SECTION 230923.12 - CONTROL DAMPERS

Revise this Section by deleting and inserting text to meet Project-specific requirements.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

1. GENERAL
	* + 1. RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

* + - * 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
			1. SUMMARY
				1. Section includes the following types of control dampers and actuators for DDC systems:

Rectangular control dampers.

Round control dampers.

General control-damper actuator requirements.

Pneumatic actuators.

Electric and electronic actuators.

* + - * 1. Related Requirements:

Retain subparagraphs below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.

Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 230923.12.

* + - 1. DEFINITIONS

Retain terms that remain after this Section has been edited for a project.

* + - * 1. DDC: Direct-digital control.
				2. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.
			1. CLOSEOUT SUBMITTALS
				1. Operation and Maintenance Data: For control dampers to include in operation and maintenance manuals.
1. PRODUCTS

See Editing Instruction No. 1 in the Evaluations for cautions about named manufacturers and products. For an explanation of options and Contractor's product selection procedures., see Section 016000 "Product Requirements."

* + - 1. PERFORMANCE REQUIREMENTS
				1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
				2. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.

Retain "Delegated Design" Paragraph below if Contractor is required to assume responsibility for design.

* + - * 1. Delegated Design: Engage a qualified professional[**engineer**], as defined in Section 014000 "Quality Requirements," to size products where indicated as delegated design.
				2. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.
				3. Backup Power Source: Systems and equipment served by a backup power source shall have associated control damper actuators served from a backup power source.
				4. Environmental Conditions:

Provide electric control-damper actuators, with protective enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Electric control-damper actuators not available with integral enclosures, complying with requirements indicated, shall be housed in protective secondary enclosures.

Hazardous Locations: Explosion-proof rating for condition.

* + - * 1. Selection Criteria:

Control dampers shall be suitable for operation at following conditions:

Supply Air: <**Insert pressure and coincident temperature requirements**>.

Return Air: <**Insert pressure and coincident temperature requirements**>.

Outdoor Air: <**Insert pressure and coincident temperature requirements**>.

Mixed Air: <**Insert pressure and coincident temperature requirements**>.

Exhaust Air: <**Insert pressure and coincident temperature requirements**>.

<**Insert system and requirements**>.

Retain first subparagraph below to define fail positions unless otherwise indicated.

Fail positions unless otherwise indicated:

Supply Air: [**Close**] [**Last position**] [**Open**].

Return Air: [**Close**] [**Last position**] [**Open**].

Outdoor Air: [**Close**] [**Last position**] [**Open**].

Mixed Air: [**Close**] [**Last position**] [**Open**].

Exhaust Air: [**Close**] [**Last position**] [**Open**].

<**Insert system and requirements**>.

Dampers shall have stable operation throughout full range of operation, from design to minimum airflow over varying pressures and temperatures encountered.

Select modulating dampers for a pressure drop of [**2**] [**5**] <**Insert number**> percent of fan total static pressure unless otherwise indicated.

Two-position dampers shall be full size of duct or equipment connection unless otherwise indicated.

Retain two subparagraphs below for pneumatic control dampers with special installation requirements.

Pneumatic, two-position control dampers shall provide a smooth opening and closing characteristic slow enough to avoid excessive pressure. Dampers with pneumatic actuators shall have an adjustable opening time (valve full closed to full open) and an adjustable closing time (valve full open to full closed) ranging from zero to 10 seconds. Opening and closing times shall be independently adjustable.

Control-damper, pneumatic-control signal shall not exceed 200 feet (60 m). For longer distances, provide an electric/electronic control signal to the damper and an electric solenoid valve or electro-pneumatic transducer at the damper to convert the control signal to pneumatic.

* + - 1. RECTANGULAR CONTROL DAMPERS
				1. General Requirements:

Unless otherwise indicated, use parallel blade configuration for two-position control, equipment isolation service, and when mixing two airstreams. For other applications, use opposed blade configuration.

Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.

Retain subparagraph below for single source responsibility.

Damper actuator shall be factory installed by damper manufacturer as integral part of damper assembly. Coordinate actuator location and mounting requirements with damper manufacturer.

* + - * 1. Rectangular Dampers with Aluminum Airfoil Blades:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9665) Subject to compliance with requirements, provide products by one of the following:

ABI

[Arrow United Industries](http://www.specagent.com/Lookup?uid=123457114721).

[Ruskin Company](http://www.specagent.com/Lookup?uid=123457068469).

Approved equivalent.

Requirements in subparagraphs below are based on Ruskin's "CD50 series."

Performance:

Leakage: AMCA 511, Class 1A. Leakage shall not exceed 3 cfm/sq. ft. (15.2 L/s per sq. m) against 1-in. wg (250-Pa) differential static pressure.

Pressure Drop: 0.05-in. wg (12.5 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested according to AMCA 500-D, figure 5.3.

Velocity: Up to 6000 fpm (30 m/s).

Temperature: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

Damper shall have AMCA seal for both air leakage and air performance.

Construction:

Frame:

Material: ASTM B211, Alloy 6063 T5 extruded-aluminum profiles, 0.07 inch (1.8 mm) thick.

Hat-shaped channel with integral flange(s). Mating face shall be a minimum of 1 inch (25 mm).

Width not less than 5 inches (125 mm).

Blades:

Hollow, airfoil, extruded aluminum.

Parallel or opposed blade configuration as required by application.

Material: ASTM B211, Alloy 6063 T5 aluminum, 0.07 inch (1.8 mm) thick.

Width not to exceed 6 inches (150 mm).

Length as required by close-off pressure, not to exceed 48 inches (1200 mm).

Seals:

Blades: Replaceable, mechanically attached extruded silicone, vinyl, or plastic composite.

Jambs: Stainless steel, compression type.

Axles: 0.5-inch- (13-mm-) diameter [**plated**] [**or**] [**stainless**] steel, mechanically attached to blades.

Bearings:

Molded synthetic or stainless-steel sleeve mounted in frame.

Where blade axles are installed in vertical position, provide thrust bearings.

Linkage:

Concealed in frame.

Constructed of aluminum and [**plated**] [**or**] [**stainless**] steel.

Hardware: Stainless steel.

Transition:

For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connection.

Factory mount damper in a sleeve with a close transition to mate to field connection.

Damper size and sleeve shall be connection size plus 2 inches (50 mm).

Sleeve length shall be not less than 12 inches (300 mm) for dampers without jackshafts and shall be not less than 16 inches (450 mm) for dampers with jackshafts.

Sleeve material shall match adjacent duct.

Retain "Additional Corrosion Protection for Corrosive Environments" Subparagraph below for applications requiring additional protection against corrosion.

Additional Corrosion Protection for Corrosive Environments:

Provide anodized finish for aluminum surfaces in contact with airstream. Anodized finish shall be a minimum of 0.0007 inch (0.018 mm) thick.

Axles, damper linkage, and hardware shall be constructed of Type 316L stainless steel.

Retain "Airflow Measurement" Subparagraph below for damper applications with integral airflow measurement.

Airflow Measurement:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9666) Subject to compliance with requirements, provide products by one of the following:

[Ebtron, Inc](http://www.specagent.com/Lookup?uid=123457121423).

[Ruskin Company](http://www.specagent.com/Lookup?uid=123457068499).

PCE Instruments

Approved equivalent.

Requirements in subparagraphs below are based on Ruskin's "AMS50 series."

Where indicated, provide damper assembly with integral airflow monitoring.

Zero- to 10-V dc or 4- to 20-mA scaled output signal for remote monitoring of actual airflow.

Accuracy shall be within 5 percent of the actual flow rate between the range of minimum and design airflow. For applications with a large variation in range between the minimum and design airflow, configure the damper sections and flow measurement assembly as required to comply with the stated accuracy over the entire modulating range.

Provide a straightening device as part of the flow measurement assembly to achieve the specified accuracy with configuration indicated.

Suitable for operation in untreated and unfiltered air.

Provide temperature and altitude compensation and correction to maintain accuracy over temperature range encountered at site altitude.

Provide automatic zeroing feature.

Retain "Airflow Control" Subparagraph below for damper applications with integral airflow control.

Airflow Control:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9667) Subject to compliance with requirements, provide products by one of the following:

[Ebtron, Inc](http://www.specagent.com/Lookup?uid=123457121424).

[Ruskin Company](http://www.specagent.com/Lookup?uid=123457068501).

Systemair

Approved equivalent.

Requirements in subparagraphs below are based on Ruskin's "IAQ50X series."

Where indicated, provide damper assembly with integral airflow measurement and control.

A factory-furnished and -calibrated controller shall be programmed, in nonvolatile EPROM, with application-specific airflow set point and range.

The controller and actuator shall communicate to control the desired airflow.

The controller shall receive a zero- to 10-V dc input signal and report a zero- to 20-mA output signal that is proportional to the airflow.

Airflow measurement and control range shall be suitable for operation between 150 to 2000 fpm (0.8 to 10 m/s).

Ambient Operating Temperature Range: Minus 40 to plus 140 deg F (Minus 40 to plus 60 deg C).

Ambient Operating Humidity Range: 5 to 95 percent relative humidity, non-condensing.

Provide unit with control transformer rated for not less than 85 VA. Provide transformer with primary and secondary protection and primary disconnecting means. Coordinate requirements with field power connection.

Provide screw terminals for interface to field wiring.

Factory mount electronics within a NEMA 250, Type 1 painted steel enclosure.

* + - * 1. Rectangular Dampers with Steel Airfoil Blades:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9668) Subject to compliance with requirements, provide products by the following:

Greenheck

[Ruskin Company](http://www.specagent.com/Lookup?uid=123457068473).

United Enertech

Approved equivalent.

Requirements in subparagraphs below are based on Ruskin's "CD60 series."

Performance:

Leakage: AMCA 511, Class 1A. Leakage shall not exceed 3 cfm/sq. ft. (15.2 L/s per sq. m) against 1-in. wg (250-Pa) differential static pressure.

Pressure Drop: 0.06-in. wg (15 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested according to AMCA 500-D, figure 5.3.

Velocity: Up to 6000 fpm (30 m/s).

Temperature: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

Damper shall have AMCA seal for both air leakage and air performance.

Construction:

Frame:

Material: ASTM A653/A653M galvanized-steel profiles, 0.06 inch (1.6 mm) thick.

Hat-shaped channel with integral flanges. Mating face shall be a minimum of 1 inch (25 mm).

Width not less than 5 inches (125 mm).

Blades:

Hollow, airfoil, galvanized steel.

Parallel or opposed blade configuration as required by application.

Material: ASTM A653/A653M galvanized steel, 0.05 inch (1.3 mm) thick.

Width not to exceed 6 inches (150 mm).

Length as required by close-off pressure, not to exceed 48 inches (1200 mm).

Seals:

Blades: Replaceable, mechanically attached extruded silicone, vinyl, or plastic composite.

Jambs: Stainless steel, compression type.

Axles: 0.5-inch- (13-mm-) diameter [**plated**] [**or**] [**stainless**] steel, mechanically attached to blades.

Bearings:

Stainless steel mounted in frame.

Where blade axles are installed in vertical position, provide thrust bearings.

Linkage:

Concealed in frame.

Constructed of aluminum and [**plated**] [**or**] [**stainless**] steel.

Hardware: Stainless steel.

Transition:

For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connection.

Factory mount damper in a sleeve with a close transition to mate to field connection.

Damper size and sleeve shall be connection size plus 2 inches (50 mm).

Sleeve length shall be not less than 12 inches (300 mm) for dampers without jackshafts and shall be not less than 16 inches (450 mm) for dampers with jackshafts.

Sleeve material shall match adjacent duct.

Retain "Additional Corrosion Protection for Corrosive Environments" Subparagraph below for applications requiring additional protection against corrosion.

Additional Corrosion Protection for Corrosive Environments:

Provide epoxy finish for surfaces in contact with airstream.

Axles, damper linkage, and hardware shall be constructed of Type 316L stainless steel.

* + - * 1. Industrial-Duty Rectangular Dampers with Steel Airfoil Blades:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9835) Subject to compliance with requirements, provide products by one of the following:

[Arrow United Industries](http://www.specagent.com/Lookup?uid=123457114671).

[Ruskin Company](http://www.specagent.com/Lookup?uid=123457068477).

Nailor

Approved equivalent.

Requirements in subparagraphs below are based on Ruskin's "CD30AF series."

Performance:

Leakage: Leakage shall not exceed 3 cfm/sq. ft. (15.2 L/s per sq. m) against 1-in. wg (250-Pa) differential static pressure.

Pressure Drop: 0.06-in. wg (15 Pa) at 2000 fpm (10 m/s) across a 48-by-48-inch (1200-by-1200-mm) damper when tested according to AMCA 500-D, figure 5.3.

Velocity: Up to 4000 fpm (20 m/s).

Temperature: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).

Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length, minimum 10-in. wg (2500 Pa).

Construction:

Frame:

Material: [**Galvanized**] [**or**] [**stainless**] steel, 0.11 inch (2.8 mm) thick.

C-shaped channel. Mating face shall be a minimum of 1 inch (25 mm).

First option in first subparagraph below is standard offering. Second option provides additional protection to blades.

Width not less than [**3 inches (75 mm)**] [**blade width plus 2 inches (50 mm)**].

Blades:

Hollow, airfoil, [**galvanized**] [**or**] [**stainless**] steel.

Parallel or opposed blade configuration as required by application.

Material: [**Galvanized**] [**or**] [**stainless**] steel, 0.06 inch (1.6 mm) thick.

Second option in first subparagraph below is standard offering.

Width not to exceed [**6 inches (150 mm)**] [**8 inches (200 mm)**].

Length not to exceed [**36 inches (900 mm)**] [**48 inches (1200 mm)**] [**60 inches (1500 mm)**].

Seals:

Blades: Replaceable, mechanically attached EPDM or extruded silicone.

Jambs: Stainless steel, double compression type.

Axles: 0.5- or 0.75-inch- (13- or 19-mm-) diameter [**plated**] [**or**] [**stainless**] steel, mechanically attached to blades[**and continuous from end to end**].

Bearings:

Stainless-steel sleeve type mounted in frame.

Where blade axles are installed in vertical position, provide thrust bearings.

Linkage:

Face linkage exposed to airstream.

Constructed of [**plated**] [**or**] [**stainless**] steel.

Hardware: Stainless steel.

* + - * 1. Rectangular Dampers with Aluminum Flat Blades:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9836) Subject to compliance with requirements, provide products by one of the following:

[Arrow United Industries](http://www.specagent.com/Lookup?uid=123457114722).

Greenheck

[Ruskin Company](http://www.specagent.com/Lookup?uid=123457068481).

Approved equivalent.

Requirements in subparagraphs below are based on Ruskin's "CD51 series."

Performance:

Leakage: Leakage shall not exceed 3.2 cfm/sq. ft. (16.2 L/s per sq. m) against 1-in. wg (250-Pa) differential static pressure.

Pressure Drop: 0.07-in. wg (17.5 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested according to AMCA 500-D, figure 5.3.

Velocity: Up to 2000 fpm (10 m/s).

Temperature: Minus 50 to plus 250 deg F (Minus 46 to plus 121 deg C).

Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length, not to exceed 3-in. wg (750 Pa).

Damper shall have AMCA seal for both air leakage and air performance.

Construction:

Frame:

Material: ASTM B211, Alloy 6063 T5 extruded-aluminum profiles, 0.12 inch (3.2 mm) thick.

Hat-shaped channel[**with integral flanges**].

Width not less than 5 inches (125 mm).

Blades:

Flat blades of extruded aluminum.

Parallel or opposed blade configuration as required by application.

Material: ASTM B211, Alloy 6063 T5 extruded-aluminum profiles, 0.12 inch (3.2 mm) thick.

Width not to exceed 6 inches (150 mm).

Length as required by close-off pressure, not to exceed 48 inches (1200 mm).

Seals:

Blades: Replaceable, mechanically attached extruded silicone, vinyl or plastic composite.

Jambs: Stainless steel, compression type.

Axles: 0.5-inch- (13-mm-)diameter [**plated**] [**or**] [**stainless**] steel, mechanically attached to blades.

Bearings:

Molded-synthetic sleeve, mounted in frame.

Where blade axles are installed in vertical position, provide thrust bearings.

Linkage:

Concealed in frame.

Constructed of [**plated**] [**or**] [**stainless**] steel.

Hardware: Stainless steel.

Transition:

For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connection.

Factory mount damper in a sleeve with a close transition to mate to field connection.

Damper size and sleeve shall be connection size plus 2 inches (50 mm).

Sleeve length shall be not less than 12 inches (300 mm) for dampers without jackshafts and shall be not less than 16 inches (450 mm) for dampers with jackshafts.

Sleeve material shall match adjacent duct.

Retain "Additional Corrosion Protection for Corrosive Environments" Subparagraph below for applications requiring additional protection against corrosion.

Additional Corrosion Protection for Corrosive Environments:

Provide anodized finish for aluminum surfaces in contact with airstream. Anodized finish shall be a minimum of 0.0007 inch (0.018 mm) thick.

Axles, damper linkage, and hardware shall be constructed of Type 316L stainless steel.

* + - * 1. Rectangular Dampers with Steel Flat Blades:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9837) Subject to compliance with requirements, provide products by one of the following:

[Arrow United Industries](http://www.specagent.com/Lookup?uid=123457114704).

Greenehck

[Ruskin Company](http://www.specagent.com/Lookup?uid=123457068485).

Approved equivalent.

Requirements in subparagraphs below are based on Ruskin's "CD36 series."

Performance:

Leakage: Leakage shall not exceed 4.8 cfm/sq. ft. (24.3 L/s per sq. m) against 1-in. wg (250-Pa) differential static pressure.

Pressure Drop: 0.1-in. wg (25 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested according to AMCA 500-D, figure 5.3.

Velocity: Up to 1500 fpm (7.6 m/s).

Temperature: Minus 25 to plus 180 deg F (Minus 32 to plus 82 deg C).

Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length, not to exceed 4-in. wg (1000 Pa).

Damper shall have AMCA seal for both air leakage and air performance.

Construction:

Frame:

Material: [**Galvanized**] [**or**] [**stainless**] steel, 0.06 inch (1.6 mm) thick.

Hat-shaped channel[**with integral flanges**].

Width not less than 5 inches (125 mm).

Blades:

Flat blades with multiple grooves positioned axially for reinforcement.

Parallel or opposed blade configuration as required by application.

Material: [**Galvanized**] [**or**] [**stainless**] steel, 0.06 inch (1.6 mm) thick.

Width not to exceed 6 inches (150 mm).

Length as required by close-off pressure, not to exceed 48 inches (1200 mm).

Seals:

Blades: Replaceable, mechanically attached, PVC-coated polyester.

Jambs: Stainless steel, compression type.

Axles: 0.5-inch- (13-mm-) diameter [**plated**] [**or**] [**stainless**] steel, mechanically attached to blades.

Bearings:

Molded-synthetic sleeve, mounted in frame.

Where blade axles are installed in vertical position, provide thrust bearings.

Linkage:

Concealed in frame.

Constructed of [**plated**] [**or**] [**stainless**] steel.

Hardware: Stainless steel.

* + - * 1. Insulated Rectangular Dampers:

Requirements in subparagraphs below are based on TAMCO's "9000ECT series."

Performance:

Leakage: AMCA 511, Class 1A. Leakage shall not exceed 3 cfm/sq. ft. (15.2 L/s per sq. m) against 1-in. wg (250-Pa) differential static pressure and shall not exceed 4.9 cfm/sq. ft. (25 L/s per sq. m) against 4-in. wg (1000-Pa) differential static pressure at minus 40 deg F (minus 40 deg C).

Pressure Drop: 0.1-in. wg (25 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested according to AMCA 500-D, figure 5.3.

Velocity: Up to 4000 fpm (20 m/s).

Temperature: Minus 100 to plus 185 deg F (Minus 73 to plus 85 deg C).

Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

Damper shall have AMCA seal for both air leakage and air performance.

Construction:

Frame:

Material: ASTM B211, Alloy 6063 T5 extruded-aluminum profiles, 0.08 inch (2.0 mm) thick.

C-shaped channel with integral flange(s). Mating face shall be a minimum of 1 inch (25 mm).

Width not less than 4 inches (100 mm).

Entire frame shall be thermally broken by means of polyurethane resin pockets, complete with thermal cuts.

Damper frame shall be insulated with polystyrofoam on four sides.

Blades:

Hollow shaped, extruded aluminum.

Blades shall be internally insulated with expanded polyurethane foam and shall be thermally broken. Complete blade shall have an insulating factor of R-2.29 and a temperature index of 55.

Parallel or opposed blade configuration as required by application.

Material: ASTM B211, Alloy 6063 T5 aluminum, 0.08 inch (2.0 mm) thick.

Width not to exceed 6 inches (150 mm).

Length as required by close-off pressure, not to exceed 48 inches (1200 mm).

Seals: Blade and frame seals shall be of flexible silicone and secured in an integral slot within the aluminum extrusions.

Axles: 0.44-inch- (11-mm-) diameter [**plated**] [**or**] [**stainless**] steel, mechanically attached to blades.

Bearings:

Bearings shall be composed of a Celcon inner bearing fixed to axle, rotating within a polycarbonate outer bearing inserted in the frame, resulting in no metal-to-metal or metal-to-plastic contact.

Where blade axles are installed in vertical position, provide thrust bearings.

Linkage:

Concealed in frame.

Constructed of aluminum and [**plated**] [**or**] [**stainless**] steel.

Hardware: Stainless steel.

Transition:

For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connection.

Factory mount damper in a sleeve with a close transition to mate to field connection.

Damper size and sleeve shall be connection size plus 2 inches (50 mm).

Sleeve length shall be not less than 12 inches (300 mm) for dampers without jackshafts and shall be not less than 16 inches (450 mm) for dampers with jackshafts.

Sleeve material shall match adjacent duct.

Retain "Additional Corrosion Protection for Corrosive Environments" Subparagraph below for applications requiring additional protection against corrosion.

Additional Corrosion Protection for Corrosive Environments:

Provide anodized finish for aluminum surfaces in contact with airstream. Anodized finish shall be a minimum of 0.0007 inch (0.018 mm) thick.

Axles, damper linkage, and hardware shall be constructed of Type 316L stainless steel.

* + - 1. ROUND CONTROL DAMPERS
				1. Round Dampers, Sleeve Type:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9839) Subject to compliance with requirements, provide products by the following:

[Ruskin Company](http://www.specagent.com/Lookup?uid=123457068491).

The Duct Shop

Nailor

Approved equivalent.

Requirements in subparagraphs below are based on Ruskin's "CDRS25 series."

Performance:

Leakage: Leakage shall not exceed 0.15 cfm/in. (0.0028 L/s per mm) of perimeter blade at 4-in. wg (1000-Pa) differential static pressure.

Pressure Drop: 0.02-in. wg (5 Pa) at 1500 fpm (7.6 m/s) across a 12-inch (300-mm) damper when tested according to AMCA 500-D, figure 5.3.

Velocity: Up to 4000 fpm (20 m/s).

Temperature: Minus 25 to plus 200 deg F (Minus 32 to plus 93 deg C).

Pressure Rating: 8-in. wg (2000 Pa) for sizes through 12 inches (300 mm), 6-in. wg (1500 Pa) for larger sizes.

Construction:

Frame:

Material: [**Galvanized**] [**or**] [**stainless**] steel, 0.04 in (1.0 mm) thick.

Outward rolled stiffener beads positioned approximately 1 inch (25 mm) inboard of each end.

Sleeve-type connection for mating to adjacent ductwork.

Size Range: 4 to 24 inches (100 to 600 mm).

Length not less than 7 inches (175 mm).

Provide 2-inch (50-mm) sheet metal stand-off for mounting actuator.

Blade: Double-thickness circular flat blades sandwiched together and constructed of [**galvanized**] [**or**] [**stainless**] steel.

Blade Seal: Polyethylene foam seal sandwiched between two sides of blades and fully encompassing blade edge.

Axle: 0.5-inch- (13-mm-) diameter [**plated**] [**or**] [**stainless**] steel, mechanically attached to blade.

Bearings: Stainless-steel sleeve pressed into frame.

* + - * 1. Round Dampers, Flanged Type:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9840) Subject to compliance with requirements, provide products by one of the following:

[Arrow United Industries](http://www.specagent.com/Lookup?uid=123457114724).

Greenheck

[Ruskin Company](http://www.specagent.com/Lookup?uid=123457068495).

Approved equivalent.

Requirements in subparagraphs below are based on Ruskin's "CDR82 series."

Performance:

Leakage: Leakage shall not exceed 0.15 cfm/in. (0.0028 L/s per mm) of perimeter blade at 4-in. wg (1000-Pa) differential static pressure.

Pressure Drop: 0.03-in. wg (7.5 Pa) at 1500 fpm (7.6 m/s) across a 12-inch (300-mm) damper when tested according to AMCA 500-D, figure 5.3.

Velocity: Up to 4000 fpm (20 m/s).

Temperature: Minus 25 to plus 250 deg F (Minus 32 to plus 121 deg C).

Pressure Rating: 8-in. wg (2000 Pa) for sizes through 36 inches (900 mm) in diameter, 6-in. wg (1500 Pa) for larger sizes.

Construction:

Frame:

Size Range: 4 to 60 inches (100 to 1500 mm).

Material: [**Galvanized**] [**or**] [**stainless**] steel.

Sizes through 24 Inches (600 mm) in Diameter: 0.15 inch (4 mm) thick.

Sizes 26 through 48 Inches (650 through 1200 mm) in Diameter: 0.25 inch (6 mm) thick.

Larger Sizes: 0.31 inch (8 mm) thick.

Flanges:

Outward rolled with bolt holes on each end of frame for mating to adjacent ductwork.

Face: Not less than 1.25 inch (31 mm) for damper sizes through 12 inches (300 mm) in diameter, 1.5 inch (38 mm) for damper sizes 14 through 24 inches (350 through 600 mm) in diameter, and 2 inches (50 mm) for larger sizes.

Length (Flange Face to Face): Not less than 8 inches (200 mm).

Provide 3-inch (75-mm) sheet metal stand-off for mounting actuator.

Blade: Reinforced circular flat blade constructed of [**galvanized**] [**or**] [**stainless**] steel.

Sizes through 24 Inches (600 mm): 0.15 inch (4 mm) thick.

Sizes 26 through 48 Inches (650 through 1200 mm): 0.19 inch (5 mm) thick.

Larger Sizes: 0.25 inch (6 mm) thick.

Blade Stop: Full circumference, located in airstream, minimum 0.5 by 0.25 inch (13 by 6 mm) [**galvanized-**] [**or**] [**stainless-**] steel bar.

Blade Seal: Neoprene, mechanically attached to blade and fully encompassing blade edge.

Axle: [**Plated**] [**or**] [**stainless**] steel, mechanically attached to blade.

Sizes through 14 Inches (350 mm): 0.5 inch (13 mm) in diameter.

Sizes 16 through 42 Inches (400 through 1050 mm): 0.75 inch (19 mm) in diameter.

Larger Sizes: 1 inch (25 mm) in diameter.

Bearings: Stainless-steel sleeve pressed into frame.

* + - 1. GENERAL CONTROL-DAMPER ACTUATORS REQUIREMENTS
				1. Actuators shall operate related damper(s) with sufficient reserve power to provide smooth modulating action or two-position action and proper speed of response at velocity and pressure conditions to which the damper is subjected.
				2. Actuators shall produce sufficient power and torque to close off against the maximum system pressures encountered. Actuators shall be sized to close off against the fan shutoff pressure as a minimum requirement.
				3. The total damper area operated by an actuator shall not exceed 80 percent of manufacturer's maximum area rating.
				4. Provide one actuator for each damper assembly where possible. Multiple actuators required to drive a single damper assembly shall operate in unison.
				5. Avoid the use of excessively oversized actuators which could overdrive and cause linkage failure when the damper blade has reached either its full open or closed position.
				6. Use jackshafts and shaft couplings in lieu of blade-to-blade linkages when driving axially aligned damper sections.
				7. Provide mounting hardware and linkages for connecting actuator to damper.
				8. Select actuators to fail in desired position in the event of a power failure.

In "Actuator Fail Positions" Paragraph below, retain second option with any subparagraphs.

* + - * 1. Actuator Fail Positions:[**See Drawings.**][**As indicated below:**]

In subparagraphs below, "Last position" option is unavailable with pneumatic actuators.

Exhaust Air: [**Close**] [**Last position**] [**Open**].

Outdoor Air: [**Close**] [**Last position**] [**Open**].

Supply Air: [**Close**] [**Last position**] [**Open**].

Return Air: [**Close**] [**Last position**] [**Open**].

<**Insert system and fail position**>.

* + - 1. PNEUMATIC ACTUATORS
				1. Where two or more actuators are installed for interrelated operation in unison, such as dampers used for mixing, provide the dampers with a positive positioner.
				2. Equip pneumatic modulating actuators with a positive positioner, having the following performance characteristics:

Linearity: Plus or minus 1 percent of output signal span.

Hysteresis: 0.5 percent of the span.

* + - * 1. Provide each positioner with an integrally mounted air set and pressure gauges for supply, input and output. Positioners shall operate on a 3- to 15-psig (21- to 103-kPa) input signal unless otherwise required to satisfy the control sequences of operation.
				2. Rate actuators for a pressure of at least 25 psig (172 kPa).
				3. Provide actuators with replaceable diaphragms.
				4. Actuator Construction:

Construct the diaphragm casing and plate of cast iron, steel, or cast aluminum.

Construct the yoke of cast iron, steel, or cast aluminum.

Construct the diaphragm of reinforced synthetic rubber or nitrile.

Construct the spring, stem, and spring adjuster of steel or steel alloy.

* + - * 1. Provide actuator with adjustable stops for both maximum and minimum positions.
				2. Provide a position indicator and graduated scale on each actuator. Indicate open and closed travel limits.
			1. ELECTRIC AND ELECTRONIC ACTUATORS
				1. Type: Motor operated, with or without gears, electric and electronic.
				2. Voltage:

[**See Drawings**] [**Voltage selection is delegated to professional designing control system**] [**24 V**] [**120 V**] <**Insert requirement**>.

Actuator shall deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.

Actuator shall function properly within a range of 85 to 120 percent of nameplate voltage.

* + - * 1. Construction:

Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.

100 up to 400 W: Gears ground steel, oil immersed, shaft-hardened steel running in bronze, copper alloy, or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel, or cast-aluminum housing.

Greater Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

* + - * 1. Field Adjustment:

Spring return actuators shall be easily switchable from fail open to fail closed in the field without replacement.

Provide gear-type actuators with an external manual adjustment mechanism to allow manual positioning of the damper when the actuator is not powered.

* + - * 1. Two-Position Actuators: Single direction, spring return or reversing type.
				2. Modulating Actuators:

Capable of stopping at all points across full range, and starting in either direction from any point in range.

Control Input Signal:

Retain subparagraphs below that remain after revising "Control Damper Applications" Article. See Evaluations for further discussion.

Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position, and other input drives actuator to close position. No signal of either input remains in last position.

Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for [**zero- to 10-**] [**or**] [**2- to 10-**]V dc [**and**] [**4- to 20-mA**] signals.

Pulse Width Modulation (PWM): Actuator drives to a specified position according to a pulse duration (length) of signal from a dry-contact closure, triac sink or source controller.

Retaining "Programmable Multi-Function" Subparagraph below limits manufacturer choices. Belimo Americas (USA) is most well-known manufacturer offering product.

Programmable Multi-Function:

Control input, position feedback, and running time shall be factory or field programmable.

Diagnostic feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.

Service data, including at a minimum, number of hours powered and number of hours in motion.

* + - * 1. Position Feedback:

Retain one of first two subparagraphs below to provide a signal for remote monitoring of position through positive means. Remote monitoring requires additional control inputs. Coordinate requirements with interface to control system.

[**Equip**] [**Where indicated, equip**] two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of [**open**] [**and**] [**close**] position.

[**Equip**] [**Where indicated, equip**] modulating actuators with a position feedback through [**current**] [**or**] [**voltage**] signal for remote monitoring.

Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

* + - * 1. Fail-Safe:

Where indicated, provide actuator to fail to an end position.

Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.

Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.

* + - * 1. Integral Overload Protection:

Provide against overload throughout the entire operating range in both directions.

Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

* + - * 1. Damper Attachment:

Unless otherwise required for damper interface, provide actuator designed to be directly coupled to damper shaft without need for connecting linkages.

Attach actuator to damper drive shaft in a way that ensures maximum transfer of power and torque without slippage.

Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

* + - * 1. Temperature and Humidity:

Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of [**minus 20 to plus 120 deg F (minus 29 to plus 49 deg C)**] <**Insert temperature range**>.

Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from [**5 to 95**] <**Insert numbers**> percent relative humidity, non-condensing.

* + - * 1. Enclosure:

Suitable for ambient conditions encountered by application.

NEMA 250, Type 2 for indoor and protected applications.

NEMA 250, Type 4 or Type 4X for outdoor and unprotected applications.

Provide actuator enclosure with a heater and controller where required by application.

* + - * 1. Stroke Time:

Operate damper from fully closed to fully open within [**15**] [**60**] [**75**] [**90**] [**150**] <**Insert number**> seconds.

Operate damper from fully open to fully closed within [**15**] [**60**] [**75**] [**90**] [**150**] <**Insert number**> seconds.

Move damper to failed position within [**5**] [**15**] [**30**] <**Insert number**> seconds.

Select operating speed to be compatible with equipment and system operation.

Actuators operating in smoke control systems comply with governing code and NFPA requirements.

* + - * 1. Sound:

Spring Return: 62 dBA.

Non-Spring Return: 45 dBA.

1. EXECUTION
	* + 1. EXAMINATION
				1. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
				2. Examine roughing-in for dampers and instruments installed in duct systems to verify actual locations of connections before installation.
				3. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
				4. Proceed with installation only after unsatisfactory conditions have been corrected.

Retain "Control-Damper Applications" Article below unless requirements for different applications are indicated on Drawings. Where Drawings indicate only some requirements, revise article below to suit Project.

* + - 1. CONTROL-DAMPER APPLICATIONS

Retain this article unless all requirements for control devices for different applications are indicated on Drawings. Where Drawings indicate only some requirements, revise article accordingly.

Delete article if instrument types are indicated on Drawings.

* + - * 1. Control Dampers:

Retain paragraph below if requirements are delegated.

* + - * 1. Select from damper types indicated in "Control Dampers" Article to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.

Copy and revise subparagraphs below to suit each unique application requiring a different control-damper type.

Rectangular Exhaust Air Duct Applications with SMACNA Construction Class <**Insert value**> and Velocities to <**Insert value**>: [**Rectangular dampers with aluminum airfoil blades**] [**Rectangular dampers with steel airfoil blades**] [**Industrial-duty rectangular dampers with steel airfoil blades**] [**Rectangular dampers with aluminum flat blades**] [**Rectangular dampers with steel flat blades**] [**Insulated rectangular dampers**] [**Round dampers, sleeve type**] [**Round dampers, flange type**].

Round Exhaust Air Duct Applications with SMACNA Construction Class <**Insert value**> and Velocities to <**Insert value**>: [**Rectangular dampers with aluminum airfoil blades**] [**Rectangular dampers with steel airfoil blades**] [**Industrial-duty rectangular dampers with steel airfoil blades**] [**Rectangular dampers with aluminum flat blades**] [**Rectangular dampers with steel flat blades**] [**Insulated rectangular dampers**] [**Round dampers, sleeve type**] [**Round dampers, flange type**].

Rectangular Outdoor Air Duct Applications with SMACNA Construction Class <**Insert value**> and Velocities to <**Insert value**>: [**Rectangular dampers with aluminum airfoil blades**] [**Rectangular dampers with steel airfoil blades**] [**Industrial-duty rectangular dampers with steel airfoil blades**] [**Rectangular dampers with aluminum flat blades**] [**Rectangular dampers with steel flat blades**] [**Insulated rectangular dampers**] [**Round dampers, sleeve type**] [**Round dampers, flange type**].

Round Outdoor Air Duct Applications with SMACNA Construction Class <**Insert value**> and Velocities to <**Insert value**>: [**Rectangular dampers with aluminum airfoil blades**] [**Rectangular dampers with steel airfoil blades**] [**Industrial-duty rectangular dampers with steel airfoil blades**] [**Rectangular dampers with aluminum flat blades**] [**Rectangular dampers with steel flat blades**] [**Insulated rectangular dampers**] [**Round dampers, sleeve type**] [**Round dampers, flange type**].

Rectangular Return Air Duct Applications with SMACNA Construction Class <**Insert value**> and Velocities to <**Insert value**>: [**Rectangular dampers with aluminum airfoil blades**] [**Rectangular dampers with steel airfoil blades**] [**Industrial-duty rectangular dampers with steel airfoil blades**] [**Rectangular dampers with aluminum flat blades**] [**Rectangular dampers with steel flat blades**] [**Insulated rectangular dampers**] [**Round dampers, sleeve type**] [**Round dampers, flange type**].

Round Return Air Duct Applications with SMACNA Construction Class <**Insert value**> and Velocities to <**Insert value**>: [**Rectangular dampers with aluminum airfoil blades**] [**Rectangular dampers with steel airfoil blades**] [**Industrial-duty rectangular dampers with steel airfoil blades**] [**Rectangular dampers with aluminum flat blades**] [**Rectangular dampers with steel flat blades**] [**Insulated rectangular dampers**] [**Round dampers, sleeve type**] [**Round dampers, flange type**].

Rectangular Supply Air Duct Applications with SMACNA Construction Class <**Insert value**> and Velocities to <**Insert value**>: [**Rectangular dampers with aluminum airfoil blades**] [**Rectangular dampers with steel airfoil blades**] [**Industrial-duty rectangular dampers with steel airfoil blades**] [**Rectangular dampers with aluminum flat blades**] [**Rectangular dampers with steel flat blades**] [**Insulated rectangular dampers**] [**Round dampers, sleeve type**] [**Round dampers, flange type**].

Round Supply Air Duct Applications with SMACNA Construction Class <**Insert value**> and Velocities to <**Insert value**>: [**Rectangular dampers with aluminum airfoil blades**] [**Rectangular dampers with steel airfoil blades**] [**Industrial-duty rectangular dampers with steel airfoil blades**] [**Rectangular dampers with aluminum flat blades**] [**Rectangular dampers with steel flat blades**] [**Insulated rectangular dampers**] [**Round dampers, sleeve type**] [**Round dampers, flange type**].

* + - 1. INSTALLATION, GENERAL
				1. Furnish and install products required to satisfy most stringent requirements indicated.
				2. Properly support dampers and actuators, tubing, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a <**Insert valve**> force.
				3. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
				4. Seal penetrations made in fire-rated and acoustically rated assemblies.
				5. Fastening Hardware:

Stillson wrenches, pliers, or other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.

Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.

Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

* + - * 1. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Director’s Representative's access, confirm unrestricted ladder placement is possible under occupied condition.
				2. Corrosive Environments:

Use products that are suitable for environment to which they will be subjected.

If possible, avoid or limit use of materials in corrosive environments, including, but not limited to, the following:

Laboratory exhaust airstreams.

Process exhaust airstreams.

<**Insert applications**>.

Use Type 316 stainless-steel tubing and fittings when in contact with a corrosive environment.

When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.

Where actuators are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

* + - 1. ELECTRIC POWER
				1. Furnish and install electrical power to products requiring electrical connections.
				2. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
				3. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
				4. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."
			2. CONTROL DAMPERS
				1. Install smooth transitions, not exceeding [**15**] [**30**] <**Insert number**> degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.
				2. Clearance:

Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.

Install dampers with at least 24 inches (600 mm) of clear space on sides of dampers requiring service access.

* + - * 1. Service Access:

Dampers and actuators shall be accessible for visual inspection and service.

Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Section 233300 "Air Duct Accessories."

* + - * 1. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.
				2. Attach actuator(s) to damper drive shaft.
				3. For duct-mounted and equipment-mounted dampers installed outside of equipment, install a visible and accessible indication of damper position from outside.
			1. CONNECTIONS
				1. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
			2. IDENTIFICATION
				1. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
				2. Install engraved phenolic nameplate with damper identification on damper[**and on face of ceiling where damper is concealed above ceiling**].
			3. CHECKOUT PROCEDURES
				1. Control-Damper Checkout:

Check installed products before continuity tests, leak tests, and calibration.

Check dampers for proper location and accessibility.

Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

For pneumatic products, verify air supply for each product is properly installed.

For pneumatic dampers, verify that pressure gages are provided in each air line to damper actuator and positioner.

Verify that control dampers are installed correctly for flow direction.

Verify that proper blade alignment, either parallel or opposed, has been provided.

Verify that damper frame attachment is properly secured and sealed.

Verify that damper actuator and linkage attachment are secure.

Verify that actuator wiring is complete, enclosed, and connected to correct power source.

Verify that damper blade travel is unobstructed.

* + - 1. ADJUSTMENT, CALIBRATION, AND TESTING:
				1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.
				2. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressure.
				3. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.
				4. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION 230923.12