SECTION 230953 - PNEUMATIC AND ELECTRIC CONTROL SYSTEM FOR HVAC

This Section includes equipment and devices normally found in complete pneumatic control system. Use section to define complete system or used to complement electronic or digital system.

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:

Control panel enclosures.

Receiver controllers.

Pneumatic system accessories.

Alarm system.

Air supply.

Air supply piping and tubing.

Refrigerated air dryer.

Control valves.

Pneumatic valve actuators.

Control air dampers.

Pneumatic damper actuators.

Inlet vane actuators.

Outside air measuring and modulation device.

* + - * 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 isolation for control air compressors for placement by this section.

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

Section 232116 - Hydronic Piping Specialties: Product requirements for thermometer sockets and gage taps. Installation requirements for piping products furnished in this section.

Section 233300 - Air Duct Accessories: Product requirements for duct mounted thermometers. Installation requirements for dampers and other duct mounted products furnished in this section.

* + - 1. REFERENCES

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

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

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

* + - * 1. American Society of Mechanical Engineers:

ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.

ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

* + - * 1. ASTM International:

ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

ASTM A536 - Standard Specification for Ductile Iron Castings.

ASTM B32 - Standard Specification for Solder Metal.

ASTM B88 - Standard Specification for Seamless Copper Water Tube.

ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

ASTM D2737 - Standard Specification for Polyethylene (PE) Plastic Tubing.

* + - * 1. American Welding Society:

AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.

* + - * 1. National Electrical Manufacturers Association:

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

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

UL 1820 - Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics.

* + - 1. SYSTEM DESCRIPTION

Use this article carefully; restrict statements to describe components used to assemble system. Do not repeat statements made in SUMMARY article; Section includes paragraph.

* + - * 1. Provide pneumatic control systems consisting of thermostats, control valves, dampers and actuators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.
			1. SUBMITTALS

Only request submittals needed to verify compliance with Project requirements.

* + - * 1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
				2. Manufacturer’s installation instructions shall be provided along with product data.
				3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
				4. Section 013300 - Submittal Procedures: Submittal procedures.
				5. Shop Drawings: Indicate operating data, system drawings, piping and wiring diagrams, and written detailed operational description of sequences. For automatic dampers submit arrangement, velocities, and static pressure drops for each system. For automatic valves submit size, flow, and pressure drop for each valve. Coordinate submittals with information required in Section 230993.
				6. Product Data: Submit description and engineering data for each control system component. Include sizing.

Air Control Dampers: Submit manufacturer's product data.

Include leakage, pressure drop, and sample calibration curves.

Indicate materials, construction, dimensions, and installation details.

Include the following paragraph for submitting physical samples for selection of finish, color, texture, and other properties.

* + - * 1. Samples: Submit [**two**] <**\_\_\_\_\_\_\_\_**> of [**each type of room thermostat and cover**] [**thermostat guard**] [**each exposed control component**].
				2. Design Data: Indicate [**sizing and selection of compressor**] [**sizing of air tubing**] <**\_\_\_\_\_\_\_\_**>.
				3. Manufacturer's Installation Instructions: Submit installation instruction for each control system component.
				4. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
				5. Manufacturer’s Field Reports: After completion and checkout, submit data showing set points and final adjustments of controls.
			1. CLOSEOUT SUBMITTALS
				1. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Revise shop drawings to reflect actual installation and operating sequences.
				2. Operation and Maintenance Data: Submit systems descriptions, set points, and controls settings and adjustments. Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
			2. QUALITY ASSURANCE
				1. Provide pneumatic tubing located in plenums with peak optical density not greater than 0.5, average optical density not greater than 0.15, and flame spread not greater than 5 feet (1.5 m) when tested in accordance with UL 1820 “Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics”.
				2. Control Air Damper Performance: Test in accordance with AMCA 500 “Test Methods for Louvers, Dampers, and Shutters”.
				3. Perform Work in accordance with [**State**] [**Municipality**] of <**\_\_\_\_\_\_\_\_**> [**Highways**] [**Public Work's**] standard.

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

* + - * 1. Maintain one copy 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. Requirements for transporting, handling, storing, and protecting products.
				2. Accept control components on site in factory packing. Inspect for damage. Store under roof.
				3. Protect control components by leaving in shipping cases until installation, and by storing indoors.
			4. COORDINATION
				1. Section 013000 - Administrative Requirements: Requirements for coordination.
				2. Coordinate installation of control components in piping systems with work of Section 232116.
				3. Coordinate installation of control components in duct systems with work of Section 233300.
			5. WARRANTY

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

* + - * 1. Product warranties and product bonds.
				2. Furnish [**five**] <**\_\_\_\_\_\_\_\_**> year manufacturer warranty for [**control air compressor**] <**\_\_\_\_\_\_\_\_**>.
			1. MAINTENANCE SERVICE
				1. Requirements for maintenance service.

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

* + - * 1. Furnish service and maintenance of control system for [**one**] <**\_\_\_\_\_\_\_\_**> year from Date of Substantial Completion.
				2. Furnish complete service of controls systems, including callbacks. Perform minimum of <**\_\_\_\_\_\_\_\_**> complete normal inspections of approximately <**\_\_\_\_\_\_\_\_**> hours duration in addition to normal service calls to inspect, calibrate, and adjust controls. Submit written report after each inspection.
				3. Furnish [**two**] [**four**] <**\_\_\_\_\_\_\_\_**> complete inspections [**per year**], one in each season, to inspect, calibrate, and adjust controls. Submit written report after each inspection.
				4. Examine unit components [**weekly**] [**semi-monthly**] [**monthly**] [**bi-monthly**]. Clean, adjust, and lubricate equipment.
				5. Include systematic examination, adjustment, and lubrication of unit, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.
				6. Perform work without removing units from service during building normal occupied hours.
				7. Provide emergency call back service [**at all hours**] [**during working hours**] for this maintenance period.
				8. Maintain an adequate stock of parts[**, locally**] [**, near Place of the Work,**] for replacement or emergency purposes. Ensure personnel availability to ensure fulfillment of this maintenance service without unreasonable loss of time.
				9. Perform maintenance work using competent and qualified personnel under supervision [**and in direct employ**] of manufacturer or original installer.
				10. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of [**Director’s Representative.**] <**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.**>
			1. EXTRA MATERIALS
				1. Spare parts and maintenance products.
				2. Furnish [**two**] <**\_\_\_\_\_\_\_\_**> of each type of [**thermostat**] [**exposed sensor**] <**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**>.
1. PRODUCTS
	* + 1. PNEUMATIC CONTROLS

In this article, list manufacturers acceptable for this Project.

* + - * 1. Manufacturers: 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]:

Barber-Colman Co.

Honeywell, Inc.

Johnson Controls, Inc.

Landis & Gyr Powers, Inc.

Approved equivalent.

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

* + - 1. CONTROL PANEL ENCLOSURES
				1. Furnish for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gages, pilot lights, push buttons and switches flush on cabinet panel face.
				2. Construction: NEMA 250 “Enclosures for Electrical Equipment (1000 Volts Maximum)”, Type [**1**] [**3**] [**4**] [**7**] [**9**] <**\_\_\_\_\_\_\_\_**> steel [**stainless steel**] [**fiberglass**] [**plastic**] enclosure.
				3. Covers: Continuous hinge, held closed by [**flush latch operable by [screwdriver] [key]**] [**hasp and staple for padlock**].
				4. Enclosure Finish: [**Manufacturer's standard enamel**] [**None**] <**\_\_\_\_\_\_\_\_**>.
			2. RECEIVER CONTROLLERS
				1. Single or dual input models [**with control point adjustment**] <**\_\_\_\_\_\_\_\_**> direct or reverse acting with mechanical set point adjustment [**with locking device**], proportional band adjustment, and authority adjustment. Furnish with [**proportional**] [**proportional plus integral**] control mode.
				2. Remote control point adjustment plus or minus [**20**] <**\_\_\_\_\_\_\_\_**> percent of sensor span, input signal [**3 to 13 psig**] [**1 to 20 psig**].
				3. Proportional band extending from 2-1/2 to 40 percent of primary sensor span, authority from 10 to 200 percent of primary sensor span [**and integral time 0.5 to 20 min**].
				4. Suitable for supply air pressure of [**18 psig**] [**20 psig**] with input signals of [**3 to 15 psig**] [**1 to 20 psig**] and output signal [**0 to 15 psig**] [**20 psig**].
			3. PNEUMATIC SYSTEMS ACCESSORIES
				1. Water Temperature Controllers: Operate on adjustable differential over adjustable temperature range and suitable for operating control valve furnished.
				2. Pressure Gages: Manufacturer's standard, black letters on white background, [**3-1/2 inch**] [**2-1/2 inch**] [**2 inch**] diameter, flush or surface mounted, with [**front calibration screw**] suitable dial range calibrated to match sensor, in appropriate units.
				3. Instrument Pressure Gages: Manufacturer's standard, black letters on white background, [**2 inch**] [**1-1/2 inch**] diameter, stem mounted with suitable dial range.
				4. Diaphragm Control and Instrument Valves: [**1/2 inch**] [**3/8 inch**] forged brass body with reinforced teflon diaphragm, stainless steel spring, and color coded phenolic handle.
				5. Gage Cocks: Tee or level handle, bronze, rated for 125 psig.
				6. Relays: For summing, reversing, amplifying, highest or lowest pressure selection, with fixed 1: 1 [**or adjustable**] input/output ratio.
				7. Switches: With indicating plates, accessible adjustment, calibrated and marked.
			4. ALARM SYSTEM
				1. Enclosure Construction: NEMA 250 “Enclosures for Electrical Equipment (1000 Volts Maximum)”, Type [**1**] [**3**] [**4**] [**8**] <**\_\_\_\_\_\_\_\_**>.
				2. Furnish alarm panel with individual indication, horn, silenced acknowledge switch, and test switch.
				3. At alarm condition indication light flashes and alarm sounds. Horn stops when acknowledge switch is pushed and system indicates alarm conditions by continuous light until trouble condition has cleared. Alarm sounds again when second alarm occurs before first one has cleared.
				4. Furnish remote panels [**as indicated on Drawings**] with duplicate functions of primary panel. Furnish alarm silence/acknowledge switch to acknowledge alarm from each panel.
				5. Furnish panels in locations described to serve duplicate functions of primary panel. Furnish alarm silence/acknowledge switch to acknowledge alarm from each panel.
				6. Furnish dry contacts at main alarm panel for use with remote alarm monitoring system to indicate [**each**] alarm condition.
			5. AIR SUPPLY

In this article, list manufacturers acceptable for this Project.

Select appropriate compressor configuration. Duplex type compressor allows for standby in case of compressor failure.

* + - * 1. Manufacturers: 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

Campbell Hausfeld

DeWalt

Approved equivalent.

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

* + - * 1. Compressor and Receiver: [**Simplex**] [**Duplex**] belt driven air compressor and [**ASME labeled**] tank unit with belt guard, silencers, flexible connections, air filter, automatic and manual drain assemblies, oil and particle filter for minimum 0.5 micron particles, pressure reducing valves, and pressure relief valves.
				2. Size [**each**] compressor and storage tank to limit compressor starts to maximum [**10**] <**\_\_\_\_\_\_\_\_**> for each hour and [**50**] [**30**] percent running time.
				3. Pressure Control: Zinc or aluminum casting, rated for service with elastomeric diaphragm, adjustable electric contacts. Control set to start and stop compressor at [**50 and 65 psig**] [**60 and 80 psig**] [**70 and 90 psig**] [**100 and 125 psig**]. Second Compressor, when used, starts at [**50 and 65 psig**] [**60 and 80 psig**] [**70 and 90 psig**].
				4. Electrical Alternation Set: With motor starters to operate compressors [**alternately**] [**on time schedule**].
				5. Pressure Regulators: Zinc or aluminum castings, rated for service with elastomeric diaphragm, balanced construction to automatically prevent pressure build up, and producing flat, reduced pressure curve for system capacity demand.
				6. Particle Filters: Zinc or aluminum castings with filtration efficiency at rated air flow of 97 percent, rated for service with threaded connections, quick-disconnect service devices, aluminum bowl or plastic bowl with metal guard equipped with manual drain cock, to separate liquid and solid particles.
				7. Combination Filter/Regulators: Zinc or aluminum casting rated for service, with elastomeric diaphragm and balanced construction to automatically prevent pressure build-up. Filter/regulator produces flat, reduced pressure curve for system capacity demand and has threaded pipe connections, quick-disconnect service devices, aluminum bowl or plastic bowl with metal guard equipped with manual drain cock to separate liquid and solid particles.
				8. Airborne Oil Filter: Rated for service with filtration efficiencies of 99.9 percent for particles of 0.025 micron or larger particles of airborne lubricating oil.
				9. Pressure Relief Valves: ASME rated and labeled for high-pressure side and sized for installed capacity of pressure regulators at low pressure. Set at maximum 20 percent above low pressure.
				10. Pressure Reducing Stations: Assembly of two pressure regulators arranged in parallel to reduce high-pressure air to required controls pressure.
			1. REFRIGERATED AIR DRYER

In this article, list manufacturers acceptable for this Project.

* + - * 1. Manufacturers: 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]:

Ingersoll

Speedaire

Approved equivalent.

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

* + - * 1. General Assembly: Self-contained, commercial quality, refrigerated, compressed air dryer complete with heat exchangers, moisture separator, and internal wiring and piping. Furnish air inlet and outlet connections connected through manual by-pass valve.
				2. Heat Exchangers: Air to refrigerant coils. Furnish centrifugal type moisture separator located at discharge of compressed air complete with automatic trap assembly. Furnish automatic control system to bypass refrigeration system on low or no load conditions.
				3. Refrigeration Unit: Hermetically sealed, operating to maintain dew point of [**5 degrees F**] [**13 degrees F at 20 psig**] [**0 degrees F at 100 psig**]. House in steel cabinet with access door and panel.
				4. Accessories: Air inlet temperature gage, air inlet pressure gage, on/off switch, high temperature light, power on light, refrigerant gage on back, air outlet temperature gage, air outlet pressure gage [**, contacts for remote indication of power status, and high temperature alarm**].
			1. AIR SUPPLY PIPING AND TUBING
				1. Copper Tubing: ASTM B280 “Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service”, drawn.

Fittings: ASME B16.22 “Wrought Copper and Copper Alloy Solder Joint Pressure Fittings” wrought copper.

Joints: Braze, AWS A5.8 “Specification for Filler Metals for Brazing and Braze Welding” BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

* + - * 1. Copper Tubing: ASTM B88 “Standard Specification for Seamless Copper Water Tube”, Type K, drawn.

Fittings: ASME B16.18 “Cast Copper Alloy Solder Joint Pressure Fittings”, cast brass, or ASME B16.22 “Wrought Copper and Copper Alloy Solder Joint Pressure Fittings” solder wrought copper.

Joints: [**ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, [lead free] solder**] [**AWS A5.8 Classification BCuP-3 or BCuP-4 silver braze.**]

* + - * 1. Copper Tubing: ASTM B88 “Standard Specification for Seamless Copper Water Tube”, Type K, annealed.

Fittings: ASME B16.18 “Cast Copper Alloy Solder Joint Pressure Fittings”, cast brass, or ASME B16.22 “Wrought Copper and Copper Alloy Solder Joint Pressure Fittings” solder wrought copper.

Joints: [**ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, [lead free] solder**] [**AWS A5.8 Classification BCuP-3 or BCuP-4 silver braze.**]

* + - * 1. Virgin Polyethylene Non-metallic Tubing: ASTM D2737 “Standard Specification for Polyethylene (PE) Plastic Tubing”, with flame-retardant harness for multiple tubing.

Fittings: Polyethylene.

Joints: Compression or push-on type.

* + - 1. CONTROL VALVES

In this article, list manufacturers acceptable for this Project.

* + - * 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Johnson Controls, Inc.

Siemens Industry, Inc., Building Technologies Division.

Approved equivalent.

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

* + - * 1. Globe Pattern:

2 inches and Smaller: Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends [**with back seating capacity packable under pressure**].

2-1/2 inches and Larger: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.

Hydronic Systems:

Rate for service pressure of 125 psig at 250 degrees F.

Replaceable plugs and seats of [**stainless steel**] [**brass**].

Indicate valve sizing criteria here. Or delete the following paragraph and indicate valve pressure drop in schedule at end of this section or in control valve schedule on Drawings.

Sizing: [**3 psig**] [**<\_\_\_\_\_\_\_\_> psig**] maximum pressure drop at design flow rate.

Furnish two-way valves with equal percentage characteristics. Furnish three way valves with linear characteristics. Size two-way valve actuators to close valves against pump shut off head.

Steam Systems:

Rate for service pressure of 125 psig at 250 degrees F.

Replaceable plugs and seats of stainless steel.

Choose one of the following 3 paragraphs to indicate valve sizing criteria. Or delete the following paragraphs and indicate valve pressure drop in schedule at end of this section or in control valve schedule on Drawings.

Sizing: Pressure drop across steam valve at maximum flow as indicated on Drawings.

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

Sizing: 10 psig inlet pressure and 5 psig pressure drop.

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

Sizing: Pressure drop across steam valve equal to maximum flow of 80 percent of inlet steam pressure for low-pressure systems and 42 percent for high-pressure systems.

Furnish valves with modified linear characteristics.

* + - * 1. Ball Valves:

Threaded ends for 2-way valves 3 inches and smaller. Threaded ends for 3-way valves 2 inches and smaller.

Forged brass body, chrome plated brass ball and blowout proof stem and EPDM O-rings with minimum 600 psig rating.

Fluid Temperature Range: minus 20 to 250 degrees F.

Indicate valve sizing criteria here. Or delete the following paragraph and indicate valve pressure drop in schedule at end of this section or in control valve schedule on Drawings.

Sizing: [**3 psig**] [**<\_\_\_\_\_\_\_\_> psig**] maximum pressure drop at design flow rate.

Flow Characteristics: Furnish 2-way valves with equal percentage characteristics. Furnish 3-way valves with equal percentage characteristic through control port and linear characteristic through bypass port.

Size 2-way valve actuators to close valves against pump shut off head.

* + - * 1. Butterfly Valves:

Service Pressure Rating: 125 psig at 250 degrees F.

Construction: ASTM A126 “Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings” cast-iron or ASTM A536 “Standard Specification for Ductile Iron Castings” ductile-iron body and bonnet, extended neck, stainless steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.

Body Style: Wafer, or Lug.

Disc: [**Bronze**] [**Aluminum bronze**] [**Stainless steel**].

Resilient replaceable seat for service to [**180 degrees F**] [**250 degrees F**].

Indicate valve sizing criteria here. Or delete the following paragraph and indicate valve pressure drop in schedule at end of this section or in control valve schedule on Drawings.

Size for [**1 psig**] [**<\_\_\_\_\_\_\_\_> psig**] maximum pressure drop at design flow rate.

* + - * 1. Terminal Unit Control Valves:

Brass body, Class 250, nickel plated brass ball, with optimizer insert for modulating applications, blowout resistant stem, threaded ends.

Two or three way as indicated in schedule or on Drawings.

Integral actuator.

Spring return required for unit ventilator heating valves and other terminal equipment with outside air.

Furnish non-spring return valves with manual override capability built into actuator.

Minimum Fluid Temperature: 20 degrees F.

Maximum Operating Conditions: 250 degrees F.

Indicate valve sizing criteria here. Or delete the following paragraph and indicate valve pressure drop in schedule at end of this section or in control valve schedule on Drawings.

Sizing: [**4**] <**\_\_\_\_\_\_\_\_**> psig maximum pressure drop at design flow rate, to close against pump shutoff head.

Flow Characteristics: Furnish two-way and three-way valves with equal percentage characteristics.

* + - 1. PNEUMATIC VALVE ACTUATORS

In this article, list manufacturers acceptable for this Project.

* + - * 1. Manufacturers: 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]:

Fisher-Emerson

Johnson Controls

Approved equivalent.

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

* + - * 1. Temperature Range: Valve operator capable of operating in ambient temperatures of minus 22 to 140 degrees F.
				2. Rolling diaphragm, spring loaded, piston type with spring range [**2 to 5 psig**] [**3 to 10 psig**] [**8 to 11 psig**] [**as indicated on Drawings**].
				3. Furnish valves with spring return type operator to return to normal position [**as indicated in sequences**] [**as indicated on Drawings**] for freeze, fire, or temperature protection.
				4. Select operator for full shut off at maximum pump differential pressure.
			1. CONTROL AIR DAMPERS

In this article, list manufacturers acceptable for this Project.

* + - * 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Arrow United Industries.

Ruskin Company.

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

* + - * 1. Frames: [**Galvanized steel**] [**Extruded aluminum**] [**Rolled carbon steel**] [**Stainless steel**], welded or riveted with corner reinforcement, minimum [**12 gage**] [**<\_\_\_\_\_\_\_\_> gage**].
				2. Blades: [**Galvanized steel**] [**Extruded aluminum**] [**Rolled carbon steel**] [**Stainless steel**], maximum blade size [**8 inches**] [**6 inches**] [**<\_\_\_\_\_\_\_\_> inches**] wide, 48 inches long, minimum [**22 gage**] [**<\_\_\_\_\_\_\_\_> gage**], attached to minimum 1/2 inch shafts with set screws.
				3. Blade Seals: [**Synthetic elastomeric**] [**Neoprene**] [**inflatable**] mechanically attached, field replaceable.
				4. Jamb Seals: Stainless steel spring.

Select appropriate shaft bearing type. Lubrication free bearings are more expensive but are more suited to higher pressure.

* + - * 1. Shaft Bearings: [**Oil impregnated sintered bronze**] [**Graphite impregnated nylon sleeve, with thrust washers at bearings**] [**Lubricant free, stainless steel, single row, ground, flanged, radial, anti-friction type with extended inner race**].
				2. Linkage Bearings: [**Oil impregnated sintered bronze**] [**Graphite impregnated nylon**].

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

* + - * 1. Outside Air Damper Leakage: Maximum leakage rate of [**3.0**] <**\_\_\_\_\_\_\_\_**> cfm per square foot at [**1.0**] <**\_\_\_\_\_\_\_\_**> inches wg pressure differential.

Leakage rates for other dampers in air systems could be specified using one of the following two paragraphs.

* + - * 1. Damper Leakage: Maximum [**2**] <**\_\_\_\_\_\_\_\_**> percent at 4 inch wg differential pressure when sized for 2000 fpm face velocity.

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

* + - * 1. Damper Leakage: Maximum <**\_\_\_\_\_\_\_\_**> cfm per square foot at [**1.0**] <**\_\_\_\_\_\_\_\_**> inches wg pressure differential.
				2. Maximum Pressure Differential: 6 inches wg.
				3. Temperature Limits: - 40 to 200 degrees F.
			1. PNEUMATIC DAMPER ACTUATORS

In this article, list manufacturers acceptable for this Project.

* + - * 1. Manufacturers: 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]:

Belimo

Bettis

Siemens

Approved equivalent.

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

* + - * 1. General: Furnish even proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Furnish spring return for two-position control and for fail-safe operation.
				2. Rolling diaphragm piston type [**with adjustable stops**].
				3. Pilot Positioners: Starting point adjustable from 2 to 12 psig and operating span adjustable from 5 to 13 psig.
			1. INLET VANE ACTUATORS

In this article, list manufacturers acceptable for this Project.

* + - * 1. Manufacturers: 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]:

Flextech Industries

JASC Controls

Approved equivalent.

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

* + - * 1. High pressure with pilot positioners and sufficient force to move vanes when fan is started with vanes in closed position. Return vane operator to closed position on fan shutdown.
			1. OUTSIDE AIR MEASURING AND MODULATION DEVICE

In this article, list manufacturers acceptable for this Project.

* + - * 1. Manufacturers: 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]:

Honeywell

Johnson Controls

Trane Co.

Approved equivalent.

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

Device velocity range is between 300 fpm to 2,000 fpm.

* + - * 1. Factory assembled damper, airflow monitor, actuator, and accessories.
				2. Damper and airflow measurement assembly sized to accommodate [**minimum**] [**economizer**] outside airflow [**as indicated on Drawings**].
				3. Construction:

Frame: Extruded aluminum.

Blades:

Modulating Air Control:

Style: Airfoil-shaped, single-piece.

Action: Parallel.

Orientation: Horizontal.

Material: Heavy gage 6063-T5 extruded aluminum.

Width: Maximum 5 inches.

Stationary Sensing:

Style: Airfoil-shaped, single-piece.

Orientation: Horizontal.

Material: Heavy gage 6063-T5 extruded aluminum.

Width: Maximum 5-1/4 inches.

Finish: Anodized.

Bearings: Self-lubricating molded synthetic sleeve, turning in extruded hole in frame.

Seals:

Blade: Extruded rubber. Mechanically attached to blade edge.

Jamb: Stainless steel, flexible metal compression type.

Linkage: Concealed in frame.

Axles: Minimum 1/2 inch diameter plated steel, hex-shaped, mechanically attached to blade.

Mounting: Vertical.

Electric Actuator: 24 V, 60 Hz, modulating, with position feedback.

Digital Controller: Application specific controller. Programming logic and calibration in nonvolatile EPROM. Controller uses generic 0 - 10 vdc inputs and outputs for interface to building automation system.

Air Straightener Section: 3 inches deep section contained in 5 inch long sleeve attached to damper-airflow monitor frame.

Finish: Mill aluminum.

* + - * 1. Performance Data:

Temperature Rating: Withstand -40 to 140 degrees F.

Accuracy: Plus or minus 5 percent.

Leakage: Maximum of [**2.0**] [**3.0**] <**\_\_\_\_\_\_\_\_**> cfm per square foot at [**1.0**] <**\_\_\_\_\_\_\_\_**> inches wg pressure differential.

Measures from 15 percent to 100 percent of unit nominal air flow.

Adjusts air flow for temperature variations.

Provides 2 to 10 volt DC signal corresponding to actual air flow.

* + - * 1. Accessories:

Actuator Heater: Allow actuator operation in ambient temperatures to -40 degrees F.

* + - 1. ELECTRICAL CHARACTERISTICS AND COMPONENTS

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

* + - * 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 pneumatic tubing is clear of water, oil or other contaminants and compressed air supply has filter and dryer operating before installing control devices or actuators.
				3. Verify air handling units and ductwork installation is complete and air filters are in place before installing sensors in air streams.
				4. Verify location of thermostats [**and**] [**humidistats**] and other exposed control sensors with Drawings before installation.
				5. Verify building systems to be controlled are ready to operate.
			2. EXISTING WORK
				1. Remove exposed abandoned tubing [**, including abandoned control devices above accessible ceiling finishes**]. Cut tubing flush with walls and floors, cap, and patch surfaces.
				2. Maintain access to existing controls and other installations remaining active and requiring access. Modify installation or install access panel [**as indicated on Drawings**].
				3. Extend existing control installations using materials and methods [**compatible with existing installations, or**] specified in this Section.
			3. INSTALLATION
				1. Install Work in accordance with [**State**] [**Municipality**] of <**\_\_\_\_\_\_\_\_**> [**Highways**] [**Public Work's**] standards.

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

* + - * 1. Mount compressor and tank unit on vibration isolation [**consisting of springs, with minimum [1 inch] [2 inches] static deflection and 1 inch clearance to floor**]. [**Refer to Section 230548**]. Isolate air supply with wire braid reinforced rubber hose [**or polyethylene tubing**]. Pipe manual and automatic drains to nearest floor drain.
				2. Install instrument air piping from compressor through filter, pressure reducing valve, and pressure relief valve. Install pressure gages at inlet and outlet of assembly. Install shutoff valves to isolate each piece of equipment. Install bypass valves at <**\_\_\_\_\_\_\_\_**>.
				3. Install pressure reducing stations consisting of pressure reducing valve, particle filter, bypass with valves, pressure gage on inlet and outlet, and pressure relief valve.
				4. Install refrigerated air dryer in discharge-air line from tank. Mount dryer on wall on rubber in shear mounts. Install pressure regulator downstream of dryer. Install piping from automatic drain to nearest floor drain.
				5. Install copper tubing in mechanical rooms at the following locations:

Where subject to damage or temperatures in excess of 200 degrees F.

Where adjacent to heating pipes passing through common sleeve.

Where not readily accessible.

* + - * 1. In mechanical rooms, at installer’s option, install bundled plastic tubing installed with junction boxes or single plastic tubing with tray or raceway.
				2. [**Solder**] [**Braze**] copper tubing joints except at instruments or equipment. Install compression fittings at instruments or equipment.
				3. Install tubing concealed from view in [**finished**] [**occupied**] <**\_\_\_\_\_\_\_\_**> spaces.
				4. Install tubing exposed only in [**mechanical rooms,**] [**storage rooms**] <**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_'**> [**and other unfinished spaces**].
				5. Install tubing mechanically attached to supporting surfaces.
				6. Install sleeves through concrete surfaces minimum one inch size, extended 6 inches above floors and one inch below bottom surface of slabs.
				7. Purge tubing with dry, oil-free compressed air before connecting control instruments.

Use the following paragraph for heating or chilled water systems to charge system’s expansion tank.

* + - * 1. Install instrument air tubing with check and hand valves to expansion tanks with Schraeder fittings and hose.
				2. Install instrument air tubing with check and hand valves to [**chiller**] <**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**>.
				3. Install [**thermostats,**] [**humidistats,**] [**space temperature sensors,**] <**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**> [**and other exposed control sensors**] after locations are coordinated with other Work.
				4. Install [**thermostats,**] [**humidistats,**] [**space temperature sensors,**] <**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**> [**and other exposed control sensors**] [**60 inches**] [**48 inches**] [**42 inches**] above floor. Align with light switches [**and humidistats**] [**and <\_\_\_\_\_\_\_\_>**].
				5. Install freeze protection thermostats using flanges and element holders.
				6. Install outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors [**with sun shield**].
				7. Provide separable sockets for liquids and flanges for air bulb elements. Refer to Section 232116.

For following paragraphs, add to list of locations or indicate on Drawings.

* + - * 1. Install thermostats in aspirating boxes in [**public areas**] [**entrances**] [**handball courts**] [**gymnasiums**] [**high security areas**] [**and**] <**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**> [**and as indicated on Drawings**].
				2. Install guards on thermostats in [**public areas**] [**entrances**] [**handball courts**] [**gymnasiums**] [**and other public areas**] [**and as indicated on Drawings**].
				3. Install valves with position indicators and with pilot positioners where sequenced with other controls.
				4. Install separate steam valves for each bank of coils. Install two valves in parallel where steam load exceeds 1500 lb./hr with 1/3 - 2/3 load capacities sequenced with smaller valve opening first.
				5. Install mixing dampers of [**opposed**] [**or**] [**parallel**] blade construction arranged to mix streams. Provide pilot positioners on mixed air damper motors. [**Provide separate minimum outside air damper section adjacent to return air dampers with separate damper motor.**]
				6. Install isolation (two-position) dampers of parallel blade construction.
				7. Install pilot positioners on pneumatic damper actuators sequenced with other controls.
				8. Install [**pressure gages**] [**test plugs**] on branch lines at each receiver controller and signal lines at each transmitter except individual room controllers.
				9. Install damper motors on outside of duct in warm areas. Do not install motors in locations at subject to outdoor temperatures.
				10. Individually calibrate outside air measuring and modulation device to proper airflow set points.
				11. Install control panels adjacent to associated equipment on vibration free walls or freestanding supports. [**Use one cabinet for more than one system in same equipment room.**] [**Use one cabinet for each system.**] Install engraved plastic nameplates for instruments and control components inside cabinets and engraved plastic nameplates on each cabinet face. Label with appropriate equipment or system designation.
				12. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
			1. FIELD QUALITY CONTROL
				1. After completion of installation, test and adjust control equipment. Submit data showing set points and final adjustments of controls.
				2. Test pneumatic systems to system pressure maximum of 30 psig. Check calibration of instruments. Recalibrate instruments out of calibration. Replace defective instruments.
			2. DEMONSTRATION AND TRAINING
				1. Demonstrate complete operation of systems, including sequence of operation prior to Date of Substantial Completion.
				2. Demonstrate complete and operating system to Director’s Representative.
			3. SCHEDULES

Include schedules to identify individual control valves or control dampers. Where contractor is to size dampers or valves or where Drawings indicate sizes, schedule may not be required. Coordinate with clause "Submittals for Review".

Consider the following examples when developing Project schedules. Edit schedules to be consistent with equipment tags utilized on project.

* + - * 1. Control Valve Schedule:

Control Valve Tag: CV-1:

Size: <**\_\_\_\_\_\_\_\_**>.

Cv: <**\_\_\_\_\_\_\_\_**>.

Operator Spring Range: <**\_\_\_\_\_\_\_\_**>.

Normal Position: <**\_\_\_\_\_\_\_\_**>.

Control Valve Tag: CV-2:

Size: <**\_\_\_\_\_\_\_\_**>.

Cv: <**\_\_\_\_\_\_\_\_**>.

Operator Spring Range: <**\_\_\_\_\_\_\_\_**>.

Normal Position: <**\_\_\_\_\_\_\_\_**>.

* + - * 1. Control Damper Schedule:

Control Damper Tag: CD-1:

Height: <**\_\_\_\_\_\_\_\_**>.

Width: <**\_\_\_\_\_\_\_\_**>.

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

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

Control Damper Tag: CD-2:

Height: <**\_\_\_\_\_\_\_\_**>.

Width: <**\_\_\_\_\_\_\_\_**>.

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

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

END OF SECTION 230953