SECTION 231600 – REFRIGERANT COMPRESSORS

This Section includes refrigeration compressors for use in refrigeration systems, packaged with controls and motor starters.

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:

Reciprocating compressors.

Screw compressors.

Scroll compressors.

* + - * 1. Related Sections:

Section 033000 - Cast-In-Place Concrete: Execution requirements for concrete bases specified by this section.

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 isolation for placement by this section.

Section 230993 - Sequence of Operations for HVAC Controls: Sequences of operation for compressors specified in this section.

Section 232300 - Refrigerant Piping: Execution requirements for refrigerant piping.

Section 260503 - Equipment Wiring Connections: Execution requirements for electrical connections to Refrigeration Compressors specified by this section.

* + - 1. REFERENCES

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

* + - * 1. American Bearing Manufacturers Association:

ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

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

ARI 520 - Positive Displacement Condensing Units.

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

ASHRAE 23 - Methods of Testing for Rating Positive Displacement Refrigerant Compressors and Condensing Units.

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

* + - * 1. National Electrical Manufacturers Association:

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

* + - * 1. Underwriters Laboratories Inc.:

UL 207 - Refrigerant-Containing Components and Accessories, Nonelectrical.

* + - 1. DEFINITIONS
				1. Coefficient of Performance (COP) - cooling: The ratio of the rate of heat removal to the rate of energy input, in consistent units, for a complete refrigerating system or some specific portion of that system under designated operating conditions.
				2. Integrated Part-Load Value (IPLV): A 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 the 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 General Conditions.
				2. Manufacturer’s installation instructions shall be provided along with product data.
				3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).

Only request submittals needed to verify compliance with Project requirements.

* + - * 1. Section 013300 - Submittal Procedures: Submittals procedures.
				2. Shop Drawings: Indicate components, assembly, dimensions, weights and loads, required clearances, and location and size of field connections. Indicate accessories for complete system.
				3. Product Data: Submit rated capacities, accessories, electrical nameplate data and wiring diagrams.
				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.
				6. Manufacturer's Field Reports: Submit start-up report indicating results of testing, dehydration, and starting of machine.
				7. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
				8. Manufacturer's installation instructions shall be provided along with product data.
				9. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
			1. CLOSEOUT SUBMITTALS
				1. Section 017716 – Contract Closeout000 - Execution and Closeout Requirements: Closeout procedures.
				2. Operation and Maintenance Data: Submit start-up instructions, maintenance instructions, parts lists, controls, and accessories.
			2. QUALITY ASSURANCE
				1. Performance Ratings: [**Coefficient of Performance (COP)**] [**and**] [**Integrated Part-Load Value (IPLV)**] not less than prescribed by ASHRAE 90.1 “Energy Standard for Buildings Except Low-Rise Residential Buildings”.
				2. Perform Work in accordance with [**State**] [**Municipality**] of <**\_\_\_\_\_\_\_\_**> [**Highways**] [**Public Work's**] standards.

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. FIELD MEASUREMENTS
				1. Verify field measurements prior to fabrication.
			4. WARRANTY

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

* + - * 1. Section 017716 – Contract Closeout000 - Execution and Closeout Requirements: Product warranties and product bonds.
				2. Furnish [**five**] <**\_\_\_\_\_\_\_\_**>-year manufacturer's warranty for compressors.
			1. EXTRA MATERIALS
				1. Section 017716 – Contract Closeout000 - Execution and Closeout Requirements: Spare parts and maintenance products.
				2. Furnish [**one**] <**\_\_\_\_\_\_\_\_**> complete change of lubricating oil.
1. PRODUCTS
	* + 1. REFRIGERATION COMPRESSORS

In this article, list manufacturers acceptable for this Project.

* + - * 1. [Manufacturers](http://www.specagent.com/LookUp/?ulid=8334&mf=04&src=wd):

Substitutions: [Section 016000 - Product Requirements] [Not Permitted].

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=9748) Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

Carrier Global Corp.

Emerson Electric Co.

Mitsubishi Electric Corp.

Approved equivalent.

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

* + - 1. MANUFACTURED UNITS
				1. Compressor Units: [**Hermetic**] [**Semi-hermetic (serviceable hermetic)**] [**Open**] compressor and motor, with [**cylinder unloading**] crankcase heater, suction and discharge service valves, vibration isolators, and control panel.
				2. Construction and Ratings: In accordance with ARI 520 “Positive Displacement Condensing Units” [**and UL 207**]. Test in accordance with ASHRAE 23 “Methods of Testing for Rating Positive Displacement Refrigerant Compressors and Condensing Units”.
			2. HERMETIC COMPRESSORS

In this article, list manufacturers acceptable for this Project.

* + - * 1. [Manufacturers](http://www.specagent.com/LookUp/?ulid=8335&mf=04&src=wd):

Substitutions: [Section 016000 - Product Requirements] [Not Permitted].

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=9748) Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

Copeland

Danfoss

Embraco

Emerson Electric Co.

Approved equivalent.

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

* + - * 1. Reciprocating Compressors:

Unit: Hermetically sealed motor-compressor with crankcase heater, suction and discharge service valves, and control panel.

Motor: Constant speed 3600 rpm, suction gas cooled with overheating protection.

Crankcase Heater: Energize [**continuously**] [**when compressor is not operating**].

Controls: Factory wired for crankcase heater, terminal strip for connection to power with electronic protection module incorporating overload and single phase protection, high discharge temperature, and anti-recycling timer.

* + - * 1. Scroll Compressors:

Unit: Direct drive, hermetic, 3600 RPM, fixed compression, scroll motor-compressor with control panel.

Features: Centrifugal oil pump, sump oil heater, oil level sight glass, oil charging valve, two point lubrication for each motor bearing, flooded lubrication for journal and thrust bearings, check valve on scroll discharge port.

Motor: Suction gas-cooled, hermetically sealed, squirrel cage induction.

Control panel: Factory mounted panel with separate starter and refrigeration control sections:

Starter section:

Non-fused molded-case disconnect switch.

Single point power connection and grounding lug.

Control power transformer with fuse.

Solid state overload relay for each compressor.

Phase loss/reversal monitor.

Cycle counter and hour meter for each compressor.

Refrigeration section:

Anti-recycle timer.

Reset relay.

Reset switch.

Low and high-pressure control.

Motor winding temperature protection.

Manual reset for compressor overload, high motor temperature, and low and high refrigerant pressure.

Automatic Capacity Reduction: [**Wire steps to terminal strip. Refer to Section 230993.**] [**Electronic logic controller and room thermostat controls unit.**] [**Electronic logic controller and air temperature sensor controls unit and hot gas bypass regulator valve.**]

* + - * 1. Performance:

Capacity: <**\_\_\_\_\_\_\_\_**> tons (<**\_\_\_\_\_\_\_\_**> kW) of refrigeration.

Suction Temperature: <**\_\_\_\_\_\_\_\_**> degrees F (<**\_\_\_\_\_\_\_\_**> degrees C).

Condensing temperature: <**\_\_\_\_\_\_\_\_**> degrees F (<**\_\_\_\_\_\_\_\_**> degrees C).

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

IPLV: <**\_\_\_\_\_\_\_\_**>.

* + - 1. SEMI-HERMETIC COMPRESSORS

In this article, list manufacturers acceptable for this Project.

* + - * 1. [Manufacturers](http://www.specagent.com/LookUp/?ulid=8336&mf=04&src=wd):

Substitutions: [Section 016000 - Product Requirements] [Not Permitted].

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=9748) Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

Copeland

Danfoss

Embraco

Emerson Electric Co.

Approved equivalent.

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

* + - * 1. Reciprocating Compressors:

Unit: Serviceable hermetic reciprocating motor-compressor with positive displacement oil pump lubrication system, [**spring loaded heads and replaceable cylinder liners,**] crankcase heater, suction inlet screen, discharge service valves and control panel.

Automatic Capacity Reduction Equipment: Suction valve unloading with lifting mechanism [**solenoid**] [**gas pressure**] operated. Furnish capability for unloaded compressor start.

Motor: Constant speed 1800 rpm, suction gas cooled with electronic overheating protection in each phase, [**full**] [**reduced**] voltage starting.

Crankcase Heater: Energize [**continuously**] [**when compressor is not operating**].

Controls:

Control Panel: Factory mounted and wired, NEMA 250 “Enclosures for Electrical Equipment” [**Type 1**] [**Type 4**] <**\_\_\_\_\_\_\_\_**> enclosure, steel, containing power and control wiring, [**molded case disconnect switch,**] factory wired for single point power connection.

Starter: [**Full**] [**Part winding**], with manual reset current overload protection, starter relay, control power transformer, terminal strip for connection to interface equipment.

Safety Controls: Manually reset, adjustable high and low-pressure cutouts, low oil pressure cutout.

Panel Face: Compressor run light, start-stop switch, circuit breaker, demand limit switch, elapsed time meter, crankcase heater start-stop switch and light.

* + - * 1. Screw Compressors:

Unit: Direct drive, semi-hermetic 3600 RPM, fixed compression, rotary screw compressor with control panel.

Features: Differential refrigerant pressure oil pump, oil heater, oil separator and filter, oil charging valve.

Motor: Suction gas-cooled, hermetically sealed, squirrel cage induction.

Control panel: Factory mounted, NEMA 250 “Enclosures for Electrical Equipment” [**Type 1**] [**Type 4**] <**\_\_\_\_\_\_\_\_**> enclosure with starter and refrigeration controls including:

Non-fused molded-case disconnect switch.

Single point power connection and grounding lug.

Anti-recycle timer.

Solid state overload relay for each compressor.

Phase loss/reversal monitor.

Cycle counter and hour meter for each compressor.

Low and high-pressure control.

Automatic shutdown compressor overload and low and high refrigerant pressure.

Automatic Capacity Reduction: Continuously variable slide valve with infinitely variable control to 25 percent of full load.

* + - * 1. Performance:

Capacity: <**\_\_\_\_\_\_\_\_**> tons (<**\_\_\_\_\_\_\_\_**> kW) of refrigeration.

Suction Temperature: <**\_\_\_\_\_\_\_\_**> degrees F (<**\_\_\_\_\_\_\_\_**> degrees C).

Condensing temperature: <**\_\_\_\_\_\_\_\_**> degrees F (<**\_\_\_\_\_\_\_\_**> degrees C).

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

IPLV: <**\_\_\_\_\_\_\_\_**>.

* + - * 1. Electrical Characteristics:

<**\_\_\_\_\_\_\_\_**> HP (<**\_\_\_\_\_\_\_\_**> kW).

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

* + - 1. OPEN COMPRESSORS

In this article, list manufacturers acceptable for this Project.

* + - * 1. [Manufacturers](http://www.specagent.com/LookUp/?ulid=8337&mf=04&src=wd):

Substitutions: [Section 016000 - Product Requirements] [Not Permitted].

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=9748) Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

Atlas Copco

Carrier Global Cerp.

Copeland

Approved equivalent.

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

* + - * 1. Reciprocating Compressors:

Unit: Serviceable hermetic reciprocating motor-compressor with positive displacement oil pump lubrication system, [**spring loaded heads and replaceable cylinder liners,**] crankcase heater, suction inlet screen, discharge service valves, and control panel.

Automatic Capacity Reduction Equipment: Suction valve unloaders with lifting mechanism [**solenoid**] [**gas pressure**] operated. Furnish capability for unloaded compressor start.

Motor: Constant speed 1800 rpm, suction gas cooled with electronic overheating protection in each phase, [**full**] [**reduced**] voltage starting.

Crankcase Heater: Energize [**continuously**] [**when compressor is not operating**].

Controls:

Control Panel: Factory wired, steel, containing power and control wiring, [**molded case disconnect switch,**] factory wired for single point power connection.

Starter: [**Full**] [**Part winding**], with manual reset current overload protection, starter relay, control power transformer, terminal strip for connection to interface equipment.

Safety Controls: Manually reset, adjustable high and low-pressure cutouts, low oil pressure cutout.

Panel Face: Compressor run light, start-stop switch, circuit breaker, demand limit switch, elapsed time meter, crankcase heater start-stop switch and light.

* + - * 1. Screw Compressors:

Unit: Direct drive, open drive, 3600 RPM, fixed compression, rotary screw compressor with control panel.

Features: Differential refrigerant pressure oil pump, oil heater, oil separator and filter, oil charging valve, compressor bearings with ABMA 9 “Load Ratings and Fatigue Life for Ball Bearings” L10 life expectancy at 100,000 hours.

Motor: Open drip proof flange squirrel cage induction, close coupled to compressor.

Control panel: Factory mounted, NEMA 250 “Enclosures for Electrical Equipment” [**Type 1**] [**Type 4**] <**\_\_\_\_\_\_\_\_**> panel with starter and refrigeration controls including:

Non-fused molded-case disconnect switch.

Single point power connection and grounding lug.

Anti-recycle timer.

Solid state overload relay for each compressor.

Phase loss/reversal monitor.

Cycle counter and hour meter for each compressor.

Low and high-pressure control.

Automatic shutdown compressor overload and low and high refrigerant pressure.

Automatic Capacity Reduction: Continuously variable slide valve with infinitely variable control to 25 percent of full load.

* + - * 1. Performance:

Capacity: <**\_\_\_\_\_\_\_\_**> tons (<**\_\_\_\_\_\_\_\_**> kW) of refrigeration.

Suction Temperature: <**\_\_\_\_\_\_\_\_**> degrees F (<**\_\_\_\_\_\_\_\_**> degrees C).

Condensing Temperature: <**\_\_\_\_\_\_\_\_**> degrees F (<**\_\_\_\_\_\_\_\_**> degrees C).

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

IPLV: <**\_\_\_\_\_\_\_\_**>.

* + - 1. ELECTRICAL CHARACTERISTICS AND COMPONENTS

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

* + - * 1. Electrical Characteristics: In accordance with Section 260503 and the following:

[**<\_\_\_\_\_\_\_\_> hp (<\_\_\_\_\_\_\_\_> W).**] [**<\_\_\_\_\_\_\_\_> 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. INSTALLATION
				1. Provide for connection to electrical service. Refer to Section 260503.
				2. Align compressor package on steel or concrete foundations. [**Refer to Section 033000.**]
				3. Install units on [**rubber-in-shear**] vibration isolation. [**Refer to Section 230548.**]
				4. Provide connection to refrigerant piping. Refer to Section 232300.
			2. MANUFACTURER'S FIELD SERVICES
				1. Section 014000 - Quality Requirements: Manufacturers? field services.
				2. Furnish services of factory trained representative for minimum [**one**] <**\_\_\_\_\_\_\_\_**> days to leak test, refrigerant pressure test, evacuate, dehydrate, charge, start-up, calibrate controls, and instruct Director’s Representative on operation and maintenance.
				3. Furnish initial charge of refrigerant and oil.
			3. DEMONSTRATION AND TRAINING
				1. Section 017000 - Execution and Closeout Requirements: Requirements for demonstration and training.
				2. Demonstrate start-up, and instruction on operation and maintenance to Director’s Representative.
			4. SCHEDULES

Include schedule when more than one compressor of differing sizes are specified. Complete schedule in conjunction with identification method used on drawings, or include schedule on drawings. No units of measure are indicated; they may be added to schedule legend or indicated within each insert. Coordinate equipment tags and abbreviations with project specific requirements.

Consider the following examples when developing Project schedule.

* + - * 1. Refrigerant Compressors Schedule:

Equipment Tag: <C-1>:

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

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

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

Refrigeration Effect: <**\_\_\_\_\_\_\_\_**>.

Refrigerant: <**\_\_\_\_\_\_\_\_**>.

Saturated Suction Temp: <**\_\_\_\_\_\_\_\_**>.

Saturated Discharge Temp: <**\_\_\_\_\_\_\_\_**>.

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

RPM: <**\_\_\_\_\_\_\_\_**>.

Starter Type: <**\_\_\_\_\_\_\_\_**>.

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

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

IPLV: <**\_\_\_\_\_\_\_\_**>.

Equipment Tag: <C-2>:

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

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

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

Refrigeration Effect: <**\_\_\_\_\_\_\_\_**>.

Refrigerant: <**\_\_\_\_\_\_\_\_**>.

Saturated Suction Temp: <**\_\_\_\_\_\_\_\_**>.

Saturated Discharge Temp: <**\_\_\_\_\_\_\_\_**>.

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

RPM: <**\_\_\_\_\_\_\_\_**>.

Starter Type: <**\_\_\_\_\_\_\_\_**>.

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

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

IPLV: <**\_\_\_\_\_\_\_\_**>.

END OF SECTION 236100