan discharge to return fan inlet to control duct static pressures. Control operation by sensing current to supply fan motor.

* + - * 1. Capacity - Roof Top Heat Pumps:

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.

Heat Pump Heating:

Rated heating output: **<\_\_\_\_\_\_\_\_>** Btuh.

Rated outdoor air temperature: **[47 degrees F DB and 43 degrees F WB] [17 degrees F DB and 15 degrees F WB]**.

Rated air temperature entering indoor coil: 70 degrees F.

Co-efficient of performance: Minimum **<\_\_\_\_\_\_\_\_>**.

Heat Pump Cooling Capacity:

Rated cooling output: **<\_\_\_\_\_\_\_\_>** Btuh.

Air entering evaporator coil: **<\_\_\_\_\_\_\_\_>** degrees F DB, **<\_\_\_\_\_\_\_\_>** degrees F WB.

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

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

Supply Air:

Air flow: **<\_\_\_\_\_\_\_\_>** cfm.

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

**[Return] [Exhaust]** Air:

Air flow: <\_\_\_\_\_\_\_\_> cfm.

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

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

Use the following paragraph in conjunction with Schedule for different capacity units.

Scheduled Performance:

Cooling capacity: ARI 210/240 “Unitary Air-Conditioning and Air-Source Heat Pump Equipment” test conditions.

Cooling capacity: **<\_\_\_\_\_\_\_\_>** degrees F condenser ambient air.

Heat pump capacity:

Rated outdoor air temperature: **[47 degrees F DB and 43 degrees F WB] [17 degrees F DB and 15 degrees F WB]**.

Rated air temperature entering indoor coil: 70 degrees F.

Sound Rating Numbers: ARI 270 “Sound Rating of Outdoor Unitary Equipment”.

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

* + - 1. UNITARY HEAT PUMP 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:

Carrier Global Corporation.

ClimateMaster, Inc.

Daikin-McQuay.

Trane Inc.

York.

Approved equivalent.

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

* + - * 1. Product Description: Packaged, self-contained, factory assembled, pre-wired unit, consisting of cabinet, compressor, condensing coil, evaporator fan, evaporator coil, [discharge plenum,] [outside air connection,] [heating coil,] air filters, and controls; fully charged with refrigerant and filled with oil.
				2. Assembly: **[Up flow] [Horizontal flow]** air delivery, in draw-through configuration **[as indicated on Drawings]**.
				3. Cabinet:

Frame and Panels: Galvanized steel with baked enamel finish, easily removed access-doors or panels.

Insulation: Minimum 1/2-inch thick acoustic duct liner for lining cabinet interior.

Drain Pan: Galvanized steel with corrosion-resistant coating or molded corrosion-resistant material.

* + - * 1. Supply Air Fan:

Fan: **[V-Belt driven, with permanently lubricated bearings] [Direct drive], [double width, double inlet, forward curved centrifugal] [propeller]** fan, statically and dynamically balanced, resiliently mounted.

V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed. Variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position as recommended by manufacturer or minimum 1.5 times nameplate rating of motor.

* + - * 1. Compressor: Hermetically sealed, 3600 rpm maximum resiliently mounted with positive lubrication and internal motor protection.
				2. Supply Air Coil:

Direct expansion coiling coil of copper **[or aluminum]** tubes expanded into aluminum fins.

Refrigeration circuit with expansion device, **[filter-drier]**, and charging valves.

* + - * 1. Condenser:

There are three condenser options: water cooled condenser, remote mounted air-cooled condenser, and integral air-cooled condenser. Edit accordingly.

Water Cooled Condenser: Co-Axial, copper tube in copper tube or shell and tube with **[finned]** copper tubes in steel shell with water temperature actuated water-regulating valve.

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

Remotely Mounted Air Cooled Condenser: **[Terminating suction and liquid refrigerant piping with service valves within unit.] [Refer to Section 238216.]**

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

Integral Air Cooled Condenser:

Fan: Statically and dynamically balanced, with permanently lubricated bearings.

V-Belt Drive: Dynamically balanced, bored to fit shafts and keyed. Variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position as recommended by manufacturer or minimum 1.5 times nameplate rating of motor.

* + - * 1. Heating Coil: Helical nickel-chrome resistance wire coil heating elements with refractory ceramic support bushings, with **[automatic reset thermal cut-out], [built-in magnetic contactors], [manual reset thermal cut-out], [airflow proving device]**, load fuses.

Select desired filters.

* + - * 1. Air Filters: Easily removed **[one inch thick permanent cleanable] [2 inch thick disposable glass fiber]** panel filters.
				2. Controls:

Factory wired controls including **[contactor], [high and low pressure cutouts], [internal winding thermostat for compressor], [control circuit transformer], [non-cycling reset relay.]**

Thermostat to cycle cooling within unit with 'fan-off-cool' switch allowing continuous fan operation, or cycling fan on call for cooling.

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

Room thermostat to control cooling with 'cool-off' selector switch and 'auto-on' fan control switch.

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

Low voltage, adjustable **[room]** thermostat to control **[heater stages in sequence with delay between stages,]** compressor, **[condenser,]** and supply fan to maintain temperature setting. Include system selector switch **[(heat-off-cool)] [(off-heat-auto-cool)] [and fan control switch (auto-on)]**.

Use the following paragraph for more detailed controls.

Refer to Section **[230923] [230953]**. **[Refer to Section 230993 for sequence of operation.]**

* + - * 1. Capacity - Unitary Heat Pump Units:

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.

Cooling:

Cooling capacity: **<\_\_\_\_\_\_\_\_>** Btuh.

Air flow: **<\_\_\_\_\_\_\_\_>** cfm.

Air entering evaporator: **<\_\_\_\_\_\_\_\_>** degrees F DB and **<\_\_\_\_\_\_\_\_>** degrees F WB.

Air leaving evaporator: **<\_\_\_\_\_\_\_\_>** degrees F DB and **<\_\_\_\_\_\_\_\_>** degrees F WB.

Water entering condenser: **<\_\_\_\_\_\_\_\_>** degrees F.

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

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

Cooling:

Cooling capacity: **<\_\_\_\_\_\_\_\_>** Btuh.

Air flow: **<\_\_\_\_\_\_\_\_>** cfm.

Air entering evaporator: **<\_\_\_\_\_\_\_\_>** degrees F DB and **<\_\_\_\_\_\_\_\_>** degrees F WB.

Air leaving evaporator: **<\_\_\_\_\_\_\_\_>** degrees F DB and **<\_\_\_\_\_\_\_\_>** degrees F WB.

Refrigerant saturated suction temperature: **<\_\_\_\_\_\_\_\_>** degrees F.

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

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

Cooling:

Cooling capacity: **<\_\_\_\_\_\_\_\_>** Btuh.

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

Air entering evaporator: **<\_\_\_\_\_\_\_\_>** degrees F DB and **<\_\_\_\_\_\_\_\_>** degrees F WB.

Air leaving evaporator: **<\_\_\_\_\_\_\_\_>** degrees F DB and **<\_\_\_\_\_\_\_\_>** degrees F WB.

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

Air entering condenser: **<\_\_\_\_\_\_\_\_>** degrees F.

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

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

Heat Pump Heating:

Rated heating output: **<\_\_\_\_\_\_\_\_>** Btuh.

Reverse cycle COP: **<\_\_\_\_\_\_\_\_>**.

Heating:

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

* + - 1. ELECTRICAL CHARACTERISTICS AND COMPONENTS

Select one or more of the following subparagraphs for Project conditions.

* + - * 1. Electrical Characteristics:

**[<\_\_\_\_\_\_\_\_> hp.] [<\_\_\_\_\_\_\_\_> rated load amperes.]**

**<\_\_\_\_\_\_\_\_>** 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. Motors: In accordance with Section 230513.
				2. Disconnect Switch: Factory mount **[in control panel] [on equipment]**.
1. EXECUTION
	* + 1. EXAMINATION
				1. Section 013000 - Administrative Requirements: Coordination and project conditions.
				2. Verify roof curbs are installed and dimensions are **[as indicated on shop drawings] [instructed by manufacturer]**.
				3. Verify concrete housekeeping pad is sized and located correctly.
				4. Verify piping rough-in is at correct location.
				5. Verify electrical rough-in is at correct location.
			2. INSTALLATION
				1. Install rooftop units on factory built roof-mounting curb with watertight enclosure to protect ductwork and utility services. Install roof mounting curb level.
				2. Install unit on concrete housekeeping pad, minimum 3-1/2 inches high and 6 inches larger than unit on each side. Refer to Section 033000.
				3. Locate remote panels **[as indicated on Drawings.] <\_\_\_\_\_\_\_\_.>**
				4. Install indoor units on vibration isolators. Refer to Section 230548.
				5. Connect indoor units to supply and return ductwork with flexible connections. Refer to Section 233300.
				6. Install refrigerant piping from indoor to outdoor unit. Install refrigerant specialties **[furnished with unit] [specified in Section 232300]. [Refer to Section 232300.]**
				7. Install the following piping accessories on condenser water piping connections. Refer to Section 232113.

On inlet:

Thermometer well for temperature limit controller.

Thermometer well and thermometer.

Strainer.

Flow switch.

Flexible pipe connection.

Pressure gage.

Shut-off valve.

On outlet:

Thermometer well and thermometer.

Flexible pipe connection.

Pressure gage.

**[Shut-off] [Balancing]** valve.

* + - * 1. Install condensate piping from drain pan to **[nearest floor drain.] [condensate drainage system.]** **<\_\_\_\_\_\_\_\_.>**
				2. Install accessories furnished loose for field mounting.
				3. Install electrical devices furnished loose for field mounting.
				4. Install control wiring between unit control panel and field mounted control devices.
			1. MANUFACTURER'S FIELD SERVICES
				1. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.
			2. CLEANING
				1. Section 017716 - Contract Closeout : Requirements for cleaning.
				2. After construction is completed, including painting, clean exposed surfaces of units.
				3. Vacuum clean coils and inside of cabinets.
				4. Touch up marred or scratched surfaces of factory finished cabinets, using finish materials furnished by manufacturer.
				5. Install new throwaway filters in units after Substantial Completion.

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

* + - * 1. Install temporary filters during construction period. Replace with permanent filters after Substantial Completion.
			1. DEMONSTRATION
				1. Section 017716 - Contract Closeout : Requirements for demonstration and training.
				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 **<\_\_\_\_\_\_\_\_>** of training date.
			1. PROTECTION OF FINISHED WORK
				1. Section 017716 - Contract Closeout : Requirements for starting and adjusting.

Use the following when units are located in finished space.

* + - * 1. Protect finished surfaces of cabinets with protective covers during remainder of construction.
			1. SCHEDULES

Include schedule when more than one size or type unit is required.

Consider the following examples when developing Project schedules.

* + - * 1. Roof top Heat Pumps Schedule:

RT-1:

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

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

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

Supply Fan:

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

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

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

[Return] [Exhaust] Fan:

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

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

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

Cooling:

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

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

Evaporator Entering Dry Bulb Temperature: **<\_\_\_\_\_\_\_\_>**.

Evaporator Entering Wet Bulb Temperature: **<\_\_\_\_\_\_\_\_>**.

Evaporator Leaving Dry Bulb Temperature: **<\_\_\_\_\_\_\_\_>**.

Evaporator Leaving Wet Bulb Temperature: **<\_\_\_\_\_\_\_\_>**.

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

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

Heat:

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

Output

Outdoor Dry Bulb Air Temperature: **<\_\_\_\_\_\_\_\_>**.

Outdoor Wet Bulb Air Temperature: **<\_\_\_\_\_\_\_\_>**.

COP: **<\_\_\_\_\_\_\_\_>**.

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

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

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

RT-2:

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

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

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

Supply Fan:

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

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

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

**[Return] [Exhaust]** Fan:

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

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

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

Cooling:

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

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

Evaporator Entering Dry Bulb Temperature: **<\_\_\_\_\_\_\_\_>**.

Evaporator Entering Wet Bulb Temperature: **<\_\_\_\_\_\_\_\_>**.

Evaporator Leaving Dry Bulb Temperature: **<\_\_\_\_\_\_\_\_>**.

Evaporator Leaving Wet Bulb Temperature: **<\_\_\_\_\_\_\_\_>**.

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

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

Heat:

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

Output

Outdoor Dry Bulb Air Temperature: **<\_\_\_\_\_\_\_\_>**.

Outdoor Wet Bulb Air Temperature: **<\_\_\_\_\_\_\_\_>**.

COP: **<\_\_\_\_\_\_\_\_>**.

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

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

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

* + - * 1. Unitary Heat Pump Units Schedule:

HP-1:

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

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

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

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

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

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

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

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

Leaving Air Dry Bulb Temperature: **<\_\_\_\_\_\_\_\_>**.

Leaving Air Wet Bulb Temperature: **<\_\_\_\_\_\_\_\_>**.

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

Heat Pump Source:

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

**[Water Temperature]**: **<\_\_\_\_\_\_\_\_>.**

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

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

**[Fan] [Pump]** Motor Power: <\_\_\_\_\_\_\_\_>.

Heating:

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

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

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

HP-2:

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

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

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

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

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

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

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

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

Leaving Air Dry Bulb Temperature: **<\_\_\_\_\_\_\_\_>**.

Leaving Air Wet Bulb Temperature: **<\_\_\_\_\_\_\_\_>**.

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

Heat Pump Source:

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

**[Water Temperature]: <\_\_\_\_\_\_\_\_>**.

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

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

[Fan] [Pump] Motor Power: **<\_\_\_\_\_\_\_\_>**.

Heating:

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

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

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

END OF SECTION 238143