PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 230500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein.

1.2 DESCRIPTION OF WORK

A. A laboratory airflow control system shall be furnished under this section. The exhaust volume of a laboratory fume hood shall be controlled precisely to maintain a constant average face velocity into the fume hood to ensure the capture and containment of fumes. The control system shall maintain the airflow balance by accurately controlling the airflow into and out of laboratory rooms and maintaining a net negative (or positive) pressurization. The control system shall provide a means for maintaining the minimum ventilation requirements (air exchange rate) and maintaining temperature control in the laboratory.

B. The system shall include separate, stand-alone electronic or digital control panels, one per pressurization zone, general room exhaust valves, supply air make-up valves, hood exhaust valves, hood fume sash position sensors, fume hood monitors, constant volume air flow control valves, and control connections between devices.

C. The specified air flow control system's constant volume valves do not require pneumatic air, power wiring or control wiring, except where indicated on details. Air flow control systems requiring pneumatic air, power wiring or control wiring for constant volume valves are required to furnish and install whatever additional support is needed to provide a complete and operational system. The cost of this additional support shall be included in the airflow control systems vendors bid.

D. The specified control system's airflow control valves are inlet and discharge insensitive. Air flow control systems requiring minimum duct diameters are required to furnish and install whatever additional ductwork is needed for proper system operation and published ASHRAE industrial ventilation handbook requirements. The construction of airflow probes shall conform to the concentric circles process for measurement. The cost of this additional ductwork, fittings, engineering, and coordination shall be included.

E. Volumetric Pressurization control is the basis of design for this project with the corridor fed a constant amount of air and room offsets held constant. Through the wall pressure sensing is not acceptable, and is specifically excluded.

F. Any electronic to pneumatic converters required shall be factory mounted. Where airflow control valves are to be combined with airflow sensors, the flow sensor and transmitter shall be installed at he factory, and calibrated in an NIST traceable wind tunnel per AMCA Standard 610-93, "Methods of Testing Airflow Measurement Stations for Rating" Figure 3 without airflow straighteners and the 8.5 D dimension reduced to 2D.

1.3 RELATED WORK DESCRIBED ELSEWHERE:

A. Section 230500: Basic HVAC Materials and Methods

B. Section 230900: Building Automation System (BAS) Controls

C. Section 233113: Air Distribution

D. Division 26: Electrical

1.4 QUALITY ASSURANCE

A. Source Quality Control:
1. Air control equipment, with the exception of pneumatic tubing, fittings, wire, conduit and other standard marketed apparatus, shall bear the nameplate of the specified “Manufacturer”.
2. Bids by wholesalers, contractors, and/or franchised dealers without a minimum of ten successfully completed projects are not acceptable. Provide references to demonstrate compliance.
3. Primary equipment shall be the product of a single manufacturer except where indicated otherwise in the specifications or on the drawings. The laboratory pressurization and fume hood controls are to be the product of that manufacturer.
4. The laboratory control manufacturer shall have a minimum of 10 years experience in laboratory airflow control.
5. Laboratory pressurization and fume hood velocity control:
   a. The manufacturer shall have successful customer installations of the specified fume hood control system in operations for a period of over five years, and shall submit a list of these installations. Where the manufacturer cannot demonstrate five years of system operation provide a letter of commitment from the manufacturing firm President stating that the firms resources will be made available to successfully complet the project. The manufacturer is to further arrange for at least one site visit to an installation to enable the Owner’s Representative to view the control system in operation.
   b. The contractor shall ensure that the manufacturer provides instruction and installation, testing, balancing, and commissioning the system. Instruction shall be by personnel experienced in the installation and commissioning of these systems, and shall be for a minimum of seven days.
6. The contractor shall ensure that the manufacturer will have qualified technical personnel fully commission and certify the system foe operation according to the sequence of operations and within specified performance tolerance.
7. The manufacturer shall review the system for proper installation and shall warranty the system for parts and labor for five years after the system has been proved and accepted as complete by the Owner’s Representative. The manufacturer shall include two visits to the site to confirm the system is operating as commissioned within the first six months after acceptance. A report confirming proper operation shall be issued to the Owner’s Representative for their records. The manufacturer shall review the building at the end of two years. A report shall be issued to the Owner’s Representative reporting the status of the system. Calibration of the system is covered under this warranty, and any labor and materials required to keep this system in calibration for the five years shall be the sole responsibility of the laboratory pressurization and fume hood control manufacturer. The

submittal shall include a description and demonstration of auto-zero modules and software to allow for the periodic, automatic adjustment of all flow transmitter's zero settings.

B. System Turn-Over and Service: Upon completion of all system start-up and checkout procedures, and while mechanical systems are monitoring and controlling in a "normal operating" condition, the Contractor shall demonstrate the performance of the complete system to maintain flows, temperatures, and pressures to the Owner's Representative.

C. The manufacturer shall guarantee the airflow control system installed under this SECTION of the specification to be free from defects in workmanship and material under normal use for a period of five years after the acceptance by the pursuant to the system turn-over requirements. The airflow control manufacturer at no charge to the Owner shall correct any defects in workmanship or materials during the guarantee period.

D. The airflow controls sub-contractor is to coordinate and work with the test and balance contractor for the performance of the balancing of the system as specified in Section 230800 – Mechanical Systems Commissioning and Section 230593 – Testing, Adjusting and Balancing.

1.5 PRODUCT HANDLING

A. Protection: Use all means necessary to protect airflow controls materials before, during and after installation and to protect the installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Owner's Representative, and at no additional cost to the Owner.

1.6 SUBMITTALS

A. General
1. Submit per Section 230500, airflow control panels, coordinate with controls, alarm contacts, thermostats, panelboards, schematic drawings, and accessories; the submission of individual items or portions of equipment required will not be acted on individually.
2. Submit (before installation) a coordinated schedule with temperature control contractor of all thermostats, valves, pressure and temperature sensor, panels, locations for review. Schedule shall include room or space number.

B. Shop Drawings
1. Submit details of system for review, which shall include valve schedules, local control panels, coordinated electric, piping and wiring diagrams, flow diagrams, and a complete description of the sequence of operation of each system.
2. Use same nomenclature on flow diagrams as used on Contact Drawings, and adjacent to each item note the following designations or settings where applicable:
a. Name of item.
b. Range and setting.

c. Each room pressurized schedule.

3. Schematic airflow control diagrams shall show proposed arrangement of equipment and sequence of operation.

4. Floor plans to show location of airflow control valves, makeup air control panels, power supplies, required clearances, and other applicable devices.

C. Product Data:

1. Submit for all airflow controls and accessories mounted on same, complete with plastic enclosed control diagrams and sequence of operation sheet mounted on and clearly identified on it.

D. Maintenance Data and Operating Instructions: Upon completion of the Work and prior to final acceptance, provide copies of "System's Operation and Maintenance Manuals" for the installed control system in accordance with requirements of Section 230500: Basic Materials and Methods. Manuals shall consist of copies of all airflow control submittals, including schematic diagrams, panel drawings, component part drawings, accessories and operation and maintenance instructions.

E. Submit sample of service contract.

F. Submit certified performance tests as specified.

G. Submit written plan for commissioning and acceptance testing procedures.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Equipment shall be shipped in its original packages to prevent damaging or entrance of foreign matter. All handling and shipping shall be performed in accordance with manufacturer's recommendations.

1.8 MANUFACTURERS

A. Accutrol / AccuValve® Airflow Control Valves or equal

PART 2 - PRODUCT

2.1 GENERAL

A. The airflow control valves shall include the following components:

1. Supply Air Valves and General Exhaust Air Valves

a. Consists of airflow control valve with vortex airflow sensor electric actuator. Airflow control valves serving lab spaces with one or more fume hoods shall be equipped with high speed actuators (Speed of Response of < 1 sec). Airflow control valves serving lab spaces without fume hood shall be equipped with standard speed actuators(Speed of Response of < 20 sec).

b. Tracking pair air valves shall be equipped with integrated high performance closed loop feedback controller.

2. Fume Hood Exhaust Air Valves

c. Consists of airflow control valve with vortex airflow sensor, high speed electric actuator (Speed of Response of < 1 sec) and integrated high performance closed loop feedback controller.

2.2 SUPPLY, EXHAUST AND FUME HOOD EXHAUST AIRFLOW CONTROL VALVES

A. The Airflow Control Valve shall be a multichamber AccuValve® or approved equal.
   1. The Airflow Control Valve shall consist of a compression section, two airflow control surfaces, factory-mounted digital vortex airflow measuring device factory-mounted electric actuator and integral access panel. Airlfow Control Valves serving lab spaces with one or more fume hoods shall be equipped with high speed actuator with response time of < 1 sec. Airlfow Control Valves serving lab spaces without fume hood shall be equipped with standard speed actuator with response time of < 20 sec.
   2. Tracking pair and fume hood exhaust Airflow Control Valves shall be equipped with integrated high performance closed-loop feedback controller with native BACnet.

B. The compression section shall divide the airstream into at least two separate airstreams. Each airstream shall be approximately equal in size and the total open area shall be approximately 50% of the duct open area. The divided sections shall cause compression therefore creating a more laminar flow for better airflow measurement and turndown. The compression section shall be of an aerodynamic shape with a static regain section to insure minimal pressure drop. The valve shall not require any duct straight runs either upstream or downstream of the airflow valve to achieve required specified performance.

C. Airflow control valves shall be a linear type and shall operate with a minimum turndown ratio of 8 to 1. Accuracy of the airflow valve shall be 5% of reading in the 8 to 1 range of the damper.

D. The airflow control valve shall be capable of being mounted in any position (360º mounting plane) in ductwork without the need for recalibration. It shall not be required to specify mounting plane when ordering valve. Airflow valves that must be ordered and mounted in either a vertical or horizontal plane will not be acceptable.

E. Valve body material for Fume Hood and General Exhaust shall be 316SS; 20gauge for body and 16gauge for blades. Valve shaft material shall be 316SS. Coated valves will not be acceptable.

F. Valve body material for supply shall be 304SS; 20gauge for body and 16gauge for blades. Valve shaft material shall be 316SS. Coated valves will not be acceptable.

G. Airflow control valves shall operate without linkages, springs, levers, or bearings, in the airstream due to the effect of exhaust air on those materials, and shall exhibit no deadband or hysteresis. Airflow control valves shall be provided as “fail last position”. Airflow valves provided for Fume Hood Exhaust application shall be provided as “fail safe position”.

H. All critical components of the airflow control valve shall be easily accessable from one side of the valve. All linkages shall be out of the airstream to avoid possible corrosion and loss of accuracy. Airflow valves that cannot be mounted with accessible control components (i.e. pivot arm/actuator) in the 4-8 o’clock orientation will not be acceptable.

I. Airflow control valves shall be of a low pressure drop design for energy efficiency. Valves shall not require greater pressure drop than listed at Max CFM (Max L/s or

CMH) on project valve schedule or 0.3" wc (75Pa), whichever is less. Airflow control valves that require higher pressures to operate shall not be acceptable. The provision of a larger airflow control valve that is scheduled to accommodate the lower scheduled pressure drop will not be acceptable. Airflow control valves that require higher pressures to operate will not be acceptable.

J. The airflow valve shall be complete with a digital vortex type airflow sensing device providing true airflow feedback for the system. Airflow valves using mechanical means for creating pressure independence will not be acceptable. Airflow valves incorporating pitot, orifice, venturi airflow or thermal airflow measurement will not be acceptable.

K. Demand Based Static Pressure Reset Control (DBSPRC) – Valve must be capable of being utilized with a demand based static pressure reset control scheme as described in ASHRAE Standard 90.1-6.5.3.2.3.

1. DBSPRC offers considerable savings in operating cost by minimizing the static pressure in the duct thereby allowing the supply and exhaust fans to operate at lower brakehorsepower. To utilize DBSPRC the airflow valve must incorporate airflow measurement and closed loop control. Through the measurement of true airflow, the valve will modulate to the proper airflow volume. This will occur regardless of the static pressure in the duct. Information on the valve postion will then be communicated to the BAS which will use that information to reset the static pressure in the duct to the minimum setpoint possible to maximize energy savings.
2. An open loop venturi valve shall not be acceptable because it relies on a calibrated spring and plunger which only drives to a specific valve position and relies on the spring to compensate for pressure changes. Therefore valve position is not indicative of required static pressure in the system and a venturi valve cannot be used for DBSPRC.
3. A mechanical based aiflow control valve such as a venturi valve that cannot meet the demand based static pressure reset control scheme as described in ASHRAE Standard 90.1-6.5.3.2.3 shall not be acceptable.
4. Should a venturi valve be offered as a substitute for a low pressure drop closed loop control valve the contractor offering the valve must provide <u>each</u> venturi valve with a static pressure reset kit which requires duct straight runs of 3x Duct Diameter (upstream of venturi valve) and 4x Duct Diameter (downstream of venturi valve) ensuring that the pressure pickups are located such that they will not be susceptible to clogging or condensation within the tubes. The contractor substituting the venturi valve shall also be responsible for associated design change and field duct changes to accompany the requirement of straight duct run upstream and downstream of the venturi valve (see above).
5. In addition to the above (Item 3) requirement, the contractor offering the substituted venturi valve must provide the owner the loss in operating savings without DBSPRC of $50,000.00 per 10,000 CFM of exhaust which represents the extra energy cost to the owner over the life of the building.

L. Airflow measuring devices shall be of the Vortex Shedding type, capable of continuously monitoring the airflow volume of the duct served and electronically transmitting a signal linear to the airflow volume. Pitot, Orifice Venturi or Thermal Airflow sensors shall not be acceptable due to their susceptibility to coating and plugging of the sensors which could cause serious errors in readings and resultant safety issues in the room.

M. Individual airflow sensors shall be of rugged construction, and shall not require special handling during installation. Sensors shall be mounted on support bars. Standard materials shall be manufactured of corrosion resistant plastic.

N. Individual velocity sensors shall not be affected by dust, temperature, pressure, or humidity. The sensors shall be passive in nature, with no active parts within the air stream. The output from individual sensors shall be linear with respect to airflow velocity and shall be capable of sensing airflow in one direction only. The velocity sensors shall not require calibration.

O. Velocity sensing methods other than those specified shall not be acceptable. For another velocity sensing method to be considered it must provide the basic requirements for linear electronic output, turndown, accuracy, materials of construction, and output signal. If differential pressure devices are to be considered (such as pitot and venturi), dual differential pressure transmitters, the span of the lower transmitter being one tenth the span of the higher, with an accuracy not less than +/- 0.5%, shall be utilized to provide the required turndown. Orifice type devices shall have a Beta ratio of 0.7 or less, and shall be installed in accordance with ASME MFC-3M guidelines for up and downstream conditions.

P. The airflow sensors shall be easily accessable in the valve for inspection without removing valve from the duct. Airflow control valves provided without built in inspection ports will not be acceptable.

Q. Use of valve or damper position for calculation of airflow volume is not acceptable. Direct airflow measurements must be taken.

R. Airflow control valves shall have an integral closed-loop feeedback controller. Airflow measurement through the vortex airflow sensor shall send the digital signal to the controller which modulates the low speed electric actuator to maintain desired airflow setpoint. The airflow setpoint shall have the capability of being provided through analog input, digital input, communications over BACnet MS/TP or AVC internal program memory. Analog output signal shall be provided for airflow and alarm outputs must be provided to indicate abnormal airflow conditions.
   1. Airflow Control Valve integral controller shall provide an EIA-485 port supporting BACnet MS/TP as a Full Master Node state machine. Field programming shall be accomplished through an intuitive PC based UI (User Interface) tool. Connection between the integral controller and the computer shall be provided through a USB port located on the AVC control module.
   2. Power requirement for each airflow valve with integral controller shall not exceed 28VA for all single valves and 55VA for dual valves.

S. The airflow control valve shall not exceed the NC levels shown in the Table 1. NC levels are calculated based on the octave band sound attenuation factors shown in Table 2.
   1. If the airflow control device cannot meet the NC levels specified a properly sized silencer or sound attenuator must be used.
   2. All silencers 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.
   3. Due to the increased pressure requirements of a venturi valve if a venturi is submitted it must meet the NC levels specified in Table 1 with 2.0" of pressure across the valve instead of 1.0" for an dual chamber valve.

Table 1: Maximum NC Levels of Supply, Radiated and Exhaust airflow control valves

Valve Size	Airflow	Pressure Drop ("wg)		Maximum NC Level		
inches	CFM	AccuValve	Venturi	Supply	Radiated	Exhaust
6	290	1.0	2.0	<20	<20	51
8	700	1.0	2.0	23	27	49
10	1000	1.0	2.0	23	22	41
12	1500	1.0	2.0	25	21	52
14	2200	1.0	2.0	22	23	51
12x18	2000	1.0	2.0	29	27	47
12x24	3000	1.0	2.0	25	26	44
12x36	4500	1.0	2.0	33	31	51
12x48	6000	1.0	2.0	29	30	47

Table 2: Octave Band Sound Attenuation Factors

Radiated Sound	Octave Band					
	2	3	4	5	6	7
Environmental Effect	2	1	0	0	0	0
Ceiling/Space Effect	16	18	20	26	31	36
Total dB Reduction	18	19	20	26	31	36

Discharge Sound	Octave Band					
	2	3	4	5	6	7
Environmental Effect	2	1	0	0	0	0
Duct Lining	2	6	12	25	29	18
End Reflection	9	5	2	0	0	0
5 ft., 8 in Flex Duct	6	10	18	20	21	12
Space Effect	5	6	7	8	9	10
Total dB Reduction	24	28	39	53	59	40

Exhaust Sound	Octave Band					
	2	3	4	5	6	7
Environmental Effect	2	1	0	0	0	0
Space Effect	5	6	7	8	9	10
Total dB Reduction	7	7	7	8	9	10

The following dB adjustments are used, per ARI 885-98 for the calculation of NC above 300 CFM						
	Octave Band					
	2	3	4	5	6	7
300-700 CFM	2	1	1	-2	-5	-1
Over 700 CFM	4	3	2	-2	-7	-1

2.3 FUME HOOD AIRFLOW VOLUME CONTROLLER

A. Exhaust airflow volume shall be controlled based on sash position at each laboratory fume hood by a dedicated fume hood controller. The fume hood controller shall be a fully functioning, independent control unit, capable of operating as a standalone element in a distributed laboratory airflow control system. Control hardware distribution shall be such that the failure of one controller shall not affect any other fume hoods on the network.

B. The fume hood controller shall consist of a controller, display module and sash position sensors. The sash position sensors shall mount physically on the fume hood sash and frame assemblies.

C. The fume hood controller shall also have integral airflow measurement circuitry to receive a signal directly proportional to duct air velocity, from a vortex-shedding type airflow measuring device, for the purpose of monitoring and controlling fume hood airflow volume. The signal shall be digitally processed by the controller, with no analog-to-digital circuitry required, eliminating A/D conversion error. The airflow measurement shall be incorporated in the control sequence as performed by the airflow controller, and communicated to other airflow controllers, via the network, as required. Measurement system accuracy shall be plus or minus 2% of volumetric airflow rate. Turndown capability shall be at least 10:1.

D. The fume hood sash shall be fitted with sash position measuring sensor(s). Vertical position measuring devices shall be of the retracting drawstring potentiometer type. The sensors shall be permanently affixed to the fume hood structrue and the drawstring affixed to the moving sash frame as best fits the particular hood design. The monitor shall be able to accept up to four (4 sash position measuring arrays for applicaton on multiple-sash hoods. The monitor shall be cable-connected to and powered by the controller.

E. Horizontal position sensors shall be magnetic reed switch type. The sensor strip shall mount on the hood structure and a magnet shall be affixed to each sash frame. The horizontal sensing system shall be capable of measuring any number of sashes for hood widths up to 16’.

F. The controller module shall be microprocessor based. The transmitter module shall be powered by 24VAC. It shall be provided with two 4-20mA analog outputs, two contact inputs, a SPDT alarm relay output, and a native BACnet communications port.

G. In the controller, the actual fume hood exhaust duct airflow (CFM) shall be compared to the desired fume hood exhaust airflow setpoint. The setpoint shall be continuously reset proportional sash open area, based on sash position.

H. Control equations shall be of the P+I type. Microprocessor based controllers shall read the airflow, perform control calculations, and update the output to the damper a minimum of ten times per second. Floating "Gap" control will not be acceptable.

I. The controller shall output a 4-20mA electronic signal to a dedicated electronic actuator and airflow control valve, as specified elsewhere in this document. Control response time shall be sufficient to contain fumes at all times when the sash is opened.

J. The fume hood controller shall be fully configurable via a PC. Configuration shall be accomplished through an intuitive graphical interface. Fume hood controllers provided with menu driven configuration will not be acceptable.

K. The Controller shall have unoccupied mode capability based upon hood proximity or room occupancy.

2.4 FUME HOOD CONTROLLER DISPLAY

A. The fume hood controller shall provide a 4-digit display to indicate the caclulated face velocity or actual exhaust airflow in CFM. Energy use meters shall not be acceptable alternatives to the digital display of the above parameters.

B. A green LED shall indicate that face velocity is within operating condition at the fume hood. A red LED indicator shall display either a high or low face velocity alarm condition. When an alarm condition occurs, the alarm LED shall flash and the alarm beeper shall sound. The operator shall be able to silence the beeper through a mute button located on the face of the fume hood display.

C. The display shall provide the option to read in “Alpha” mode instead of numeric.

2.5 ROOM LEVEL CONTROLLERS

A. An Internet ready controller shall be field mounted and pre-programmed to provide control schemes applicable for a variety of room sequences. The controller shall be provided with a dual ARM processor and a built-in web server, with 16 Mbyte NOR Flash and 64 Mbyte SDRAM. The controller shall support BACnet and Modbus. The room level controller shall be powered by 24V AC/DC Power.

B. The controller shall be provided with a minimum of 30 input and output (IO) points which comprise of 8 digital inputs, 8 universal inputs, 8 digital outputs, 2 open collector outputs and 4 analog outputs. The controller shall be also be provided with an Ethernet port and 2 RS485 ports.

C. The controller shall be fully configurable via a lap-top computer or a PC utilizing a user-friendly Graphic User Interface software package. Display of current readings of all flows, outputs, tuning values, setpoints, and status values shall be available through this interface. Entry of control setpoints, and scaling and tuning constants shall also be provided by this interface.

D. The LACS supplier shall provide a full documentation package to the Owner on completion of the project. Documentation shall include as-built drawings, device lists, and controller configuration lists for each controller.

E. Power voltage requirements for the controllers shall be 24V AC/DC. Power can be provided by individual or centralized power transformers, provided by the installing contractor.

F. The Controller shall have the following I/O compliment:
   1. Univeral Input:
      a. Resistance mode, input range: 0-30K Ohm, 0-10K Ohm, 0-1.5K Ohm
      b. Voltage mode, input range: 0-10V, 0-5V
      c. Current mode, input range: 0-20mA, 4-20mA

d. Thermistor: 10K, 10K Shunt, 1K Balco, 1K Platinum

2. Digital Input:
   a. Voltage free contact input (Limit +/-5V at 500 Ohm resistance)
3. Digital Output:
   a. Relay Contacts, SPST NO, 48VA at 24VAC, Pilot Duty
4. Transistor Outputs:
   a. Open Collector Output, Isolation, 3.75KV
5. Analog Outputs:
   a. Voltage mode, output range: 0-10V
   b. Current mode, output range: 0-20mA, 4-20mA

2.6 SUPPORT SPACE ROOM TRACKING CONTROLLERS

A. Provide a BTL Listed Native BACnet Laboratory Airflow Control room tracking controller. Controller shall be wall mounted and pre-programmed for the room airflow and temperature control sequence. The room level controller shall be powered by 24V Power.

B. The controller shall be have a two-piece mechanical design

C. The controller shall have a color graphic LCD screen, animated icons and set-up menus for easy system configuration.

D. The controller shall have a BACnet Schedule with hardware real-time clock and 72-hour Real Time clock battery backup power.

E. The controller shall be capable of being provided with an integrated motion sensor.

F. Controller shall support and auto-detect remote temperature and occupancy sensor.

2.7 FACE VELOCITY CONTROLLER

A. The airflow at the fume hood shall vary in linear manner between two adjustable minimum and maximum flow setpoints to maintain a constant face velocity throughout this range. A minimum volume shall beset to ensure flow through the fume hood even with the sash totally closed.

B. The airflow through the sash can be sensed either by sash sensor or thought the wall sensing as follows:
   1. Through the side wall sensor shall consist of electronic velocity sensor mounted in a PVC shroud assembly. The sensor shall be hot-wire anemometer consisting of platinum elements in a glass encased assembly. The sensor shall be temperature compensated and produce a linear output voltage equivalent to 0-200 fpm. The sensor shall be mounted in accordance with the manufacturer's recommendations and shall be coordinated with the fume hood manufacturer. The sensor shall provide an accuracy of not less than 1% of 0-200 fpm and shall have the capability to be field-calibrated in the installed condition to provide for maximum installed accuracy and performance. Provide one sensor for every four horizontal feet of hood.
   2. A vertical sash sensor shall be provided to measure the height of each vertically moving fume hood sash. A horizontal sash sensor shall be provided for each pair of horizontal or overlapping sashes that are located on horizontal, combination, California, walk-in, or distillation type fume hoods.

2.8 INSULATION

A. Provide factory insulation jacket, premolded, with K valve corresponding to Title 24 standards.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The temperature control contractor shall install the sash sensors; interface the boxes, and the monitor on the fume hood. Vertical sash sensors and their stainless steel cables shall be hidden from view. Horizontal sash sensor bars shall be affixed to the individual sash panels. Sash interface boxes with interface cards shall be mounted within an accessible location. Fume hood monitors shall be surface mount.

B. The controls shall wire a dedicated, single phase 120 VAC power circuit to the laboratory control unit.

C. The controls contractor shall install 20 p.s.i. clean, pneumatic supply air to all variable volume airflow control valves specified as pneumatically actuated.

D. The controls contractor shall terminate and connect all cables as required. All cable and connectors shall be furnished by the controls contractor.

E. Linearized airflow valves shall be installed in the ductwork by the mechanical contractor. All reheat coils, and transitions shall be furnished and installed by the mechanical contractor.

3.2 SYSTEM PERFORMANCE REQUIREMENTS

A. The laboratory airflow control system shall be fully stand-alone for each individual laboratory or support area. The system shall not use or rely on information from controllers in other areas to control the functions within it's area.

B. The laboratory airflow control system shall employ individual Face Velocity controllers that directly measure the area of the fume hood sash opening and proportionally control the hood's exhaust airflow in a variable volume mode to maintain a constant face velocity over a minimum range of 20 to 100% at full sash opening. Safety and energy saving shall be insured through a corresponding minimum change in hood exhaust flow of 5 to 1. Response time shall be less than one second with no more than a 5% overshoot or undershoot. The system shall achieve 90% of its final value with a full height sash movement of one second.

C. The laboratory airflow control system shall respond and maintain specific airflow (+1-5% of signal) and stability (5% over/undershoot) within one second of a change in duct static pressure irrespective of the magnitude of pressure and/or flow the eliminate hunting, system oscillations, and cross talk between airflow controllers.

D. The laboratory airflow control system shall also maintain intersystem stability within one second of a change in pressure and/or flow to eliminate hunting, system oscillations, and cross talk between airflow controllers.

E. The laboratory airflow control system shall use volumetric offset to maintain room

pressurization. The system shall respond and maintain room pressurization (negative or positive) within one second of a change in room/system conditions.

F. The laboratory air flow control system shall employ highly accurate airflow controllers (± 5% of signal) with a minimum of 10 to 1 turndown to insure accurate pressurization at low airflows and guarantee the maximum system diversity and energy efficiency.

3.3 SYSTEM START-UP AND TRAINING

A. System start-up shall be provided by a factory authorized representative of the laboratory airflow controls manufacturer. Said start-up shall include setting of the fume hood face velocity and electronic verification of supply, makeup, general exhaust, and return airflows. The balancing contractor shall be responsible for final verification and reporting to all airflows.

B. The laboratory airflow control system manufacturer shall furnish a minimum of eight hours of training for the Owner's Representative to provide an overview of the job specific airflow control components, calibration procedures in resetting fume hood velocities, general procedures for verifying airflows of air valves, and general troubleshooting procedures.

3.4 SEQUENCE OF OPERATION

A. See drawings for sequence of operation.

3.5 PROCEDURE FOR PHYSICAL INSTALLATION OF VALVES

A. Read instruction completely prior to installing valves.

B. Note that number on valve label matches HVAC schedule.

C. Verify the correct airflow direction and orientation of the valve in the ductwork (e.g., horizontal).

D. Allow minimum of 14 in. (36 cm) of free unobstructed space around the valve for access. The valve may be installed in a 3600 rotation.

E. Linkage Connection. Many valves require field connection of pivot arm.

F. For multiple valves, assemble the valve sets on the floor using duct sealant and fasteners. Slip duct inside valve flange.

G. Use duct sealant on all valve/duct/drawband connections (or flange gasket for circular flanges).

H. Install a hangar stock to support the ductwork within 12 in. (30 cm) of the valve connection.

I. Follow the appropriate installation diagram. Note: screws, fasteners, duct sealant, hangar stock, companion flange, gaskets, and drawbands shall be provided by mechanical contractor.

J. All valves and airflow monitors installed in exhaust duct shall be installed with flanged connections and acid resistant gasketing.

K. Install factory insulation jacket or supply valves. Jacket provided by manufacturer.