

SECTION 23 36 16
AIRFLOW CONTROL SYSTEM

PART 1 - GENERAL

1.01 SUMMARY.

- A. The airflow control system (ACS) shall be furnished and installed to control the airflow into and out of critical spaces and non-critical spaces in medical facilities. The ACS shall vary the amount of make-up/supply air into the room to operate the spaces at the lowest possible airflow rates necessary to maintain temperature control, achieve minimum ventilation rates and maintain room pressurization in relation to adjacent spaces (positive or negative). The ACS shall be capable of operating as a standalone system or as a system integrated with the Building Management System (BMS). An optional locally mounted user interface terminal shall be available to allow room-level control variables to be displayed, and where appropriate, edited to adjust control operation.

1.02 REFERENCES.

- A. Abbreviations and Acronyms
1. ACS - Airflow Control System
 2. ATC - Advanced Temperature Control
 3. BMS - Building Management System
 4. VAV - Variable Air Volume
- B. Reference Standards
1. Air Conditioning and Refrigeration Institute ARI 880 Performance Rating of Air Terminals
 2. American Society of Heating, Refrigeration, and Air Conditioning Engineers / American National Standards Institute ASHRAE/ANSI Standard 130, Methods for Testing Air Terminal Units
 3. American National Standards Institute / American Society of Heating, Refrigeration, and Air Conditioning Engineers ANSI/ASHRAE 135-2001: BACnet® - A Data Communication Protocol for Building Automation Systems (including Standard and all published Addenda)

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination
1. The ACS representative shall coordinate all details of the installation with the successful mechanical contractor. This effort shall include complete coordination of the sheet metal layout drawings to assure that the ductwork layout and sizing is based on the actual sizes of the airflow control valves for this project.

B. Pre-installation Meetings

1. The ACS representative shall review the proper installation of the system with the sheet metal contractor and the building management system (BMS) contractor.
2. Project Installation Phase - The ACS representative shall make periodic visits to the project jobsite to assure that the system is being installed properly to assure optimal performance and that the location and orientation of the control valves is consistent for proper operation and future owner maintenance. Any discrepancies shall first be brought to the attention of the appropriate subcontractor. If no action is taken by said contractor, the representative shall bring these issues to the project manager, engineer or owner's representative for resolution.

1.04 SUBMITTALS

A. General: Submit listed Submittals in accordance with Conditions of the General Contract and Division 1 Submittal Procedures Section. ACS submittals shall contain, at a minimum, the following information:

1. Product Data Sheets
2. Equipment Schedule Sheets containing Room#, Tag#, Min/Max flows, Catalog# and other configuration data as required to provide a fully engineered ACS.
3. Installation Instructions
4. Project-specific Wiring Diagrams
5. Sequences of Operation
6. Points Lists

1.05 CLOSEOUT SUBMITTALS

A. Operation and maintenance manuals, including as-built wiring diagrams and component lists, shall be provided as closeout submittals.

1.06 QUALITY ASSURANCE

A. Certifications

1. The airflow system provider shall be an entity that designs, develops, manufactures and sells products and services to control the environment and airflow of critical spaces using a Quality Management System registered to ISO 9001:2008.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements

1. Prior to installation, the ACS shall be stored in dry conditions within an environment complying with ACS product specifications as shown on product data sheets within the submittals.
2. The ACS products shall be handled and transported in a manner consistent trade

practices for control systems and instruments.

1.08 SITE CONDITIONS

- A. The ambient environmental conditions during installation and operation shall comply with ACS product specifications as shown on the product data sheets within the submittals.

1.09 WARRANTY

- A. Warranty on Phoenix Controls manufactured equipment shall commence upon the date of shipment and extend for a period of 36 months. During this period, any defects in materials or ACS critical or non-critical airflow control system performance shall be repaired or replaced by the supplier at no cost to the owner. Extended warranty may be purchased separately.

PART 2 - PRODUCTS

2.01 AIRFLOW CONTROL SYSTEM

- A. Each critical and non-critical space shall have a dedicated airflow control system.
- B. The airflow control system shall maintain specific airflow ($\pm 5\%$ of signal within one second of a change in duct static pressure) regardless of the magnitude of the pressure change, airflow change or quantity of airflow control devices on either the supply air or exhaust air manifold (within 0.3" to 3.0" WC, 75 to 750 Pa, pressure drop).
- C. The airflow control system shall use volumetric offset control to maintain room pressurization. The system shall maintain proper room pressurization polarity (negative or positive) regardless of any change in room/system conditions, such as rapid changes in duct static pressure. Systems using differential pressure measurement or velocity measurement to control room pressurization are unacceptable.
- D. The airflow control system shall maintain specific airflow ($\pm 5\%$ of signal) with a minimum airflow turndown as shown in Section 2.02.A.4 to ensure accurate pressurization at low airflow and assure maximum energy efficiency.
- E. In the event of a power failure, airflow control devices shall fail to the last position and continue to maintain flow control within $\pm 5\%$ of signal within one second of a change in duct static pressure.

2.02 COMPONENTS

- A. Airflow Control Device - General
 - 1. The airflow control device shall be a venturi valve as manufactured by Phoenix Controls®.

2. The valve assembly manufacturer's Quality Management System shall be registered to ISO 9001:2008.
3. The airflow control device shall be pressure independent over its specified differential static pressure operating range. An integral pressure-independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure regardless of the magnitude of pressure drop (from 0.3" to 3.0" WC) (75 Pa to 750 Pa) and/or flow change or quantity of airflow controllers on a manifolded system.
4. The airflow control device shall maintain accuracy within $\pm 5\%$ of signal over an airflow turndown range of no less than:

Pressure Drop Across Valve	Valve Body Type	Airflow Range	Minimum Turndown
Medium 0.6-3.0" WC	Standard	Up to 1,000 CFM (472 l/s)	20 to 1
Medium 0.6-3.0" WC	Shut-off	Up to 850 CFM (401 l/s)	17 to 1

5. No minimum entrance or exit straight length of duct shall be required to ensure accuracy and/or pressure independence.
6. The airflow control device shall be constructed as one of the following types, depending upon application:
 - a. Class A:
 - 1) The airflow control device for non-corrosive airstreams, such as supply and general exhaust, shall be constructed of 16-gauge aluminum. The device's shaft, shaft support brackets, and internal mounting link shall be made of 316 stainless steel. The pivot arm shall be made of aluminum for standard valves and 303/304 stainless steel for shut-off valves. The pressure-independent springs shall be a spring-grade stainless steel. All shaft-bearing surfaces shall be made of a PP (polypropylene) or PPS (polyphenylene sulfide) composite.
7. A standard-speed electric actuator shall be used to modulate the airflow over the range of the specific valve size. The maximum time to modulate from minimum to maximum flow shall be less than 60 seconds for standard valves and 90 seconds for shut-off valves. A UL or CSA listed electronic actuator shall be factory mounted to the valve. The actuator shall have sufficient torque to modulate the airflow against the maximum duct static pressure (within product specifications). Loss of main power shall cause the valve to maintain its last airflow position. This position shall be maintained

until power is restored. During loss of power, the valve shall maintain pressure independence as previously specified in Section 2.01.B

8. The shut-off airflow control device shall have shut-off leakage and casing leakage of no more than (with 5.0" WC pressure):

Shut-off Valve Type and Airflow Range	Shut-off Leakage	Casing Leakage
Shut-off devices up to 850 CFM (472 l/s)	6 CFM	0.010 CFM/ft sq.
Shut-off devices up to 1,000 CFM (708 l/s)	6 CFM	0.010 CFM/ft sq.

9. Certification

- a. Each airflow control device shall be factory characterized to the job specific airflows as detailed on the plans and specifications using NIST traceable air stations and instrumentation having a combined accuracy of no more than $\pm 1\%$ of signal (5,000 to 250cfm), $\pm 2\%$ of signal (249 to 100cfm) and $\pm 3\%$ of signal (99 to 35cfm). Electronic airflow control devices shall be further characterized and their accuracy verified to $\pm 5\%$ of signal at a minimum of 48 different airflows across the full operating range of the device.
- b. Each airflow control device shall be marked with the room number, tag number, serial number, and model number. All information shall be stored by the manufacturer for use with as-built documentation.

10. Airflow control devices that are not venturi valves and are airflow measuring devices (e.g., pitot tube, flow cross, air bar, orifice ring, vortex shedder, etc.) shall only be acceptable provided these meet all the performance and construction characteristics as stated throughout this specification and:

- a. The airflow control device employs transducers manufactured by Rosemount, Bailey, Bristol, or Foxboro. Accuracy shall be no less than $\pm 0.15\%$ of span (to equal $\pm 5\%$ of signal with a 15 to 1 turndown) over the appropriate full-scale range, including the combined effects of nonlinearity, hysteresis, repeatability, drift over a one-year period, and temperature effect. 316L stainless steel materials shall be provided for all exhaust applications. The use of 304 stainless steel or aluminum materials shall be provided for all supply air applications.
- b. Airflow sensors shall be of a multi-point averaging type, 304 stainless steel for all supply and general exhaust applications, 316L stainless steel for all fume hood, canopy, snorkel, and biosafety cabinet applications. Single point sensors are not acceptable.
- c. Suppliers of airflow control devices or airflow measuring devices requiring minimum duct diameters shall provide revised duct layouts showing the required

straight duct runs upstream and downstream of these devices. Coordination drawings reflecting these changes shall be submitted by the supplier of the ACS. In addition, suppliers shall include static pressure loss calculations as part of their submittals. All costs to modify the ductwork, increase fan sizes and horsepower and all associated electrical changes shall be borne by the ACS supplier.

- d. Airflow control devices using flow measurement shall be readily removable for periodic inspection, cleaning and recalibration. Device locations and surrounding clearances shall be coordinated to allow the required maintenance.

B. Exhaust and Supply Airflow Device Controller

1. One controller shall be provided for both the supply airflow control device and the corresponding exhaust airflow control device. The controller shall be a microprocessor-based design and use closed-loop control to linearly regulate airflow based on a digital control signal. The device shall generate a digital feedback signal that represents its airflow.
2. In flow tracking applications where an exhaust device and or a return device is tracking a supply device, flow data for each device (up to 3 valves total) shall be downloaded to the controller in the factory.
3. The airflow control device shall store its control algorithms in non-volatile, rewritable memory. The device shall be able to stand alone or to be networked with other room-level digital airflow control devices through an industry standard protocol.
4. Room-level flow tracking control functions shall be embedded in and executed by one controller mounted on one of the airflow devices.
5. The room-level control network shall communicate by using BACnet® MS/TP protocol. The control device must meet the requirements of a BACnet Application Specific Controller (B-ASC Level Device), and be a BACnet Testing Laboratories (BTL) certified device. Application controllers shall be of BACnet conformance class 3 and support all BACnet services necessary to provide the following BACnet functional groups:
 - a. Files Functional Group
 - b. Reinitialize Functional Group
 - c. Device Communications Functional Group
 - 1) Refer to section 22.2 - BACnet Functional Groups, in the BACnet standard for a complete list of the services that must be directly supported to provide each of the functional groups listed above.
 - 2) Standard BACnet object types supported shall include as a minimum Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary

Value, Device, File, and Program object types.

6. The airflow control device shall use 24 VAC power \pm 15%, the industry standard.
7. The airflow control device shall be able to connect to a commissioning tool. Every node on the network shall be accessible from the BACnet Building Management System (BMS).
8. The airflow control device shall include inputs with 10-bit resolution that accept 10K thermistors, 0-10 VDC, 0-5 VDC, 0-20 mA and dry contact signals. Controller shall include binary and analog outputs on board. Analog outputs shall be 5 VDC, 0-10 VDC, 2-10 VDC, or 0-20mA. Software shall include scaling features for analog outputs. Controller shall include a 24 Vdc voltage supply for use as power supply to external sensors.
9. Controller shall also include support for interface with digital display which allows display and modification of controller set point variables.
10. The airflow control device shall meet the following agency compliance requirements- FCC Part 15 Subpart J Class A, CE, and UL 916.

2.03 ACCEPTABLE MANUFACTURERS

A. Manufacturer List

1. The plans and specifications for the airflow control system are based on systems and equipment manufactured by Phoenix Controls.
2. The airflow system provider shall be an entity that designs, develops, manufactures and sells products and services to control the environment and airflow of critical and non- critical spaces using a Quality Management System registered to ISO 9001:2008.

B. Substitute Limitations

1. The engineer and owner shall be the sole judges of quality and equivalence of equipment, materials, methods, and life cycle costs.
2. Only those systems specifically named in this specification or by addendum shall be considered for approval. Other systems submitted after the bid opening will be returned without review.
3. Any alternate proposal shall describe the manner of compliance with this minimum performance specification, with an emphasis on the following areas: proposed equipment, experience, performance verification, and maintenance. This proposal shall be separate from any BMS proposal(s), and include the scope of information and services detailed in paragraphs a through c of this subsection.

a. Proposed Equipment

- 1) Technical specification data sheets shall be provided for all proposed

system components and devices.

- 2) All proposed airflow control devices shall include discharge, exhaust and radiated sound power level performance obtained from testing in accordance with ARI Standard 880.

b. Experience

- 1) The airflow control system supplier shall provide a list of at least three similar airflow control systems installed in the state or province as part of this proposal.
- 2) The airflow control system supplier shall provide the names, addresses and telephone numbers of the consulting engineer and the owner's representative for each of these installations.

c. Performance Verification

- 1) The airflow control system supplier shall demonstrate a typical critical or non-critical space that includes a general exhaust and a supply airflow control device for the purpose of verifying the airflow control system's ability to meet the performance requirements indicated in this specification.

d. Maintenance

- 1) The ACS supplier shall provide at no additional cost to the owner during and after the warranty period five years of required preventive maintenance on all airflow sensors (e.g., pitot tube, flow cross, orifice ring, air bar, hot wire, vortex shedder, side wall sensors, etc.) and flow transducers provided under this section. Airflow sensors shall be removed, inspected, and cleaned annually during the five-year period to prevent inaccuracies due to long-term buildup from corrosion, tissues, wet or sticky particles, or other materials that foul the sensor. If impractical to remove the airflow sensors, the ACS supplier shall include in the proposal the cost of supplying and installing duct access doors, one for each sensor. The transducer shall be checked and recalibrated annually to ensure long-term accuracy. Note that auto-zero recalibration of transducers is not acceptable as a substitute for annual recalibration.

2.04 PERFORMANCE/DESIGN CRITERIA

- A. The airflow control device shall maintain pressure independence over its specified differential static pressure operating range. This shall be done via an internal spring within the cone assembly that adjusts instantly to static pressure increases or decreases by expanding or contracting to increase or decrease annular area to maintain a constant volume of air. The integral pressure-independent assembly shall respond

and maintain specific airflow within one second of a change in duct static pressure regardless of the magnitude of pressure drop (from 0.3" WC to 3.0" WC) (75 Pa to 750 Pa), flow change, or quantity of airflow controllers on a manifolded system.

- B. The airflow control device shall maintain accuracy of $\pm 5\%$ of signal over the entire airflow range.
- C. The airflow control device shall maintain accuracy within $\pm 5\%$ of signal over an airflow turndown range of no less than that listed in Section 2.02.A.4.
- D. No minimum entrance or exit straight length of duct shall be required to ensure accuracy and/or pressure independence.
- E. A standard-speed electric actuator shall be used to modulate the airflow over the range of the specific valve size. The maximum time to modulate from minimum to maximum flow shall be less than 60 seconds for standard valves and 90 seconds for shut-off valves. A UL or CSA listed electronic actuator shall be factory mounted to the valve. The actuator shall have sufficient torque to modulate the airflow against the maximum duct static pressure (within product specifications). Loss of main power shall cause the valve to maintain its last airflow position. This position shall be maintained until power is restored.
- F. Provide all supply valves with factory installed insulation of 3/8" (9.5 mm) flexible closed-cell polyethylene with flame/smoke rating not greater than 25/50 (ASTM E 84), density of 1.5 lb/ft³ (32 kg/m³), water vapor permeability of 0.0 perm-in (ASTM E 96) and water absorption of 0.0% (ASTM C 209).
- G. The airflow control valve shall be designed to operate in the following environmental ranges: 32-122 °F (0-50 °C) ambient and 10-90% non-condensing RH.
- H. Airflow Control Sound Specification
 - 1. The ACS manufacturer shall provide comprehensive sound power level data for each size airflow control device. All data shall be obtained from testing in accordance with ASHRAE/ANSI Standard 130, Methods of Testing Air Terminal Units.
 - 2. All proposed airflow control devices shall include discharge, exhaust and radiated sound power level performance.
 - 3. If the airflow control device cannot meet the sound power levels required to achieve the sound criteria appropriate for the space, as determined by the engineer, a properly sized sound attenuator must be used. All sound attenuators must be of a packless design (constructed of at least 18 gauge 316L stainless steel when used with fume hood exhaust) with a maximum pressure drop at the device's maximum rated flow rate not to exceed 0.20 inches of water.

2.05 OPERATION SEQUENCES

A. Room Volumetric Offset Control

1. The airflow control system shall control supply and exhaust airflow devices in order to maintain a volumetric offset (either positive or negative). Offset shall be maintained regardless of any change in flow or static pressure. The offset represents the air volume that enters or exits the room from the corridor or adjacent spaces.
2. The airflow control system shall maintain the fixed volumetric offset as the supply and exhaust venturi valves increase or decrease flow to meet temperature, occupancy, or ACH demands.
3. The offset control algorithm shall sum the flow values of all supply and exhaust airflow devices and command appropriate controlled devices to new set points to maintain the desired offset. This offset shall be adjustable from the BMS or locally through commissioning software installed on a laptop computer.
4. The offset control algorithm shall consider non-networked airflow control devices that consist of supply and exhaust flow devices that provide an analog signal scaled to reflect actual flow and any number of constant volume devices where the total of the supply and exhaust devices or may be included in the offset control algorithm.

B. Shut-off Control

1. The air flow control venturi valves shown on the drawings and schedules as type SOV shall be capable of shut off function. Each device shall be capable of accepting a digital input to switch the air valves from the set point flow to shut-off position.

2.06 BACnet INTERFACE TO BUILDING MANAGEMENT SYSTEMS

- A. The airflow control system network shall interface digitally with the BMS via BACnet MS/TP. All room-level points shall be available to the BMS for monitoring or trending. At a minimum, the airflow controller shall be BACnet Testing Lab (BTL) certified as an Application Specific Controller (B-ASC).
- B. All room-level points shall be available to the BMS for monitoring or trending.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The BMS contractor shall install any required routers and repeaters or supervisory controllers in an accessible location in or around the designated critical or non-critical room.

- B. The BMS shall install an appropriately sized and fused 24 Vac transformer suitable for NEC Class II wiring.
- C. The BMS contractor shall provide all required reheat coil and radiation control valves. Actuators shall be proportional or floating point control.
- D. All cable and conduit shall be furnished and installed by the BMS contractor. The BMS contractor shall terminate and connect all cables as required. The BMS shall utilize cables specifically recommended by the airflow controls supplier.
- E. The mechanical contractor shall install all airflow control devices in the ductwork and connect all airflow control valve linkages.
- F. The mechanical contractor shall install any sound attenuating devices provided by the airflow controls supplier.
- G. The mechanical contractor shall provide and install all reheat coils and duct transitions.
- H. The mechanical contractor shall install all reheat and radiation control valves.
- I. The mechanical contractor shall provide and install insulation as required.
- J. Each pressurization zone shall have either a dedicated, single-phase primary circuit or a secondary circuit disconnect.

3.02 SYSTEM STARTUP

- A. System start-up shall be provided by a factory-authorized representative of the airflow control system manufacturer. Start-up shall also provide electronic verification of airflow, supply, make-up, general exhaust, system programming and integration to BMS (when applicable). Successful bidders shall have at least 3 local certified factory-authorized technicians available for start-up and service.
- B. The balancing contractor shall be responsible for final verification and reporting of all airflows.
- C. The airflow control system supplier shall furnish a minimum of eight hours of owner training by factory trained and certified personnel. The training will provide an overview of the job specific airflow control components, verification of initial fume hood monitor calibration, general procedures for verifying airflows of air valves and general troubleshooting procedures.
- D. Operation and maintenance manuals, including as-built wiring diagrams and component lists, shall be provided for each training attendee.

3.03 CLOSEOUT ACTIVITIES

A. Training

1. The ACS supplier shall furnish a minimum of eight hours of owner training by factory trained and certified personnel. The training will provide an overview of the job specific airflow control components, general procedures for verifying airflows of air valves and general troubleshooting procedures.
2. Operation and maintenance manuals, including as-built wiring diagrams and component lists, shall be provided for each training attendee.

B. Maintenance

1. The airflow control valve utilizing flow metering and volumetric offset shall require no scheduled maintenance.
2. Systems using airflow management sensors/transducers (e.g., pitot tube, flow cross, orifice ring, air bar, hot wire, vortex shedder, side wall sensors, etc.) shall provide at no additional cost to the owner during and after the warranty period five years of required preventive maintenance on all airflow sensors.
 - a. Airflow sensors shall be removed, inspected, and cleaned semi-annually during the five-year period to prevent inaccuracies due to long-term buildup of dust, lint corrosion, wet or sticky particles, or other materials that foul the sensors.
 - b. If impractical to remove the airflow sensors, the critical airflow control system supplier shall include in the proposal the cost of supplying and installing duct access doors, one for each sensor, so that they may be cleaned in place.
 - c. The transducer shall be checked and recalibrated every 6 months to ensure long-term accuracy.
 - d. Note that auto-zero recalibration of transducers is not acceptable as a substitute for semi-annual recalibration.

END OF SECTION