SECTION 23 36 16.00

LABORATORY AIRFLOW CONTROL SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

The laboratory airflow control system (LACS) shall be furnished and installed to control the airflow and zone temperature in the laboratory spaces of the facility. The LACS shall vary the amount of 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 LACS shall be integrated with the Building Management System (BMS) via BACnet.

1.02 REFERENCES

A. Abbreviations and Acronyms

1. LACS – Laboratory Airflow Control System
2. BMS – Building Management System
3. VAV – Variable Air Volume
4. CSCP – Critical Spaces Controls Platform
5. PBC – Programmable BACnet Controller
6. ACM – Actuator Control Module (Include only for HIGH-SPEED zones)
7. FHD – Fume Hood Display (Include only if fume hoods are present)
8. RPI – Room Pressure Indicator

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 135-2012: BACnet® - A Data Communication Protocol for Building Automation Systems (including the standard and all published addenda).

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination

1. The LACS representative shall coordinate all installation details with the successful mechanical and controls (BMS) contractors. This includes ensuring the sheet metal layout drawings are aligned with the actual sizes of the airflow control valves, and verifying proper ductwork layout and sizing. Coordination for seamless integration with the BMS is also required.

B. Pre-installation Meetings

1. The LACS representative shall review the installation process with both the sheet metal contractor and the building management system (BMS) contractor to ensure proper setup.
2. During the Project Installation Phase, the LACS representative shall make periodic site visits to confirm proper installation, optimal system performance, and correct placement and orientation of airflow control valves, transformers, and BACnet integration panels, ensuring compatibility for operation and future maintenance.

1.04 SUBMITTALS

A. General: Submit the following submittals in accordance with the Conditions of the General Contract and Division 1 Submittal Procedures:

1. Product Data Sheets
2. Equipment Schedule Sheets, including Room#, Tag#, Min/Max flow rates, Catalog# and any additional configuration data to ensure a fully engineered LACS solution.
3. Installation Instructions
4. Project-specific Wiring Diagrams
5. Sequences of Operation
6. BACnet Integration Points List

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Manuals

1. Submit operation and maintenance manuals, including as-built wiring diagrams, component lists, and multi-mode airflow balance tables as closeout submittals.

1.06 QUALITY ASSURANCE

A. Certifications

1. The airflow system provider shall design, develop, manufacture, and sell products and services for controlling the environment and airflow of critical spaces. The provider must be certified under 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 LACS products shall be stored in a dry environment that complies with product specifications outlined in the submittals.
2. Handling and transportation of LACS products must follow industry best practices for control systems and instruments.

1.08 SITE CONDITIONS

A. Environmental Conditions

1. The ambient environmental conditions during installation and operation must comply with the product specifications outlined in the submittals.

1.09 WARRANTY

A. Warranty Period

1. The warranty period shall begin on the date of shipment and extend for a period of 60 months for all airflow control devices and 36 months for all other control system components.

PART 2 - PRODUCTS

2.01 AIRFLOW CONTROL SYSTEM

A. Each laboratory space shall be equipped with a dedicated airflow control system.
B. The system shall use volumetric offset control to maintain room pressurization and ensure proper room pressurization polarity (negative or positive) despite changes in room/system conditions, such as VAV fume hoods, door movements, or fluctuations in duct static pressure. The airflow control system shall not rely on flow measurement technologies such as pitot tubes, vortex shedders, or thermal anemometers for airflow control. Additionally, single or multiple-blade damper-style airflow control systems are not acceptable.
C. In case of a power failure, the airflow control devices shall fail to the last position and maintain flow control within ±5% of the signal, within one second of duct static pressure change. Single or multiple-blade dampers that fail open or in position, are not acceptable due to lack of mechanical pressure independence.

2.02 COMPONENTS

A. Airflow Control Device – General

1. The airflow control device shall be a venturi valve, manufactured by Phoenix Controls®.

2. The valve assembly manufacturer's Quality Management System shall be registered to ISO 9001:2008.
3. The device shall be OSHPD tested and certified per 2013 CBC, 2012 IBC, ASCE 7-10, and ICC-ES-AC-156.
4. The device shall be pressure-independent over its specified differential static pressure operating range (0.6" to 3.0" WC) and shall maintain airflow accuracy within one second of any change in static pressure, irrespective of the pressure drop or flow change.
5. The device shall maintain accuracy within ±5% of the signal, with a turndown range* as follows:
    a. 8" Valve: Up to 700 CFM, Turndown: 20:1
    b. 10" Valve: Up to 1,000 CFM, Turndown: 20:1
    c. 12" Valve: Up to 1,500 CFM, Turndown: 16.6:1
    d. 14" Valve: Up to 2,500 CFM, Turndown: 12.5:1

    * turndown range is defined as controllable maximum / controllable minimum
6. The device shall not require a minimum entrance or exit straight length of duct for accuracy or pressure independence.
7. No rotational/axial orientation shall be required for accuracy or pressure independence.
8. The device shall maintain pressure independence even with power loss.
9. Devices that use ASHRAE 130 minimum operating pressure as a rating for design pressure are not acceptable.
10. The device shall achieve maximum turndown at its stated minimum operating differential pressure.
11. The airflow control device shall be constructed as follows:
    a. Class A: For non-corrosive airstreams (e.g., supply and general exhaust), made of 16-gauge aluminum.
    b. Class B: For corrosive airstreams (e.g., fume hoods), made of 16-gauge aluminum with a corrosion-resistant phenolic coating and 316 stainless steel shaft and components.

       Note: Devices in corrosive environments must use stainless steel sensors (pressure sensors, vortex shedders, thermal anemometers, etc.).
12. Actuation:
    a. For standard-speed operation, a CSA-certified, UL-recognized electronic actuator shall be factory-mounted, with a fail-to-last-position feature.
    b. For high-speed operation, a CE-certified, UL-listed, IP56-rated actuator shall be factory-mounted. It must be capable of maintaining its fail-safe position upon power loss.
13. NVLAP Accreditation:
    a. The device shall be factory characterized using NVLAP Accredited air stations (ISO/IEC 17025:2005).
    b. The accuracy of the device shall be ±1% to ±3% depending on airflow range, and verified to ±5% for electronic devices across a wide range of airflow.
14. Devices that use airflow measuring (e.g., pitot tube, vortex shedding, thermal anemometer) are not acceptable.

B. Zone Airflow Device Controller

1. The controller shall be microprocessor-based, using closed-loop control to regulate airflow with a digital control signal and generate feedback representing the airflow.
2. During normal operation, each device shall reach the commanded airflow with ≤5% overshoot/undershoot within:
    a. 60 seconds for standard-speed actuation (90 seconds for shutoff from max flow).
    b. 1 second for high-speed actuation.
3. Flow tracking functions shall be pre-programmed in the Zone Controller for exhaust and return devices.
4. The controller shall store algorithms in non-volatile memory and support stand-alone or networked operation via BACnet.
5. It shall include 10-bit resolution inputs for thermistors, 0-10 VDC, 0-5 VDC, 0-20 mA, and dry contact signals. Outputs shall include 5 VDC, 0-10 VDC, 2-10 VDC, or 0-20 mA.
6. The controller shall meet FCC Part 15, CE, and UL 916 compliance.

C. Programmable BACnet Controller (PBC)

1. The device shall be a Phoenix Controls Programmable BACnet Controller (PBC), designed for zone-level control of high-speed and standard-speed Venturi valves, with up to 20 networked devices (Actuator Control Modules and Fume Hood Displays). It can function as a standalone programmable logic controller and I/O device.
2. Power & Communication:
    a. The device shall be powered by 24VAC ±15% (maximum 30 VA), 50-60Hz. Class 2 Transformer ONLY.
    b. Communication shall be via BACnet™ MS/TP or BACnet IP protocol and Bluetooth Low Energy (BLE) for mobile app connectivity.
3. Device Features:
    a. The PBC shall support up to 10 Fume Hood Displays (FHD500) and 20 networked Actuator Control Modules.
    b. The device must include a microprocessor-based controller with LED indicators for power and communication status.
4. Control Features:
    a. Zone Balance: Summing total flows and providing networked command for volumetric control, including Progressive Offset Control (POC) and overrides for cooling/heating volumetric adjustments.
    b. Comfort Control: Integrating temperature and humidity control via sensors, PID control, and reheat mechanisms.
    c. Emergency Control: Local and networked commands for emergency control positions.
    d. Occupancy Control: Configurable for occupied, unoccupied, and standby modes.
    e. Diversity Control: Allows setting lower flows based on building fan load and design.
5. Display and Status:

    a. Supports integration with the Fume Hood Display (FHD500), providing status and operational parameters.
    b. Display shall show system status, alarms, setpoints, and various operational metrics (e.g., CFM, velocity, temperature).
6. Installation & Mounting:
    a. The PBC is suitable for DIN rail mounting and panel mounting with screws. The mounting system should be flexible and adaptable for both horizontal and vertical installations.
7. Environmental Ratings:
    a. The device shall have an operating temperature range of -40°F to 122°F (-40°C to 50°C) and a storage temperature range of -40°F to 150°F (-40°C to 66°C).
    b. Protection rating: IP20, NEMA1.
8. Serviceability:
    a. The controller shall be replaced as a single unit; field servicing of the printed circuit board is not recommended due to electrostatic discharge risks.
9. Security:
    a. The device is designed to be cyber-secure but should be installed behind a firewall and protected with a VPN for network communications.
10. Agency Approvals:
    a. The PBC shall be UL 60730-1 and CE-approved, meeting BACnet™ BTL®-Listing for Advanced Application Controllers (B-AAC).

D. Actuator Control Module (ACM)

1. The Actuator Control Module (ACM) shall be a Phoenix Controls microprocessor-based device, used in conjunction with Phoenix Controls High-Speed Electric Venturi Valves. It shall provide precise control of the valve position, monitor inputs from various sensors (including sash and zone presence), and ensure the accuracy, repeatability, and speed of actuation for high-speed applications.
2. Power & Communication:
    a. The device shall be powered by 24VAC ±15%, with a maximum power requirement of 100 VA.
    b. Communication shall occur via BACnet™ MS/TP or BACnet IP and RS485, with optional connectivity to external systems for command, feedback, and alarming.
3. Device Features:
    a. The ACM shall feature an LED array on the unit to indicate the status of power, communication, input/output status, fail-safe module (FSM) status, and flow position.
    b. It supports 24VDC linear High-Speed Electric Actuators, with a response time of less than 1 second and full stroke time of under 3 seconds for high-speed applications.
    c. The ACM shall include a user interface with push buttons and a rotary knob for manual override and reset functions.
4. Fail-Safe Module (FSM):

    a. The ACM shall support an optional, pluggable Fail-Safe Module (FSM) to provide emergency backup power during power loss, allowing the actuator to reach a pre-configured flow setpoint (fully open, fully closed, or a specified flow).
    b. The FSM shall use supercapacitors for power storage and allow for emergency operation when external power is lost.
5. Integration:
    a. The ACM shall integrate with the Phoenix Controls Programmable BACnet Controller (PBC) for high-speed applications via RS485, or with third-party systems via Universal Input/Output (UIO) for analog operation.
    b. It must support integration with Fume Hood sash sensors and Zone Presence sensors for comprehensive control.
6. Installation & Mounting:
    a. The ACM shall be factory-mounted to the Venturi valve and shall be suitable for installation in boxes conforming to standard DIN43880 or mounted on a standard 1.38-inch (35 mm) panel rail.
7. Environmental Ratings:
    a. Operating temperature range: 32°F to 122°F (0°C to 50°C).
    b. Storage temperature range: 32°F to 122°F (0°C to 50°C).
    c. Humidity range: 5% to 95% RH, non-condensing.
8. Serviceability:
    a. The ACM shall be replaced as a single unit. Handling of the printed circuit board is not recommended due to the risk of electrostatic discharge.
9. Agency Approvals:
    a. The ACM shall meet UL60730-1, UL916, CE, and BTL certifications, as well as conforming to various international standards for EMC and RoHS compliance.

E. Fume Hood Display (FHD500)

1. The Fume Hood Display (FHD500) shall be a Phoenix Controls 4” color LCD capacitive touch screen display (480 x 480 pixels), designed for use with the Phoenix Controls Critical Spaces Control Platform (CSCP). The FHD500 shall support multiple applications including Constant Volume Valve (CVV), Two-State, Drive applications, and High-Speed Variable Air Volume (VAV).
2. Power & Communication:
    a. The device shall be powered by 24 VAC ±15% with a maximum power consumption of 8.68 VA, 50-60 Hz. Class 2 Transformer ONLY.
    b. Communication shall be via BACnet MS/TP, with support for a configurable baud rate (9.6Kbps to 115.2Kbps).
    c. Bluetooth Low Energy (BLE) shall be supported for connectivity with the Phoenix Controls Flow Manager App.
3. Device Features:
    a. The display shall have a touch screen with variable brightness adjustment to accommodate different lighting conditions.
    b. Buttons on the face of the monitor shall include options for muting alarms and emergency exhaust override.

    c. The Fume Hood Display shall support Vertical Sash Setup, Horizontal Sash Setup, or Combination Sash Setup (multiple vertical and horizontal sash sensors).
    d. The FHD500 shall be capable of displaying current fume hood conditions including:
        i. Face velocity, CFM, and status (Normal / Alarm)
        ii. User presence status and hood status (Normal/Alarm)
        iii. Alarm messages and hood energy waste indicators
        iv. Night energy waste alerts, hood hibernation mode, and sash open percentage.
4. Alarms:
    a. The FHD500 shall include audible and visual alarm notifications, with customizable alarm volume levels (low, medium, high).
    b. In alarm state, the background color of the screen shall change to flashing red, and the enunciator shall remain active until the alarm is cleared.
    c. The device shall have a mute function with a configurable duration.
5. Configuration & Setup:
    a. Basic configuration shall be done directly from the FHD500 unit, without the need for plug-in or third-party software. Advanced configuration and troubleshooting may be done with Phoenix Controls Workbench software.
    b. The FHD500 shall support field software upgrades over BACnet MS/TP or Wi-Fi.
    c. The device shall have a four-digit PIN code for security to prevent unauthorized changes to settings.
6. Installation & Mounting:
    a. The FHD500 shall be surface-mounted to the fume hood, with electrical conductors terminating directly to the touch screen baseplate.
7. Environmental Ratings:
    a. The operating temperature range shall be between 32°F and 122°F (0°C to 50°C).
    b. The storage temperature range shall be between -40°F and 150°F (-40°C to 65.5°C).
    c. The operating humidity range shall be between 10% and 90% relative humidity (non-condensing).
    d. The construction shall meet or exceed the IP54 rating to protect against dust and moisture.
8. Compliance & Certification:
    a. The FHD500 shall be certified as meeting CE, CSA, and RoHS standards.
    b. The unit shall be tested for cybersecurity and is suitable for non-solvent wipe down and use in environments with exposure to moderate to high particulate and humidity.
9. Integration Points:
    a. The device shall support integration with BACnet™ MS/TP or BACnet IP, with various objects such as:

b. Hood State, Sash Opening, Face Velocity, Flow Feedback, Occupancy Detected, Alarm Messages, and more.

F. Room Pressure Indicator (RPI)

1. The Room Pressure Indicator (RPI) shall be a Phoenix Controls device designed for monitoring and displaying real-time room pressure conditions. It shall feature a 4" color LCD capacitive touch screen display (480 x 480 pixels) with variable brightness adjustment for optimal visibility in various lighting conditions.
2. Power & Communication:
    a. The device shall be powered by 24VAC ±10%, 50/60Hz, with a maximum power consumption of 8.5 VA for the display and 0.18 VA for the transducer.
    b. The RPI shall connect and communicate to the BACnet MS/TP network bus, supporting baud rates from 9.6Kbps to 115.2Kbps, with adjustable APDU timeout.
    c. The device shall support BACnet integration with a minimum of 20 analog values and 10 binary values, including room pressure status and alarm conditions.
3. Device Features:
    a. The RPI shall have a status screen that provides indications of the current room pressure condition, including:
        i. Normal Pressure: Green background with "Normal" displayed.
        ii. Pressure Warning: Yellow background with "Warning" displayed.
        iii. Pressure Alarm: Red background with "Alarm" displayed.
        iv. Standby Mode: Blue background with "Standby" displayed.
    b. A configurable pressure indicator gauge with real-time pressure values shall be displayed on the screen.
    c. Alarm and warning setpoints shall be viewable and editable from the display menu.
    d. Audible alarms shall be included for alarm and warning conditions, with adjustable volume levels (low, medium, high). The alarm shall be mute-able for a configurable duration, with the ability to reset when the event is cleared.
4. Configuration & Setup:
    a. Configuration shall be done from the device’s built-in menu without requiring third-party software. The device shall support field software upgrades over BACnet MS/TP.
    b. The device shall offer the ability to upgrade to a translated language for the locale in which it is installed.
5. Construction & Mounting:
    a. The RPI shall have a gasketed faceplate and meet or exceed an IP54 rating to protect against dust and moisture, suitable for use in areas with moderate to high particulate and humidity exposure.
    b. The device shall be flush-mounted to a standard electrical enclosure, with electrical conductors terminating directly to the touchscreen baseplate.
6. General Pressure Transducers:

    a. The pressure transducer shall have a pressure range from ±0.10 in w.c. to ±1 in w.c.
    b. Calibration options for the transducer shall include 3-point (10%, 50%, and 90% of FSO) or 5-point (10%, 30%, 50%, 70%, and 90% of FSO) NIST calibration.
    c. Transducer sensor compensated temperature range: 32°F to 122°F (0°C to 50°C).
    d. Transducer enclosure shall be made of polycarbonate with a UL 94 V-0 flammability rating, suitable for use with non-corrosive, non-ionic gases (such as air).
7. Environmental Ratings:
    a. Operating temperature range: 32°F to 122°F (0°C to 50°C).
    b. Storage temperature range: -40°F to 150°F (-40°C to 65.5°C).
    c. Operating humidity range: 10% to 90% relative humidity (non-condensing).
    d. The device shall be resistant to vaporized hydrogen peroxide (VHP), formaldehyde, chlorine dioxide (Clidox), and other common chemical vapors.
8. Security:
    a. A four-digit PIN code shall be implemented to prevent unauthorized changes to setpoints, alarm thresholds, and editable control parameters.
9. Compliance & Certification:
    a. The RPI shall meet regulatory compliance with CE, CSA, and RoHS standards.
    b. The unit shall undergo cybersecurity testing by the manufacturer and be suitable for use with non-solvent wipe down.

G. Fume Hood Operation

1. A sash sensor shall be provided to measure the height of vertically moving sashes, and also for horizontal overlapping sashes. Velocity sensors for fume hood exhaust control are not acceptable.
2. The airflow shall vary linearly between adjustable minimum and maximum set points to maintain constant face velocity, with a minimum flow setting to ensure airflow even with the sash fully closed.

H. Sound Attenuation Device

1. In areas which are sensitive to noise, supply valves and general exhaust valves shall include a Neutralizer™, a tuned resonator which has been engineered to reduce noise produced by the Phoenix Controls airflow control valve, especially in the 1000, 2000 and 4000 Hz octave bands.
2. See schedule for where Neutralizers are required
3. Constructed of 24 gauge galvanized steel or 18 gauge 316 stainless steel for corrosive applications (e.g. fume hood exhausts)
4. All sound attenuators must be of a packless design with a maximum pressure drop not to exceed 0.10 inches of water column.
5. Neutralizers shall be a slip-fit design, inserted into the duct work between the valve and the room, and sealed in place by the installer.

I. Heating Coils – Heating coils shall be provided by others.

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.

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.

2.04 PERFORMANCE/DESIGN CRITERIA

A. The airflow control system shall maintain specific airflow (±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 0.6” to 3.0" WC pressure drop). The airflow control device shall maintain this pressure independence 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.

B. The airflow control device shall maintain accuracy within ±5% of signal over an airflow turndown range of no less than that listed in Section 2.02.5

C. The airflow control system shall maintain specific airflow (±5% of signal) with a minimum airflow turndown as shown in Section 2.02.5 to ensure accurate pressurization at low airflow and assure maximum energy efficiency.

D. No minimum entrance or exit straight length of duct shall be required to ensure accuracy and/or pressure independence.

E. The hood exhaust airflow control device (and all supply and general exhaust valves in a zone with a VAV fume hood) shall respond to the fume hood sash opening by achieving 90% of its commanded value within one second of the sash reaching 90% of its final position (with no more than 5% overshoot/undershoot) of required airflow. Rate of sash movement shall be from one to one and one-half feet per second.

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 LACS 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 0.10 inches of water column.

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.

   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.

   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.

   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. Space Temperature Control

1. The airflow control system shall regulate the space temperature through a simultaneous combination of programmable volumetric thermal override and control of reheat coils. The controller shall calculate separate cooling and heating set points based on a single writable set point from the BMS, with the option of a local set point offset adjustment.

   Temperature control shall be implemented through the use of independent primary cooling and heating control functions. Cooling shall be provided as a function of thermal override of conditioned air with the supply and exhaust airflow devices responding simultaneously to maintain the desired offset. Heating shall be provided through modulating the control actuator of a properly sized control valve connected to the selected reheat coil.

   For vivarium rooms, the primary temperature control loop for the lab is based on a comparison between the discharge air temperature and the set point for the discharge air. The space temperature measured by a wall sensor is used to reset the set point for discharge air.

C. Occupancy Override Control

1. The airflow control system shall have the ability to change the minimum ventilation and/or temperature control set points, based on the occupied state, to reduce energy consumption when the space is not occupied. Two occupancy modes shall be available: occupied and unoccupied. The occupancy state may be set by either the BMS as a scheduled event or a local override button that allows a user to set the space to occupied for a predetermined interval. The local timed bypass button (located on the wall mounted temp sensor) or the override contact shall be given priority over the BMS command.

D. Emergency Mode Control

1. The airflow control system shall provide a means in conjunction with a BMS supervisory controller of overriding temperature and pressurization control in response to a command indicating an emergency condition exists, and airflow control devices are to be driven to a specific flow set point. The system shall support up to four emergency control modes. The emergency control modes may be initiated either by a local contact input or BMS command. Once an emergency mode is invoked, pressurization (offset) and temperature control are overridden for the period that the mode is active. Emergency modes shall have a priority scheme allowing a more critical mode to override a previously set condition.

E. Multi-Use Inputs

1. In addition to the dedicated inputs for standard control functions, each zone shall have multi-use inputs on valve controllers for the following local monitoring or control functions such as the following:
   a. Discharge Air Sensor

b. Volumetric Cooling Override
c. Occupancy Sensor
d. Humidity Sensor
e. Pressure Monitoring
f. Emergency Switch
g. Additional Flow Inputs (Supply and Exhaust)

F. BSL3 Labs

1. For BSL3 labs, all valves shall have high-speed actuation.
2. For BSL3 labs, all valves shall be gasketed low-leakage shutoff valves with leakage of less than 0.005 CFM through the valve body when in the shutoff position.
3. For BSL3 labs, all rooms shall have pressure monitors, and there shall be two (2) central-station monitors to monitor the pressure of all the rooms.
4. For BSL3 labs, all valves shall be able to respond to complex sequences, and shall fail closed in the event of a power loss.

2.06 BACnet INTERFACE TO BUILDING MANAGEMENT SYSTEMS

A. The airflow control system network shall interface digitally with the BMS via BACnet over IP. All room-level points shall be available to the BMS for monitoring or trending. At a minimum, the BACnet router 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.

Specifier Note: Table 1 below contains the most commonly integrated points. Often there is more than one supply, general exhaust, or fume hood per room, so plan accordingly. A complete list of all points can be provided by your local Phoenix Controls representative upon request.

Point Name	Point Units
Occupancy Command	Occupied/Unoccupied
Occupancy Status	Occupied/Unoccupied
Room Temperature	°F
Room Temperature Setpoint	°F
Supply Air Temperature	°F
Supply Air Temperature Setpoint	°F
Occupied Cooling Setpoint	°F

Occupied Heating Setpoint	°F
Unoccupied Cooling Setpoint	°F
Unoccupied Heating Setpoint	°F
Cooling Demand	%
Heating Demand	%
Offset	CFM
Offset Setpoint	CFM
Supply Flow Command	CFM
Point Name	**Point Units**
Supply Flow Feedback	CFM
General Exhaust (GEX) Flow Command	CFM
GEX Flow Feedback	CFM
Fume Hood Flow Command	CFM
Fume Hood Flow Feedback	CFM
Fume Hood Sash % Open	%
Fume Hood Face Velocity	FPM
Fume Hood Face Velocity Setpoint	FPM
Fume Hood User Status	Normal/Setback
GEX Jam Alarm	Normal/Alarm
Supply Jam Alarm	Normal/Alarm
Fume Hood Jam Alarm	Normal/Alarm
Fume Hood Flow Alarm	Normal/Alarm

PART 3 - EXECUTION

Specifier Note: Paragraphs below are intended to specify how the equipment shall be handled on-site by the installer. Retain or delete paragraphs below per project requirements and specifier's practice.

3.01 INSTALLATION

A. The LACS shall install an appropriately sized and fused 24 Vac transformer suitable for NEC Class II wiring.

B. The LACS contractor shall provide all required reheat coil valves. Actuators shall be proportional.

C. All cable and conduit shall be furnished and installed by the LACS contractor. The LACS contractor shall terminate and connect all cables as required.

D. The mechanical contractor shall install all airflow control devices in the ductwork and connect all airflow control valve linkages.

E. The mechanical contractor shall install any sound attenuating devices provided by the airflow controls supplier.

F. The mechanical contractor shall provide and install all reheat coils and duct transitions.

G. The mechanical contractor shall install all reheat control valves.

H. The mechanical contractor shall provide and install insulation as required.

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 two 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. Maintenance

1. The airflow control valve utilizing flow metering and volumetric offset shall require no scheduled maintenance.
2. The LACS supplier can offer an annual service contract to insure ongoing optimal operation of the system.

END OF SECTION INSTALLATION

END OF SECTION 23 36 16.00